Encyclopedia of
POPULATION

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Encyclopedia of POPULATION

EDITED BY
Paul Demeny
Geoffrey McNicoll

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Encyclopedia of Population

Paul Demeny

Geoffrey McNicoll

Editors in Chief

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PREFACE

Population as a field of study is concerned with the membership of human groups and categories in all their variety and with the processes of change in membership. Interest in populations and population change can be found across a wide array of disciplines in the social and biological sciences—from history and economics to epidemiology and genetics. In addition, population issues have numerous political and ethical ramifications.

The Study of Population

The study of population has a history as old as the study of society itself. Its origin as a distinct field, however, is usually traced to the classical era of political economy and in particular to the writings of Thomas Robert Malthus (usually T. R. Malthus, sometimes Robert) in the late eighteenth and early nineteenth centuries. Malthus's prominent place does not derive from his popular (largely unfounded) repute as an anti-populationist but rests on his acute and wide-ranging empirical investigations of comparative demographic regimes, exploring how economic, social, and cultural circumstances influence demographic behavior and outcomes. Separate precursors of the modern-day subject lie in the "political arithmetic" of John Graunt and other scholars a century before Malthus, out of which came the systematic treatment of mortality through life tables and actuarial analysis, and in the mathematics of population change and renewal, dating from the eighteenth century. Additional, later, factors shaping the field came from the domain of public policy: social Darwinism and eugenics (an influence later to be regretted); hygiene and public health; measures toward women's emancipation; and the discourse of human rights.

The core of population studies is the subject (to many practitioners, the discipline) of demography or demographic analysis, focusing on the quantitative dimensions of population change and its explanation—a subject that can readily extend beyond human populations to other animate and even inanimate collectivities. Demographic analysis makes substantial use of applied mathematics and statistical theory. The numbers that make up its feedstock derive from longstanding government concerns with recording "vital" events (births, marriages, deaths), from the periodic complete enumeration of a country's inhabitants through censuses of population, and, in recent decades, from a large and elaborate survey-taking industry.

These threads of theory, analysis, and policy, in various combinations, form the modern tapestry of population studies. The emerging shape of the field can be observed in the proceedings of the successive quadrennial conferences of the International Union for the Scientific Investigation of Population Problems, an organization set up in the 1920s, and its successor, the present-day International Union for the Scientific Study of Population. Various entries in this encyclopedia, notably those treating the history of demography and population thought, offer a fuller description of the evolution of the subject.

Surveys and Appraisals of the Population Field

The first formal stocktaking of the field of population was the volume *Traité de démographie,* by Adolphe Landry and collaborators (Paris, 1945). This important and pioneering treatise was never translated into English. Alfred Sauvy, one of Landry's co-authors, published his two-volume *Théorie* *générale de la population* (Paris: Presses universitaires de France) in 1952 and 1954—a study whose ambition was signified by the Keynesian echoes of its title. (A one-volume English translation, *General Theory of Population,* appeared in 1969.) For an English-speaking readership the first large-scale overview of the field was *The Study of Population: An Inventory and Appraisal,* edited by Philip M. Hauser and Otis Dudley Duncan (Chicago: University of Chicago Press, 1959)—a large and impressive work that still repays reading. In some 30 chapters, well-known scholars surveyed the elements of demography, the status of demographic research in major countries, and the place of demography in the various more established social science disciplines.

The scope of demography—concepts, the institutional makeup of the field, and a who's who of demographers—was laid out by William Petersen and Renee Petersen in their 1985 *Dictionary of Demography.* Around the same time, the first specialized encyclopedia on the subject, the *International Encyclopedia of Population,* edited by John A. Ross, was issued (New York: The Free Press, 1982). More recently, a number of assessments of the field of population have been occasioned by anniversaries. Special journal issues comprising articles that survey the state of demographic research appeared on the 50th anniversary of *Population* (the journal of the Institut national d'études démographiques, Paris) in November-December 1995, and of *Population Studies* (Population Investigation Committee, London School of Economics) in November 1996; and on the 30th anniversary of *Demography* (the journal of the Population Association of America) in November 1993.

Population matters have some place in each of the three multi-volume encyclopedias of the social sciences—published in 1930–1935, 1968, and 2001—although perhaps limited by demography's uncertain status as a discipline. (The 2001 encyclopedia accepted it as "possessing a kind of disciplinary integrity.") Various specialized encyclopedias—on aging, bioethics, economics, the environment, and so on—necessarily also give appreciable space to population. In economics, what was once a strong interest in population slowly waned over the course of the twentieth century, typified by the drop from two full chapters on the subject in F. W. Taussig's *Principles of Economics* (1911), the standard university text of the early decades of the century, to a few passing paragraphs in Gregory Mankiw's 1998 *Principles.* Much of the modest population content of *The New Palgrave* (1987), a current encyclopedic authority on economics, is concerned with the microeconomics of the family.

The Encyclopedia of Population

What is the need for an encyclopedia of population at this time? One answer would be that the world's population growth is far from over, with continuing and far-reaching effects on human society and the natural environment. Even though birth rates have declined quite steeply across much of the world, another two billion people are expected to be added to the existing six billion in the period 2000–2030—almost as many as were added in 1970–2000, the peak period of the "population explosion." Large regions of the world are still characterized by pervasive poverty, poor health conditions, and intractable problems of development—each with significant demographic dimensions.

But the main reason this encyclopedia is called for is the enlargement of the scope of the subject. In the 1980s, population issues seemed to many people to connote little else but rapid population growth and measures to curtail it. Today, population growth is one concern among many. Even a partial listing suggests the breadth of this expanded range of interest: the entrenchment of very low fertility and the growing problems of old-age support; the retreat from marriage and the diversification of family forms; new medical technologies affecting reproduction and longevity; the AIDS epidemic and the resurgence of a number of other infectious diseases; increased South-North migration and refugee movements; the press for women's equality and fuller reproductive rights; a widened array of environmental effects, notably climate change; and global shifts in the relative population sizes of countries. The evolutionary bases of human development and behavior have received renewed attention, with insights drawn from radical advances in genomic research and from comparisons with other species. Many of these topics have ethical debates associated with them—longstanding, like abortion and asylum-seeking, or newfound, like genetic engineering and animal rights. Along with such contemporary issues, research on population history and prehistory has proceeded apace, settling some controversies and raising others. All this is territory staked out by the *Encyclopedia of Population.*

The *Encyclopedia of Population* is directed both to professionals in the population sciences reading outside their immediate areas of expertise and to other social scientists, college students, advanced high school students, and the educated lay reader. Catering to this range of readership is challenging. An effort is made to avoid material and jargon that would require prior specialized knowledge, but without losing significant detail through undue simplification. (Characterizations of persons named in the text of articles by their nationality or profession are included for the same reason, even when such information would be well known to many users.) Where a topic requires technical treatment, it receives it, or the reader is referred to appropriate further sources. However, the Encyclopedia is not intended to serve as a textbook on its field. If it has an ambition beyond the utilitarian it is to push out the boundaries of the subject—an ambition that stands in contrast to that implicitly set by the Population Association of America, whose journal prominently defines its scope as being "the statistical study of human populations."

Not a few topics in population studies are contentious, either in terms of research findings or, more basically, in terms of their political and ethical premises or implications. Unsurprisingly, the various authors writing on matters related to such topics may often take differing positions. We have not sought to suppress those differences, but rather to ensure a rough overall degree of balance among the articles.

The *Encyclopedia* contains 336 articles by a total of 278 authors. The contributors are all accomplished scholars, their expertise spanning a wide range of fields: biology, demography, economics, geography, history, law, philosophy, political science, public health, sociology. Many of the articles are short entries of 500–1000 words of text; only a relatively few are longer than 3000 words. Within this range, length is roughly dictated by the scope of the topic; the level of technicality is governed by what is required to explain it.

Among the short entries are 60 biographies of persons selected from those whose work has been important in the development of population studies, whether or not they were seen (or saw themselves) as "population" people. Compiling such a list entails many somewhat arbitrary choices and no two lists would be the same. In the present case, contributors to technical demography will be less in evidence in the encyclopedia than persons whose work has been influential in the development of population thought more broadly. Invidious choice among presently active scholars has been avoided by including only persons born in or before 1930, or deceased.

A thematic overview of the *Encyclopedia of Population* is given in the Topical Outline, which follows the List of Authors in the frontmatter . The Outline may be particularly helpful to students who wish to find population-related information relevant to their studies in other fields but who do not have in mind a particular topical entry. A student in environmental studies, for example, could narrow his or her search within the sixteen articles listed under the heading Environment and Resources; a political science student might scan the eleven articles listed under Political Demography, and perhaps also the ten under Population Policy.

The Population Tables at the end of the second volume presents four summary tables showing statistics on population size, rates of change, area, and density, by country, for countries of 10 million population and over. (These countries contain over 90% of the world's population.)

We hope readers of the *Encyclopedia* will find in it much material that is new to them. A test of such a work, in addition to its reference function, is the extent to which it repays browsing and offers the casual serendipitous discovery or insight. Inevitably, occasional gaps in coverage will be found. Some of these may reflect particular editorial decisions; others result from nondelivery of promised articles (the proportion of such defaults, some 7%, is relatively low for enterprises such as this). We would hope, like the editors of *The New Palgrave* (p. x), that "such errors of omission and commission . . . are unbiased, in almost every sense of the word."

Our main acknowledgment is of the encyclopedia's contributors, for their work and sometimes for their forbearance of editorial intrusiveness. Assistance from members of the committee of Editorial Advisors is also much appreciated. At Macmillan Reference, Jill Lectka, Monica Hubbard, and Nicole Watkins were efficient and congenial counterparts; to them also should go credit for ensuring that the project kept not too far behind its schedule. At the Population Council, Robert Colasacco provided administrative and secretarial assistance. The overall institutional support of the Population Council was an essential factor in the undertaking.

PAUL DEMENY
GEOFFREY MCNICOLL
NEW YORK, MARCH 2003

LIST OF ARTICLES

LIST OF CONTRIBUTORS

John A. Agnew
University of California, Los Angeles
GEOPOLITICS

Dennis Ahlburg
University of Minnesota; University of Southampton, England
ECONOMIC-DEMOGRAPHIC MODELS

John Alcock
Arizona State University
SOCIOBIOLOGY

Margo Anderson
University of Wisconsin, Milwaukee
CENSUS

Douglas L. Anderton
University of Massachusetts, Amherst
DISEASE, CONCEPTS AND CLASSIFICATION OF

Adria N. Armbrister
Mount Vernon, New York
IMMIGRATION, UNAUTHORIZED

Fred Arnold
ORC Macro, Calverton, Maryland
DEMOGRAPHIC AND HEALTH SURVEYS
GENDER PREFERENCES FOR CHILDREN

Nan Marie Astone
Johns Hopkins University
SOCIAL CAPITAL

Judith Banister
Beijing Javelin Consulting Company; Hong Kong University
ONE-CHILD POLICY

David B. Barrett
World Evangelization Research Center, Richmond, Virginia
RELIGIOUS AFFILIATION

Alaka Malwade Basu
Cornell University
CASTE

Eva Bernhardt
Stockholm University, Sweden
COHABITATION

Robert L. Bettinger
University of California, Davis
HUNTER-GATHERERS

Francesco C. Billari
Università Bocconi, Milan, Italy
LIFE COURSE ANALYSIS

Jean-Noël Biraben
Institut National d'Études Démographiques, Paris
WORLD POPULATION GROWTH

Alain Blum
Institut National d'Études Démographiques, Paris, France
FAMINE IN THE SOVIET UNION

Barry Bogin
University of Michigan, Dearborn
ANTHROPOMETRY

Donald J. Bogue
University of Chicago
HUMAN ECOLOGY

Jesper L. Boldsen
University of Southern Denmark, Odense
PREHISTORIC POPULATIONS: EUROPE

John Bongaarts
Population Council, New York
FERTILITY, PROXIMATE DETERMINANTS OF

Heather Booth
Australian National University, Canberra
POPULATION DYNAMICS

George J. Borjas
Harvard University
IMMIGRATION, BENEFITS AND COSTS OF

Nick Bostrom
Yale University
EXTINCTION, HUMAN

Patrice Bourdelais
École des Hautes Études en Sciences Sociales (EHESS), Paris
BERTILLON, JACQUES
FARR, WILLIAM

Christopher R. Browning
Ohio State University
CRIME, DEMOGRAPHY OF

John C. Caldwell
Australian National University, Canberra
DEMOGRAPHY, HISTORY OF
POPULATION ORGANIZATIONS: PROFESSIONAL ASSOCIATIONS

James R. Carey
University of California, Davis
LIFE SPAN

Bruce A. Carnes
Center on Aging NORC, University of Chicago
AGING AND LONGEVITY, BIOLOGY OF

John B. Casterline
Population Council, New York
DEMOGRAPHIC TRANSITION
FREEDMAN, RONALD

Joseph Chamie
United Nations Population Division, New York
POPULATION ORGANIZATIONS: UNITED NATIONS SYSTEM

Tony Champion
University of Newcastle upon Tyne, England
CITIES, FUTURE OF
SUBURBANIZATION

Christopher Chase-Dunn
University of California, Riverside
CITIES, SYSTEMS OF

Andrew J. Cherlin
Johns Hopkins University
FAMILY DEMOGRAPHY

Jean-Claude Chesnais
Institut National d'Études Démographiques, Paris, France
LANDRY, ADOLPHE
SAUVY, ALFRED

John I. Clarke
University of Durham, England
SEX RATIO

Lynda Clark
Centre for Population Studies, London School of Hygiene and Tropical Medicine, England
GRANDPARENTHOOD

John Cleland
London School of Hygiene and Tropical Medicine, England
MORTALITY-FERTILITY RELATIONSHIPS
WORLD FERTILITY SURVEY

Samuel Cohn, Jr.
University of Glasgow, Scotland
BLACK DEATH

David Coleman
University of Oxford, England
KEYNES, JOHN MAYNARD
POPULATION DECLINE

Michel P. Coleman
Cancer and Public Health Unit, London School of Hygiene and Tropical Medicine, England
CANCER

John Connell
University of Sydney, Australia
MICROSTATES, DEMOGRAPHY OF

Rebecca J. Cook
University of Toronto, Canada
REPRODUCTIVE RIGHTS

Eileen M. Crimmins
University of Southern California
DISABILITY, DEMOGRAPHY OF

Gretchen C. Daily
Stanford University
CARRYING CAPACITY

David Dalby
Linguasphere Observatory, Wales
LANGUAGES AND SPEECH COMMUNITIES

Herman E. Daly
University of Maryland
LIMITS TO GROWTH

Joel Darmstadter
Resources for the Future, Washington, D.C.
ENERGY AND POPULATION

Partha Dasgupta
St. John's College, University of Cambridge, England
COMMON PROPERTY RESOURCES
EXTERNALITIES OF POPULATION CHANGE

Paul A. David
Stanford University; All Souls College, Oxford, England
FERTILITY CONTROL, INDIRECT MEASUREMENT OF

Henk A. de Gans
University of Amsterdam, Netherlands
PEARL, RAYMOND

Paul Demeny
Population Council, New York
BOSERUP, ESTER
HARDIN, GARRETT
POPULATION POLICY

Bernard M. Dickens
University of Toronto, Canada
REPRODUCTIVE TECHNOLOGIES: ETHICAL ISSUES

Peter J. Donaldson
Population Reference Bureau, Washington, D.C.
BERELSON, BERNARD

D. Peter Drotman
Emory University School of Medicine; National Center for Infectious Diseases, Atlanta, Georgia
DISEASES, INFECTIOUS

Tim Dyson
London School of Economics, England
FAMINE IN SOUTH ASIA
FOOD SUPPLY AND POPULATION

Richard A. Easterlin
University of Southern California
KUZNETS, SIMON
THOMAS, DOROTHY SWAINE

Nicholas Eberstadt
American Enterprise Institute, Washington, D.C.
COMMUNISM, POPULATION ASPECTS OF

Anne H. Ehrlich
Stanford University
ECOLOGICAL PERSPECTIVES ON POPULATION

Paul Ehrlich
Stanford University
ECOLOGICAL PERSPECTIVES ON POPULATION

Paula England
Northwestern University
FEMINIST PERSPECTIVES ON POPULATION ISSUES

Thomas J. Espenshade
Office of Population Research, Princeton University
BLAKE, JUDITH

Norman Etherington
University of Western Australia, Perth
WAR, DEMOGRAPHIC CONSEQUENCES OF

Malin Falkenmark
Stockholm International Water Institute, Sweden
WATER AND POPULATION

Jane Falkingham
University of Southampton, England
WELFARE STATE

Griffith Feeney
Scarsdale, New York
DATA ASSESSMENT
LEXIS DIAGRAM
MOMENTUM OF POPULATION GROWTH

Lois A. Fingerhut
Centers for Disease Control and Prevention, National Center for Health Statistics, Hyattsville, Maryland
ACCIDENTS

Jason L. Finkle
University of Michigan
CONFERENCES, INTERNATIONAL POPULATION

Jochen Fleischhacker
Max Planck Institute for Demographic Research, Rostock, Germany
MARX, KARL

Warwick Fox
University of Central Lancashire, England
ENVIRONMENTAL ETHICS

Odile Frank
United Nations, Department of Economic and Social Affairs, New York
ABSTINENCE

Mary Anne Freedman
National Center for Health Statistics, Hyattsville, Maryland
VITAL STATISTICS

Gary P. Freeman
University of Texas, Austin
IMMIGRATION POLICIES

Paul K. Freeman
University of Denver
DISASTERS

R. G. Frey
Bowling Green State University
EUTHANASIA

William H. Frey
University of Michigan
INTERNAL MIGRATION

Tom Fricke
University of Michigan
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Frank F. Furstenberg
University of Pennsylvania
FAMILY: FUTURE

Anne H. Gauthier
University of Calgary, Canada
FAMILY ALLOWANCES

Leonid A. Gavrilov
Center on Aging, NORC, University of Chicago
AGING OF POPULATION

Nigel Gilbert
University of Surrey, England
ARTIFICIAL SOCIAL LIFE

Jeanne Gobalet
Lapkoff & Gobalet Demographic Research, Inc., Saratoga, California
STATE AND LOCAL GOVERNMENT DEMOGRAPHY

Joshua R. Goldstein
Princeton University
DIVORCE

Jack A. Goldstone
University of California, Davis
NATIONAL SECURITY AND POPULATION

Emily Grundy
Centre for Population Studies, London School of Hygiene and Tropical Medicine, England
GRANDPARENTHOOD

Thomas Gryn
Ohio State University
LONGITUDINAL DEMOGRAPHIC SURVEYS

Michel Guillot
University of Wisconsin, Madison
EVENT-HISTORY ANALYSIS
LIFE TABLES

John G. Haaga
Population Reference Bureau, Washington, D.C.
POPULATION ORGANIZATIONS: RESEARCH INSTITUTIONS

Michael R. Haines
Colgate University
TRANS-ATLANTIC MIGRATION

Catherine Hakim
London School of Economics, England
PARENTHOOD

Eugene A. Hammel
University of California, Berkeley
ANTHROPOLOGICAL DEMOGRAPHY

Michael T. Hannan
Stanford University
ORGANIZATIONS, DEMOGRAPHY OF

Henry C. Harpending
University of Utah
ARCHAEOGENETICS

Carl Haub
Population Reference Bureau, Washington, D.C.
FERTILITY MEASUREMENT
MORTALITY MEASUREMENT

Adrian C. Hayes
Johns Hopkins University
ACTION THEORY IN POPULATION RESEARCH

Jacqueline Hecht
Institut National d'Études Démographiques, Paris, France
ARIÈS, PHILIPPE
SÜSSMILCH, JOHANN

David M. Heer
University of California, San Diego
DAVIS, KINGSLEY

Judith Helzner
John D. and Catherine T. MacArthur Foundation, Chicago
REPRODUCTIVE HEALTH

Stanley K. Henshaw
Alan Guttmacher Institute, New York
INDUCED ABORTION: LEGAL ASPECTS
INDUCED ABORTION: PREVALENCE

Donald J. Hernandez
State University of New York, Albany
RACIAL AND ETHNIC COMPOSITION

Patrick Heuveline
NORC & Population Research Center, University of Chicago
AGING OF POPULATION

Allan G. Hill
Harvard School of Public Health
FAMINE IN AFRICA

Kenneth Hill
Johns Hopkins University
BRASS, WILLIAM
ESTIMATION METHODS, DEMOGRAPHIC

Charles Hirschman
University of Washington
FERTILITY TRANSITION, SOCIOECONOMIC DETERMINANTS OF

Peter Hiscock
Australian National University, Canberra
PREHISTORIC POPULATIONS: AUSTRALIA AND THE PACIFIC

Dennis Hodgson
Fairfield University
NOTESTEIN, FRANK W.
POPULATION THOUGHT, CONTEMPORARY
THOMPSON, WARREN S.

Dennis Hogan
Brown University
SOCIAL INSTITUTIONS

Robert D. Hoppa
University of Manitoba, Canada
PREHISTORIC POPULATIONS: THE AMERICAS

Shiro Horiuchi
Rockefeller University
MORTALITY, AGE PATTERNS OF

Graeme Hugo
University of Adelaide, Australia
GEOGRAPHIC INFORMATION SYSTEMS
RESETTLEMENT

Serguey Ivanov
United Nations Population Division, New York
FERTILITY, AGE PATTERNS OF

David K. Jesuit
Luxembourg Income Study, Luxembourg
POVERTY AND INCOME

S. Ryan Johansson
University of Cambridge, England
EPIDEMICS
HEALTH TRANSITION

Andrew Jorgenson
University of California, Riverside
CITIES, SYSTEMS OF

Todd M. Johnson
Gordon-Conwell Theological Seminary
RELIGIOUS AFFILIATION

Gavin W. Jones
Australian National University, Canberra
CALDWELL, JOHN C.
URBANIZATION

M.W. Jones-Lee
University of Newcastle upon Tyne, England
VALUE OF LIFE, ECONOMIC

Debra S. Judge
University of Western Australia, Perth
PRIMATE DEMOGRAPHY

Vasantha Kandiah
United Nations Population Division, New York
CONTRACEPTIVE PREVALENCE
FERTILITY, AGE PATTERNS OF

Hillard Kaplan
University of New Mexico
EVOLUTIONARY DEMOGRAPHY

Lynn A. Karoly
RAND
LABOR FORCE

Laura Katzive
Center for Reproductive Law and Policy, New York
INDUCED ABORTION: LEGAL ASPECTS

Nathan Keyfitz
Harvard University
EULER, LEONHARD
WHELPTON, P. K.

Leslie J. King
McMaster University, Hamilton, Canada
CENTRAL PLACE THEORY

Stephan Klasen
University of Munich, Germany
SEX SELECTION

Herbert S. Klein
Columbia University
AFRICAN-AMERICAN POPULATION HISTORY

Hans-Peter Kohler
University of Pennsylvania
FERTILITY, BELOW-REPLACEMENT

Laurence J. Kotlikoff
Boston University
GENERATIONAL ACCOUNTING

Philip Kreager
Somerville College, Oxford University, England
GRAUNT, JOHN
POPULATION THOUGHT, HISTORY OF

Shepard Krech III
Brown University
ENVIRONMENTAL IMPACT, HUMAN

Lauren J. Krivo
Ohio State University
CRIME, DEMOGRAPHY OF

Steven Kull
Program on International Policy Attitudes, Washington, D.C.
PUBLIC OPINION ON POPULATION ISSUES

Lewis H. Kuller
University of Pittsburgh
CARDIOVASCULAR DISEASE

David Lam
University of Michigan
BECKER, GARY S.

C. M. Langford
London School of Economics, England
CANNAN, EDWIN
GLASS, DAVID
KUCZYNSKI, R. R.

Ulla Larsen
Harvard University
INFERTILITY

Edward O. Laumann
University of Chicago
SEXUALITY, HUMAN

Jacques Ledent
Université du Québec, Canada
KEYFITZ, NATHAN

Barrett A. Lee
Pennsylvania State University
RESIDENTIAL SEGREGATION

Ronald Lee
University of California, Berkeley
AGE STRUCTURE AND DEPENDENCY
INTERGENERATIONAL TRANSFERS

Jacques Légaré
Université de Montréal, Canada
RYDER, NORMAN B.

Henri Leridon
Institut National d'Études Démographiques, Paris, France
HENRY, LOUIS
NATURAL FERTILITY

Ron Lesthaeghe
Vrije Universiteit Brussel, Belgium
QUETELET, ADOLPHE
VERHULST, PIERRE-FRANÇOIS

David Levine
OISE; University of Toronto, Canada
FAMILY RECONSTITUTION
LITERACY

Alexandra M. Levitt
National Center for Infectious Diseases, Atlanta, Georgia
DISEASES, INFECTIOUS

Massimo Livi-Bacci
University of Florence, Italy
PEOPLING OF THE CONTINENTS

Cynthia B. Lloyd
Population Council, New York
EDUCATION

Alan D. Lopez
World Health Organization, Geneva, Switzerland
DISEASE, BURDEN OF
TOBACCO-RELATED MORTALITY

Wolfgang Lutz
International Institute for Applied Systems Analysis, Laxenburg, Austria
PROJECTIONS AND FORECASTS, POPULATION

Alphonse L. MacDonald
Université René Descartes, Paris, France
FAMINE IN CHINA

POPULATION ORGANIZATIONS: NATIONAL AND INTERNATIONAL AGENCIES

F. Landis MacKellar
International Institute for Applied Systems Analysis, Laxenburg, Austria
HOMICIDE AND SUICIDE
SIMON, JULIAN L.

Rainer Mackensen
Technical University of Berlin, Germany
LÖSCH, AUGUST
SOMBART, WERNER

Diane J. Macunovich
Barnard College, Columbia University
CYCLES, POPULATION
EASTERLIN, RICHARD A.

Deborah Maine
Columbia University
MATERNAL MORTALITY

Patrick Manning
Northeastern University
SLAVERY, DEMOGRAPHY OF

Peter Marden
RMIT University, Melbourne, Australia
STATES SYSTEM, DEMOGRAPHIC HISTORY OF

Robert D. Mare
University of California, Los Angeles
SOCIAL MOBILITY

Howard Margolis
University of Chicago
RISK

Douglas S. Massey
University of Pennsylvania
INTERNATIONAL MIGRATION

Luigi Mastroianni, Jr.
University of Pennsylvania
REPRODUCTIVE TECHNOLOGIES: MODERN METHODS

Pauline M. H. Mazumdar
University of Toronto
EUGENICS

Peter McDonald
Australian National University, Canberra
FAMILY POLICY

C. Alison McIntosh
Melbourne, Australia
CONFERENCES, INTERNATIONAL POPULATION

Roderick J. McIntosh
Rice University
CLIMATE CHANGE AND POPULATION: HISTORY

A. J. McMichael
Australian National University, Canberra
ENVIRONMENTAL HEALTH

Geoffrey McNicoll
Population Council, New York
DEVELOPMENT, POPULATION AND
KING, GREGORY
MILL, JOHN STUART
OPTIMUM POPULATION
PETTY, WILLIAM
POPULATION

Barbara S. Mensch
Population Council, New York
ADOLESCENT FERTILITY

Thomas W. Merrick
World Bank Institute, Washington, D.C.
HEALTH SYSTEMS

France Meslé
Institut National d'Études Démographiques, Paris, France
CAUSES OF DEATH

Deborah Waller Meyers
Migration Policy Institute, Washington, D.C.
TEMPORARY MIGRATION

Geraldine P. Mineau
University of Utah
GENEALOGICAL RECORDS

Armindo Miranda
Chr. Michelson Institute, Bergen, Norway
BIBLIOGRAPHIC AND ONLINE RESOURCES

S. Philip Morgan
Duke University
BABY BOOM, POST–WORLD WAR II
FAMILY SIZE INTENTIONS

Martina Morris
University of Washington
SIMULATION MODELS

Peter A. Morrison
RAND, Santa Monica, California
BUSINESS DEMOGRAPHY

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Columbia University
EMERGING INFECTIOUS DISEASES

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Dryland Research, Somerset, England
TECHNOLOGICAL CHANGE AND POPULATION GROWTH

Frank Mott
Ohio State University
LONGITUDINAL DEMOGRAPHIC SURVEYS

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University of Auckland, New Zealand
FUTURE GENERATIONS, OBLIGATIONS TO

Rainer Münz
Humboldt University, Berlin, Germany
IMMIGRATION TRENDS IN MAJOR DESTINATION COUNTRIES

Krishnan Namboodiri
Ohio State University
AGE MEASUREMENT

Andrew Noymer
University of California, Berkeley
INFLUENZA
TUBERCULOSIS

Cormac Ó Gráda
University College Dublin, Ireland
FAMINE, CONCEPTS AND CAUSES OF
FAMINE IN IRELAND

Brian C. O'Neill
International Institute for Applied Systems Analysis, Laxenburg, Austria; Brown University
CLIMATE CHANGE AND POPULATION: FUTURE
PROJECTIONS AND FORECASTS, POPULATION

Philip E. Ogden
Queen Mary College, University of London, England
DENSITY AND DISTRIBUTION OF POPULATION
GEOGRAPHY, POPULATION

S. Jay Olshansky
University of Illinois, Chicago
AGING AND LONGEVITY, BIOLOGY OF

José Antonio Ortega
Universidad Autónoma de Madrid, Spain
FERTILITY, BELOW-REPLACEMENT

Lars Østby
Statistics Norway, Oslo
POPULATION REGISTERS

Anthony Paik
University of Chicago
SEXUALITY, HUMAN

Alberto Palloni
University of Wisconsin
DIFFUSION IN POPULATION THEORY

Demetrios G. Papademetriou
Migration Policy Institute, Washington, D.C.
LABOR MIGRATION, INTERNATIONAL

John Parkington
University of Cape Town, South Africa
PREHISTORIC POPULATIONS: AFRICA

Jack Parsons
Population Policy Press, Wales
LEBENSRAUM

Erin Patrick
Migration Policy Institute, Washington, D.C.
REFUGEES, DEMOGRAPHY OF

Anne R. Pebley
University of California, Los Angeles
INFANT AND CHILD MORTALITY

Mark Perlman
University of Pittsburgh
LEIBENSTEIN, HARVEY

William Petersen
Carmel, California
CONDORCET, MARQUIS DE
GODWIN, WILLIAM

James F. Phillips
Population Council, New York
DEMOGRAPHIC SURVEILLANCE SYSTEMS

Gilles Pison
Institut National d'Études Démographiques, Paris, France
MULTIPLE BIRTHS

Andrejs Plakans
Iowa State University
FAMILY: HISTORY

Kari Poikolainen
Finnish Foundation for Alcohol Studies, Helsinki, Finland
ALCOHOL, HEALTH EFFECTS OF

Robert A. Pollak
Washington University in St. Louis
FAMILY BARGAINING

John H. Pollard
Macquarie University, Australia
ACTUARIAL ANALYSIS

Geoffrey G. Pope
William Paterson University
PREHISTORIC POPULATIONS: ASIA

Dudley L. Poston, Jr.
Texas A&M University
CHINESE, OVERSEAS

Joseph E. Potter
University of Texas, Austin
MASS MEDIA AND DEMOGRAPHIC BEHAVIOR

David Malcolm Potts
University of California, Berkeley
BIRTH CONTROL, HISTORY OF
SANGER, MARGARET

Mary G. Powers
Fordham University
OCCUPATION AND INDUSTRY

Kenneth Prandy
Cardiff University, Wales
SOCIAL REPRODUCTION

Samuel H. Preston
University of Pennsylvania
FAMILY SIZE DISTRIBUTION

Thomas W. Pullum
University of Texas, Austin
FAMILY LIFE CYCLE

Radhika Ramasubban
Centre for Social and Technological Change, Mumbai, India
WOMEN'S STATUS AND DEMOGRAPHIC BEHAVIOR

Sara Randall
University College London, England
NOMADS

Jai Ranganathan
Stanford University
CARRYING CAPACITY

Tom Regan
Culture and Animals Foundation, Raleigh, North Carolina
ANIMAL RIGHTS

Robert E. Ricklefs
University of Missouri, St. Louis
ANIMAL ECOLOGY

James C. Riley
Indiana University, Bloomington
DISEASE AND HISTORY

Nancy E. Riley
Bowdoin College
GENDER

Jean-Marie Robine
INSERM, Montpellier, France
EPIDEMIOLOGICAL TRANSITION
OLDEST OLD

Kim Rodgers
Redefining Progress, Oakland, California
SUSTAINABLE DEVELOPMENT

Osamu Saito
Hitotsubashi University, Tokyo, Japan
HAYAMI, AKIRA

Warren C. Sanderson
State University of New York, Stony Brook
FERTILITY CONTROL, INDIRECT MEASUREMENT OF

Jean-Paul Sardon
Institut National d'Études Démographiques, Paris, France
CHILDLESSNESS

Italo Scardovi
Università di Bologna, Italy
BOTERO, GIOVANNI
GINI, CORRADO
PARETO, VILFREDO

Walter Scheidel
University of Chicago
ANCIENT WORLD, DEMOGRAPHY OF

Robert Schoen
Pennsylvania State University
PARTNER CHOICE

Sheldon J. Segal
Population Council, New York
CONTRACEPTION, MODERN METHODS OF
SPONTANEOUS ABORTION

Peter Selman
University of Newcastle upon Tyne, England
ADOPTION

William Seltzer
Fordham University
DATA COLLECTION, ETHICAL ISSUES IN
GENOCIDE
HOLOCAUST

Harry L. Shipman
University of Delaware
OUTER SPACE, COLONIZATION OF

Vladimir M. Shkolnikov
Max Planck Institute for Demographic Research, Rostock, Germany
MORTALITY REVERSALS

Susan Short
Brown University
SOCIAL INSTITUTIONS

Lionel Shriver
London, England
LITERATURE, POPULATION IN

John Simons
London School of Hygiene and Tropical Medicine, England
RELIGIONS, POPULATION DOCTRINES OF

Steven W. Sinding
International Planned Parenthood Federation, London, England
FAMILY PLANNING PROGRAMS

Susheela Singh
Alan Guttmacher Institute, New York
ADOLESCENT FERTILITY

Timothy M. Smeeding
Syracuse University; Luxembourg Income Study, Luxembourg
POVERTY AND INCOME DISTRIBUTION

Vaclav Smil
University of Manitoba, Canada
DIETARY REGIMES
NATURAL RESOURCES AND POPULATION
NITROGEN CYCLE

Ken R. Smith
University of Utah
GENEALOGICAL RECORDS

Richard M. Smith
University of Cambridge, England
HISTORICAL DEMOGRAPHY
LASLETT, PETER

Stanley K. Smith
University of Florida
BUSINESS DEMOGRAPHY
SMALL-AREA ANALYSIS

Timothy Snyder
Yale University
ETHNIC CLEANSING

Edward J. Spar
Council of Professional Associations on Federal Statistics, Alexandria, Virginia
DATABASES, DEMOGRAPHIC

Eric Stallard
Duke University
DISEASES, CHRONIC AND DEGENERATIVE

Katrina Stamas
Columbia University
MATERNAL MORTALITY

Richard H. Steckel
Ohio State University
NUTRITION AND CALORIE CONSUMPTION

Karl Steyaert
Redefining Progress, Oakland, California
SUSTAINABLE DEVELOPMENT

Ross M. Stolzenberg
University of Chicago
RISK

J. Edward Taylor
University of California, Davis
MIGRATION MODELS

John Taylor
Australian National University, Canberra
INDIGENOUS PEOPLES

Lars-Göran Tedebrand
Umeå University, Sweden
WICKSELL, KNUT

Michael S. Teitelbaum
Alfred P. Sloan Foundation, New York
ETHNIC AND NATIONAL GROUPS

Pál Péter Tóth
Hungarian Central Statistical Office, Demographic Research Institute, Budapest
KŐRÖSI, JÓZSEF

James Trussell
Princeton University
COALE, ANSLEY JOHNSON
FECUNDITY

Shripad Tuljapurkar
Stanford University
BIOLOGY, POPULATION
RENEWAL THEORY AND THE STABLE POPULATION MODEL

Peter Uhlenberg
University of North Carolina
VALUES AND DEMOGRAPHIC BEHAVIOR

Martin Vaessen
ORC Macro, Calverton, Maryland
DEMOGRAPHIC SURVEYS, HISTORY AND METHODOLOGY OF

Tapani Valkonen
University of Helsinki, Finland
MORTALITY DIFFERENTIALS, SOCIOECONOMIC

Dirk J. van de Kaa
University of Amsterdam, Netherlands
JOURNALS, POPULATION
SECOND DEMOGRAPHIC TRANSITION

Etienne van de Walle
University of Pennsylvania
CANTILLON, RICHARD
DUMONT, ARSÈNE
INDUCED ABORTION: HISTORY
INFANTICIDE
MOHEAU, JEAN-BAPTISTE

Evert van Imhoff
Netherlands Interdisciplinary Demographic Institute, The Hague, Netherlands
COHORT ANALYSIS

Bernard M. S. van Praag
University of Amsterdam, Netherlands
COST OF CHILDREN

Joanne van Selm
Migration Policy Institute, Washington, D.C.
ASYLUM, RIGHT OF
FORCED MIGRATION

James W. Vaupel
Max Planck Institute for Demographic Research, Rostock, Germany
BIODEMOGRAPHY
GOMPERTZ, BENJAMIN
LOTKA, ALFRED J.

Daniel R. Vining, Jr.
University of Pennsylvania
QUALITY OF POPULATION

Kenneth W. Wachter
University of California, Berkeley
STOCHASTIC POPULATION THEORY

Mathis Wackernagel
Redefining Progress, Oakland, California
SUSTAINABLE DEVELOPMENT

Paul E. Waggoner
Connecticut Agricultural Experiment Station, New Haven
DEFORESTATION
LAND USE

Linda J. Waite
University of Chicago
MARRIAGE

Ingrid Waldron
University of Pennsylvania
MORTALITY DIFFERENTIALS, BY SEX

John Waller
Wellcome Trust Centre for the History of Medicine, University College London, England
GALTON, FRANCIS

Hartmut S. Walter
University of California, Los Angeles
BIOGEOGRAPHY

Susan Cotts Watkins
University of Pennsylvania
SOCIAL NETWORKS

Michael S. Watson
American College of Medical Genetics, Bethesda, Maryland
GENETIC TESTING

James A. Weed
National Center for Health Statistics, Hyattsville, Maryland
VITAL STATISTICS

John R. Weeks
San Diego State University
REMOTE SENSING

Charles F. Westoff
Princeton University
TAEUBER, IRENE B.
UNWANTED FERTILITY

Michael J. White
Brown University
RURAL-URBAN BALANCE

Frans Willekens
University of Groningen, Netherlands
MULTISTATE DEMOGRAPHY

Robert J. Willis
University of Michigan
MICROECONOMICS OF DEMOGRAPHIC BEHAVIOR

John R. Wilmoth
University of California, Berkeley
MORTALITY DECLINE

Chris Wilson
Max Planck Institute for Demographic Research, Rostock, Germany
HOMEOSTASIS

Donald Winch
University of Sussex, England
DARWIN, CHARLES
MALTHUS, THOMAS ROBERT

Barbara L. Wolfe
University of Wisconsin, Madison
FERTILITY, NONMARITAL

James W. Wood
Pennsylvania State University
PALEODEMOGRAPHY

Robert Woods
University of Liverpool, England
CITIES, DEMOGRAPHIC HISTORY OF

Basia Zaba
Centre for Population Studies, London School of Hygiene and Tropical Medicine, England
AIDS

Zhongwei Zhao
University of Cambridge, England
HOUSEHOLD COMPOSITION

TOPICAL OUTLINE

The classification of articles that follows provides a thematic view of the encyclopedia's contents, depicting overall coverage in the various familiar divisions of the field of population studies. It is also intended to assist the user, whether researcher or browser, in locating articles broadly related to a given topic. This purpose would be defeated if articles that clearly belong under more than one category were listed only once. For example, Sex Selection might be sought under either Ethical Issues or Reproduction and Birth Control. To prevent the listing from becoming too large, however, only articles where the case for multiple entry is compelling (about one in six) are so treated. Where two categories are closely related, such as Mortality and Health on the one hand and Disease and Disability on the other, articles appear in only one of them. A more detailed means of finding cognate material is through the list of cross-references shown after each article. For finer-grained access to the encyclopedia's contents, the index should be consulted.

Biographies are not included among the articles listed in the substantive classification. They appear in the subsequent list, ordered by date of birth and grouped by the century in which the subject's main work was done.

A

ABORIGINAL DEMOGRAPHY

See *Indigenous Peoples*

ABORTION

See *Induced Abortion; Spontaneous Abortion*

ABSTINENCE

Abstinence is a state of nonengagement in sexual relations, whether voluntary or involuntary. It applies to a situation prevailing for months or years, or to a recurring situation, as in periodic abstinence. Abstinence can serve to regulate sexual activity per se, or to regulate one of the outcomes of sexual activity: fertility and transmission of disease. Abstinence is typically a function of age, sex, marital status, fecundity status, and fecundability status. Sociocultural factors influence the prevalence of abstinence, either through these characteristics or by direct influence on sexual activity (e.g., observance of celibacy, virginity, cessation of childbearing at grandmotherhood).

Abstinence prevails before sexual maturity. Where sexual maturity precedes regular exposure to intercourse, abstinence depends on customs regulating age at marriage and tolerance of sexual intercourse before marriage. Abstinence before and outside marriage is often related to gender. Women abstain more than men, most often to reduce the risk of pregnancy outside marriage, which is not tolerated in many societies.

In marriage, voluntary abstinence by women tends to occur during menstruation and pregnancy, and after delivery. Otherwise abstinence occurs principally among women for contraceptive reasons, taking three forms: periodic abstinence methodically timed to coincide with ovulation; postpartum abstinence to delay a subsequent pregnancy; and terminal abstinence to cease childbearing. Involuntary abstinence occurs also among women, influenced by their marital status (single, divorced, widowed) and duration of marriage (frequency of sexual relations declines with marriage duration).

Historically, abstinence was practiced in order to confine fertility to marital unions and to regulate marital fertility, often in conjunction with other traditional methods of fertility regulation such as withdrawal (*coitus interruptus*), abortion, or even infanticide. It occurs less for these purposes today, except in Africa. In the 1980s and 1990s, abstinence was recommended, particularly to young persons, as a means of reducing HIV/AIDS transmission, but the extent to which this advocacy has altered behavior is not clear.

Historically, long durations of postpartum abstinence were practiced in Africa. Regardless of reported reasons, abstinence improved survival chances of newborns by protecting breastfeeding from curtailment by a subsequent pregnancy. Long durations of abstinence are still found in West Africa; they have shortened substantially in East Africa, and are intermediate in length in Central and Southern Africa.

Postpartum abstinence makes a contribution to nonsusceptibility to the risk of pregnancy and thus lowers fertility, complementing the effect of lactational amenorrhea (suppression of menstruation). In 22 comparative country surveys in sub-Saharan Africa around 2000, abstinence duration exceeded lactational amenorrhea in only six cases. However, the nonsusceptible period was lengthened by abstinence in all cases, because many women who abstain are not protected by amenorrhea (the reverse also holds). In the surveys, amenorrhea ranged from 8 to 19 months, postpartum abstinence from 2 to 22 months. On average in the 22 countries, an abstinence duration of eight months extended amenorrhea by four months.

Four of ten women reporting current abstinence in African surveys are not practicing abstinence to prevent a subsequent pregnancy: An unknown proportion of this nonspecific abstinence may be involuntary. Similarly, in six national surveys in Europe, among all women 20 years and older, from one in four to three in four women who practice abstinence do so for nonspecific reasons that may be largely involuntary.

See also: *Birth Control, History of; Fertility, Proximate Determinants of.*

BIBLIOGRAPHY

Bongaarts, John, Odile Frank, and Ron Lesthaeghe. 1984. "The Proximate Determinants of Fertility in Sub-Saharan Africa." *Population and Development Review* 10: 511–537.

Demographic and Health Surveys. 2000. *Country Reports.* Calverton: Opinion Research Corporation Company (ORC Macro).

Fertility and Family Surveys in Countries of the ECE Region. 2000. *Standard Country Reports (Economic Studies No. 10).* New York and Geneva: United Nations.

ODILE FRANK

ACCIDENTS

In more precise language, accidents should be referred to as "unintentional injuries." The contention over the use of the word *accident* has to do with the issue of preventability. In common usage, the term *accident* implies that the event was random and nonpreventable. But for "accidents," whether resulting in death or lesser injury, such an implication is incorrect, hence the term *accident* is best avoided. In June 2001, the British Medical Journal took the position of "Banning the inappropriate use of 'accident' in our pages" (Davis, p. 1,320). Injuries may be intentional or unintentional. This article focuses on the latter category.

TABLE 1

Global Incidence of Mortality from Unintentional Injury (UI), by Cause and Sex, 2000

Type of injury	Males	Females	Total	Percent of total
	(thousands)			
Road traffic accidents	931	329	1,260	37.0
Poisoning	204	112	315	9.3
Falls	170	113	283	8.3
Fires	104	135	238	7.0
Drowning	301	148	450	13.2
Other UI	553	304	857	25.2
Total	2,262	1,141	3,403	100.0

SOURCE: WHO (2001).

Definition

Injury events are those in which "(1) injury occurs over a relatively short period of time—seconds or, at most, minutes, (2) the harmful outcome was not sought, and (3) the injury resulted either from one of the forms of physical energy in the environment (kinetic, chemical, thermal, electrical, or ionizing radiation) or because normal body mechanisms for using such energy were blocked by external means (such as drowning)" (Waller, p. 8). Unintentional injuries may be described simply as "unforeseen incident(s), where the intent to cause harm, injury or death was absent, but which resulted in injury" (International Classification of External Causes of Injury).

How Injury Is Classified

The World Health Organization's (WHO) International Classification of Diseases (ICD) specifies codes for diseases and injury. Injury, unlike diseases or natural causes, is captured by two distinct sets of codes, those for the nature of the injury and those for the external causes of the injury. For external causes, a single code is assigned that combines both the intentionality or manner of the injury and the

TABLE 2

Age-Adjusted Death Rates per 100,000 Population for Leading Causes of Unintentional Injury in Selected Developed Countries

	United States 1999	France 1998	Canada 1996–98	Denmark 1998	New Zealand 1994–98	Israel 1993–97	Australia 2000
Motor Vehicle and Traffic	14.7	13.3	9.4	8.4	14.7	10.5	9.0
Poisoning	4.3	0.9	2.5	2.5	0.5	0.1	4.1
Falls	3.9	4.8	3.9	16.1	3.5	1.1	2.5
Suffocation	1.8	3.9	1.2	1.0	1.1	1.0	1.1
Drowning	1.3	0.9	1.4	0.6	2.6	0.7	1.2
Fires	1.2	0.7	0.9	0.9	0.9	0.5	0.5
All Unintentional	**33.4**	**36.1**	**26.3**	**32.6**	**26.9**	**20.2**	**25.2**

Note: Rates are age-adjusted to the European Standard 2000 population. In Denmark, the rate for falls is much higher than in other countries because of the inclusion of "fractures, cause unspecified" within the category for falls.

SOURCE: Individual country vital statistics offices.

mechanism or cause of the injury. The intent of injury takes precedence in the classification, with mechanism of injury being coded within an intent category. The manner of the injury can be unintentional or "accidental," intentional (including self-inflicted and assault injuries), or of undetermined intent. For data presentation purposes, a standard framework based on groupings of ICD external cause of injury codes allows for data to be examined separately by intent as well as by mechanism.

The ICD is limited because it is a one-dimensional code system (a single code describing intent and cause) and because external cause codes often lack the specificity needed for designing or monitoring injury prevention and control activities. Hence, injury professionals around the world, under the auspices of the World Health Organization, have worked to develop a new multidimensional system for classification, the International Classification of External Causes of Injury (ICECI). The ICECI has the flexibility of coding in settings where minimal data are available as well as in those settings with great detail.

Scope

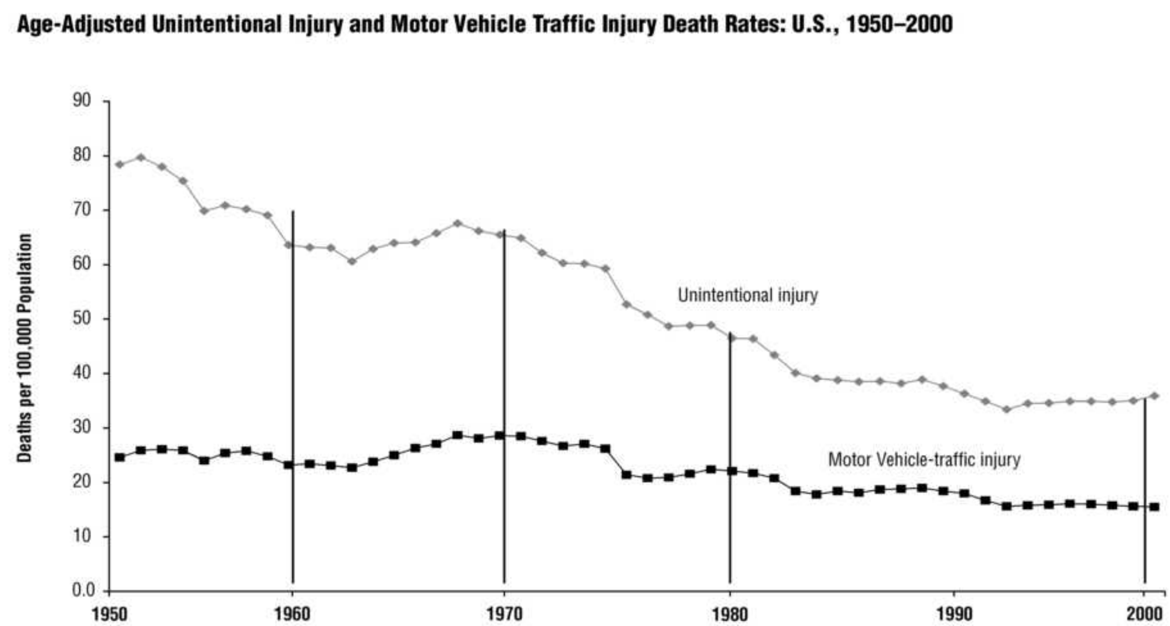
WHO estimated that there were 3.4 million unintentional injury deaths worldwide in 2000, accounting for 6 percent of all deaths and for two-thirds of all injury deaths. Deaths of males comprised 2.3 million, or two-thirds, of the unintentional injury deaths. Table 1 shows the main causes of death from unintentional injury, on a global basis and categorized by gender, in 2000. There is relatively little regional variation in unintentional injury mortality, with crude death rates ranging from lows of 44 to 50 deaths per 100,000 population per year in the Americas, the Western Pacific, and the Eastern Mediterranean to highs of 69 in Africa and Southeast Asia. Within-region variation can be much higher, however, and was most pronounced in Europe where mortality ranged from an average of 34 in countries with very low child and adult mortality to 117 where adult mortality was very high. In every region except for Europe, road traffic accidents accounted for 30 to 40 percent of all unintentional injury mortality. In Europe they accounted for 24 percent, with deaths from poisoning accounting for 21 percent.

Table 2 shows the unintentional injury death rates in the United States and selected other developed countries. To facilitate comparisons the rates here and below are age-standardized to remove the effects of differences in age distribution. In each country with the exception of Denmark, motor-vehicle traffic deaths were the leading cause of unintentional injury.

U.S. Fatal Injuries

In 1999, 97,860 persons resident in the United States died as the result of an unintentional injury. The death rate in 1999, 35.9 deaths per 100,000 population, was 23 percent lower than in 1979 and 54 percent lower than in 1950 (see Figure 1). Unintentional injury ranked as the fifth-leading cause of death for all ages in 1999, accounting for 4 percent of all

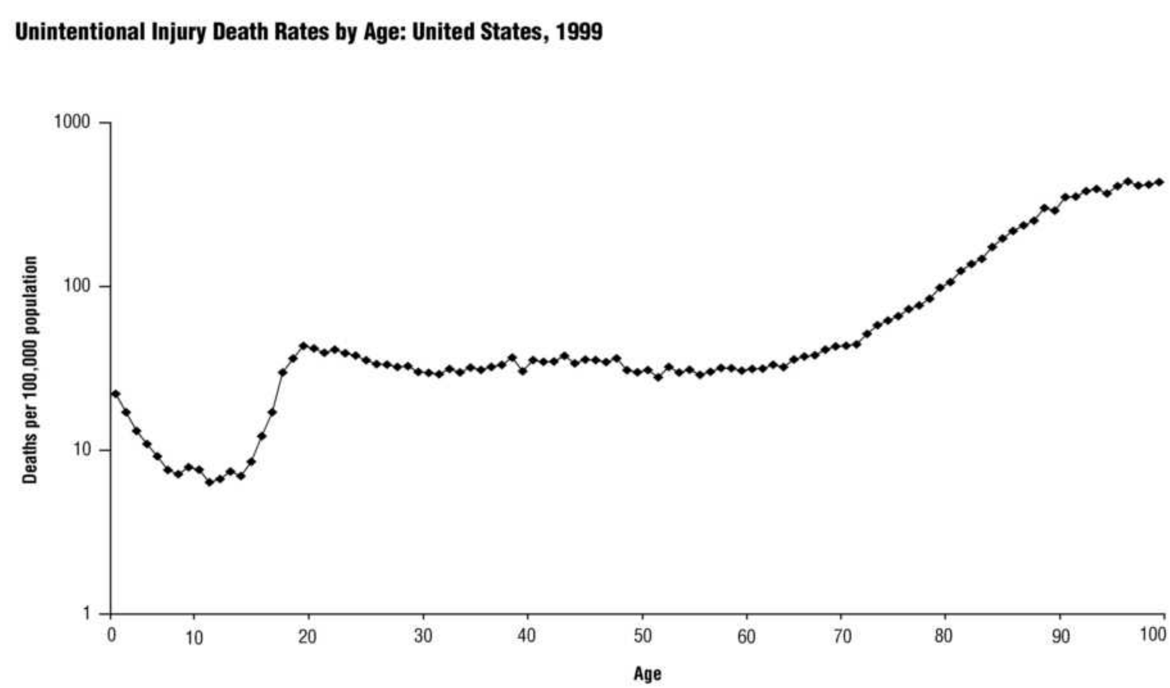
FIGURE 1



Note: Vertical lines indicate change in ICD revision which introduce minor changes in the data. Beginning with the 9th revision introduced in 1979, unintentional injury rates exclude deaths from complications of medical and surgical care. Rates are adjusted to the U.S. standard 2000 population.

SOURCE: National Vital Statistics System, NCHS.

FIGURE 2



deaths. (The four causes ranked above it were diseases of the heart, malignant neoplasms, cerebrovascular diseases, and chronic lower respiratory diseases.) In contrast, homicide (16,889 deaths) and suicide (29,199 deaths) did not rank in the top ten causes of death.

Among all causes of death in the United States, unintentional injury ranked fourth among males and seventh among females, and third to fifth across racial and ethnic groups. By age, unintentional injury was the leading cause of death for persons 1 to 34 years of age, ranked second for those 35 to 44, and ranked third for persons 45 to 54. As seen in Figure 2, the age distribution of unintentional injury includes three relatively distinct peaks—for infants, for older teens and young adults, and among the elderly.

Motor-vehicle traffic injuries continue to be the leading cause of unintentional injury death for persons 1 to 74 years of age. Between 1979 and 1999, declines in death rates from motor-vehicle traffic injuries were responsible in large part for the overall decline in unintentional injury mortality. For infants, suffocation causes more deaths than other kinds of unintentional injury, and for persons 75 years and older, falls rank highest. For persons 25 to 54, poisoning is one of the leading causes of unintentional injury death.

Nonfatal Injuries

Nonfatal unintentional injuries are more difficult to measure than fatal injuries because, unlike the case of deaths, there is no complete count of them. Usually nonfatal injuries are measured by nationally representative sample surveys, primarily of medical records. Estimates rely on what is written in the patient's medical record, and because health-care providers are often under time pressure, documentation of intent can easily be affected. When intent is not precisely stated, coding often defaults to "unintentional." Thus, estimates of unintentional injury based on surveys are likely to have an upward bias.

In the United States in 1999, there were an estimated 29.3 million visits to emergency departments for unintentional injuries, accounting for about 30 percent of all emergency department visits. In general, visit rates were higher for the younger and older populations than for the middle-aged. Falls were the leading external cause of emergency department visits, followed by motor-vehicle traffic injuries, injuries from being struck by or against an object or person, and injuries from instruments used for cutting or piercing.

Hospital admissions for unintentional injuries are less frequent than emergency department visits. In the United States, during 1998-1999, approximately 6 percent of emergency department visits for an unintentional injury resulted in an admission to the hospital with percentages ranging from about 3 to 4 percent for those younger than 45 years to upwards of 25 percent for those 75 years and older. Falls and motor-vehicle-related injuries are the leading external causes of unintentional injury resulting in hospitalization.

Estimates of the numbers of unintentional injuries and deaths in the United States are produced by the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC). Additional data on nonfatal injuries are produced by the National Electronic Injury Surveillance System (NEISS) of the U.S. Consumer Product Safety Commission. Prevention of unintentional injuries and deaths falls within the activities of the CDC's National Center for Injury Prevention and Control.

See also: *Causes of Death; Disability, Demography of; Disasters.*

BIBLIOGRAPHY

Anderson, Robert N. 2001. "Deaths: Leading Causes for 1999." *National Vital Statistics Reports* 49(11). Hyattsville, MD: National Center for Health Statistics.

Centers for Disease Control and Prevention. 1997. "Recommended Framework for Presenting Injury Mortality Data." *Morbidity and Mortality Weekly Report* 46(RR–14): 1–30.

Davis, Ronald M., and Barry Pless. 2001. "BMJ Bans 'Accidents': Accidents Are Not Unpredictable" (editorial). *British Medical Journal* 322: 1,320–1,321.

Fingerhut, Lois A., and Elizabeth McLoughlin. 2001. "Classifying and Counting Injury." In *Injury Control: A Guide to Research and Program Evaluation,* ed. Fred P. Rivara, Peter Cummings, Thomas D. Koepsell, David C. Grossman and Ronald V. Maier. New York: Cambridge University Press.

Hoyert, Donna L., Elizabeth Arias, Betty L. Smith, Sherry L. Murphy, and Kenneth D. Kochanek.

2001. "Deaths: Final Data for 1999." *National Vital Statistics Reports* 49(8). Hyattsville, MD: National Center for Health Statistics.

Institute of Medicine. 1999. *Reducing the Burden of Injury: Advancing Prevention and Treatment,* ed. Richard J. Bonnie, Carolyn E. Fulco, and Catharyn T. Liverman. Washington, D.C.: National Academy Press.

McCaig, Linda F., and Cathy W. Burt. 2001. *National Hospital Ambulatory Medical Care Survey: 1999 Emergency Department Summary.* Hyattsville, MD: National Center for Health Statistics.

Pless, Barry 2001. "Banning Accidents: An Addendum." *Injury Prevention* 7: 169–170.

Waller, Julian A. 1985. *Injury Control: A Guide to the Causes and Prevention of Trauma.* Lexington, MA: Lexington Books.

World Health Organization. 1992. *International Statistical Classification of Diseases and Related Health Problems,* 10th rev. Geneva, Switzerland: World Health Organization.

INTERNET RESOURCES.

Centers for Disease Control and Prevention. National Center for Health Statistics. 2002. <http://www.cdc.gov/nchs/>.

Centers for Disease Control and Prevention. National Center for Injury Prevention and Control. 2002. <http://www.cdc.gov/ncipc/>.

Consumer Product Safety Commission. National Electronic Injury Surveillance System (NEISS). 2003. <http://www.cpsc.gov/about/clrnghse.html>.

International Classification of External Causes of Injury. 2002. <http://www.iceci.org/>.

World Health Organization. 2001. "World Health Report 2001: Statistical Annex." <http://www.who.int/whr/2001/main/en/annex/index.htm>.

LOIS A. FINGERHUT

ACTION THEORY IN POPULATION RESEARCH

Understanding social institutions and social behavior, the province of social theory, is clearly relevant to explaining population dynamics. Demographers, however, make little systematic use of social theory. Conversely, the enormous volume of demographic research conducted since the 1950s has had little impact on the development of social theory. A more fruitful interchange between demography and social theory would benefit both fields. This entry reviews a major part of social theory—action theory—and appraises its relevance to explaining demographic change, in particular, fertility transition.

Action theory is concerned with the role of human agency in the development and maintenance of institutional structures and with the meaning of human action "from the actor's point of view." Its intellectual roots run deep in Western cultural history, but modern approaches derive largely from the seminal work of the German sociologist Max Weber (1864–1920). The following sections focus on the work of more recent theorists in the Weberian tradition: Talcott Parsons, Jürgen Habermas, and Anthony Giddens.

Talcott Parsons

The American sociologist Talcott Parsons (1902–1979) was probably the world's preeminent sociologist during the 1950s and 1960s. His theory of action was intended to provide a basic conceptual framework for unifying the social and behavioral sciences as well as explaining the development of the distinctive organizational features of modern societies.

Parsons defined action as the structures and processes through which human beings form meaningful intentions and, more or less successfully, implement them in specific situations. The basic unit of analysis is the unit act, which involves an actor (an individual or a collective), an end (a future state of affairs to which the action is oriented), a situation consisting of means (aspects over which the actor has some control) and conditions (aspects over which the actor has no control), and a normative orientation (because means and ends typically are not chosen at random but take into account shared meanings and standards).

These elements of action were seen by Parsons as being invariably organized as systems, with subsystems nested within larger systems. Cultural, social, personality, and behavioral systems were viewed as different fundamental types of action systems, each with its own distinctive organizing principles. Patterns of shared meaning—referred to as normative culture—are institutionalized in a society's social systems and internalized in its individual members' personalities.

Parsons claimed that his theory was the culmination of theoretical developments immanent in the major traditions of Western social theory. The Anglo-French positivistic tradition, for instance, privileged scientific knowledge as the only valid way to apprehend reality, with the result that it reduces the subjective meaning of action either to rational-scientific knowledge or to deviations from that standard in the form of error and superstition. The German idealistic tradition, according to Parsons, was better able to deal with the meaning of action in cases where it diverges from rational-scientific knowledge. Parsons's theory, building on Weber, was an attempt to synthesize these insights within a single comprehensive framework.

How might Parsonsian action theory bear on efforts to explain changes in fertility behavior? Classical demographic transition theory, which explains changes in fertility behavior in terms of "adaptive response to the requirements of an age of modern science and technology" and treats normative elements as simply "slowing the process of social change" (Notestein, p. 351), has many of the hallmarks of positivistic-utilitarian theory. The criticism during the 1980s and 1990s of transition theory's unilinear view of social change and neglect of cultural factors is anticipated by Parsons almost point by point in his critique of the positivistic-utilitarian system 50 years earlier in *The Structure of Social Action,* first published in 1937. The cultural theories of fertility change put forth during those decades to overcome these limitations often exhibit what Parsons described as the complementary shortcoming of idealistic theories of action: although they avoid reifying science and technology and treat cultural factors as structuring the choices involved in fertility behavior, they fall short in their treatment of the conditions of action.

Demographers nonetheless need a theory of behavior that goes beyond Parsonsian action theory. Demography lies at the intersection of the social and biological sciences. Fertility outcomes are a result of both biological and behavioral factors acting in combination, and so fertility behavior has to be analyzed in a framework like that developed by Kingsley Davis and Judith Blake (1956), which embraces both intentional behavior and unintentional biological processes. Parsons's theory considers human agency selectively only to the extent that it engages the symbolic or cultural level of representation; it therefore drives a conceptual wedge between social systems composed of meaningful action and population systems composed of discrete biological organisms. Its relevance for developing demographic theory is therefore circumscribed.

Jürgen Habermas

The contemporary German critical theorist Jürgen Habermas (born 1929) offers an alternative action-theoretic approach. Like Parsons, he criticizes positivism for the way it privileges one kind of knowledge and thus reduces the scope of rational action. In his early work (1971) Habermas distinguished three kinds of rational-scientific knowledge: (1) the empirical-analytic sciences, centering on a technical cognitive interest; (2) the historical-hermeneutic sciences, incorporating a practical cognitive interest grounded in communication; and (3) the critically oriented sciences, incorporating an emancipatory cognitive interest (that is, one aimed at overcoming irrational restraints).

Critical theory draws on both empirical-analytic knowledge of nomological (lawlike) regularities in human action and historical-hermeneutical knowledge of cultural meanings. Habermas's concept of an emancipatory cognitive interest is seen as problematic by many commentators, but it has a long intellectual history. Socrates saw self-reflection and dialogue as essential to freedom from tyranny and false beliefs. Habermas examines the conditions and constraints for emancipatory communication that are embedded in social action and modern social institutions.

Habermas's later work (1984, 1987) analyzes the ways in which different types of action can be rationalized and uses this analysis as a foundation for a critical account of the development of modern institutions (and the need for their reconstruction). It is an enormously complex exercise that spans many fields in social science, psychology, linguistics, and philosophy and is widely recognized as one of the most important achievements of late twentieth-century social theory.

What Habermas calls purposive-rational action can be rationalized by choosing more efficient or consistent means, but this is quite distinct from the kind of rationalization appropriate for communicative action. Problems of modernity are seen by Habermas as deriving from the dominance of rationalization processes of the purposive-rational type, which undermines the conditions for effective rationalization of communicative action, especially the institutions needed to support a politically vibrant public sphere. Modern societies are suffering from a "colonization of the lifeworld" by systems of purposive-rational action.

Significant links between demography and critical theory have been most striking in their absence. For example, in the 1990s there was a shift in the ideology and organization of national family planning programs from "instrumental" population control to a client-oriented reproductive health approach grounded in human rights and a more "dialogic" approach to provider–client relationships. Demographers working in this policy field faced a newfound nexus of issues involving sexual reproduction, reproductive rights, power, gender, communication, and individuation. They showed scant awareness that these were issues of central interest to critical theory. A plausible reason for this lack of awareness is the fact that demographers usually focus on increasing people's freedom from traditional institutions (e.g., increasing the autonomy of women), whereas critical theorists focus on the less conspicuous loss of freedom engendered by modern "disciplinary" institutions such as the state, the market economy, and even modern medicine.

Knowledge of critical theory would alert demographers involved with public policy to the ways in which the rationalization of conduct in one sphere of life can undermine the chances of appropriate rationalization in another sphere, particularly if the broader context of power relations is not taken into account. Reproductive rights are described in recent international declarations in terms of "the capability to reproduce and the freedom to decide if, when and how often to do so" (United Nations, paragraph 7.2), yet many women in developed countries (where fertility is below the replacement level) report that they would like more children than they actually have. Their participation in the market economy, which is increasingly rewarded, comes at the cost of time and energy devoted to child rearing. Removing gender inequality and giving people technical control over the number and timing of the children they produce are not sufficient conditions for people to have the number of children they want. This realization may push demographers into the kind of value-driven analysis enjoined by critical theorists, which relates individual behavior to political economy and communication.

Anthony Giddens

The works of Parsons and Habermas are couched in what to many people is impenetrable prose. More accessible are the works of the British sociologist Anthony Giddens (born 1938). In discussing action theory, Giddens adopts a less systematic, more eclectic approach—he calls it structuration theory—several features of which have resonance for demographic research. First, he focuses on the embodied conduct of actors and gives serious attention to the space and time dimensions (acknowledging the contribution of time geographers such as Torsten Hägerstrand). Second, he treats actors as "knowledgeable" (in their practical consciousness) about what they do. Third, he avoids many of the pitfalls associated with the conventional action–structure dualism by arguing, "Structure only exists in so far as people do things knowledgeably and do them in certain contexts that have particular consequences" (Giddens and Pierson, p. 81). Thus, institutions are reproduced through the repeated interactions of everyday life and are both enabling and constraining for human agency. Giddens, however, is of limited help in operationalizing these concepts by, for example, shedding light on the ways in which institutional factors may contribute to falling birthrates.

The Need for an Integrated Theory

None of the versions of action theory to date has integrated causal and interpretive analysis satisfactorily. An important research program in action theory is to develop a perspective on embodied action that would allow one to distinguish the different elements of action in order to clarify which ones are related causally and which ones are related in terms of schemas of meaning. The analysis of fertility behavior not only stands to gain from this program but would provide an ideal empirical case for testing and refining an integrated theory.

Social Theory and Demographic Narratives

As this brief review has tried to show, there are links and potential links between demography and social theory that have been underutilized by both sides. The Dutch demographer Dirk van de Kaa has characterized 50 years of demographic research on fertility as the development of a series of verbal theories from various disciplinary perspectives that attempt to explain some "central action" apparent in the data by locating it in "a setting which allows for an easy interpretation of that action" (van de Kaa, p. 389).

What is striking in many of these "anchored narratives" is the care and precision that go into data collection and analysis and, by contrast, the almost casual manner in which theoretical perspectives and orientations are borrowed and used to fashion interpretive narratives. Theory building in demography has not kept pace with the amassing of data, and what theory there is tends to focus on fragmentary issues and "subnarratives" rather than showing how all the elements fit together. Action theory has no ready-made answers for demographic questions, but it does present a wealth of analytical insight that can be dedicated to that task.

See also: *Culture and Population; Social Institutions.*

BIBLIOGRAPHY

Davis, Kingsley, and Judith Blake. 1956. "Social Structure and Fertility: An Analytic Framework." *Economic Development and Cultural Change* 4: 211–235.

Giddens, Anthony. 1984. *The Constitution of Society.* Berkeley and Los Angeles: University of California Press.

Giddens, Anthony, and Christopher Pierson. 1998. *Conversations with Anthony Giddens.* Cambridge, Eng.: Polity Press.

Habermas, Jürgen. 1971 (1968). *Knowledge and Human Interests.* Boston: Beacon Press.

———. 1979 (1976). *Communication and the Evolution of Society.* Boston: Beacon Press.

———. 1984, 1987 (1981). *The Theory of Communicative Action,* 2 Vols. Boston: Beacon Press.

Hayes, Adrian C. 1985. "Causal and Interpretive Analysis in Sociology." *Sociological Theory* 3(2): 1–10.

McNicoll, Geoffrey. 1994. "Institutional Analysis of Fertility." In *Population, Economic Development, and the Environment,* ed. Kerstin Lindahl-Kiessling and Hans Lanberg. Oxford: Oxford University Press.

Notestein, Frank W. 1983. "Population Growth and Economic Development." *Population and Development Review* 9: 345–360.

Parsons, Talcott. 1949 (1937). *The Structure of Social Action.* New York: Free Press.

———. 1977. *The Evolution of Societies,* ed. Jackson Toby. Englewood Cliffs, NJ: Prentice-Hall.

Turner, Bryan S., ed. 2000. *The Blackwell Companion to Social Theory,* 2nd edition. Oxford: Blackwell.

United Nations. 1994. *Programme of Action Adopted at the International Conference on Population and Development, Cairo, 5–13 September 1994.* New York: United Nations.

van de Kaa, Dirk J. 1996. "Anchored Narratives: The Story and Findings of Half a Century of Research into the Determinants of Fertility." *Population Studies* 50: 389–432.

Weber, Max. 1978 (1925). *Economy and Society: An Outline of Interpretive Sociology,* eds. Guenther Roth and Claus Wittich. Berkeley and Los Angeles: University of California Press.

ADRIAN C. HAYES

ACTUARIAL ANALYSIS

The origins of the actuarial profession can be traced to the late-seventeenth and early-eighteenth centuries when leading mathematicians were prevailed upon to compute the cost of annuities and life insurances. Many of the early great names of mathematics contributed in this way. The first professional body (the Institute of Actuaries) was established in London in 1848. Since that time, the professional interests of actuaries have widened to include pensions, general (property and casualty) insurance, health insurance, finance, and a wide range of "non traditional" problems, for which their quantitative skills and understanding of risk are readily applicable (e.g., pricing electricity supplied to a national grid).

Mortality

Most very early life tables were used and/or prepared in connection with life annuities and life insurance. The Equitable Assurance Society, which established long-term life insurance on a scientific basis in 1762, for example, used James Dobson's life table (based on London Bills of Mortality between 1728 and 1750) and Richard Price's table of 1783 (based on death records for a parish in Northampton). Price later constructed a life table from the population and deaths in Sweden, the first national life table ever made. The standard life table symbols still used in the twenty-first century were adopted as part of the International Actuarial Notation as early as 1898. Government actuaries continue to prepare the official national life tables of many countries, including Australia, the United Kingdom, and the United States.

Within a national population there is a considerable degree of mortality heterogeneity. Persons accepted for life insurance tend to have mortality that is lower than that of the national population over much of the age span because they are generally better educated, more affluent, and subject to medical scrutiny by the insurer. Purchasers of life annuities have even lower mortality as no one expecting to live only a relatively short time would purchase a life annuity. Because of these and other differences between the mortalities of the various subpopulations, many different types of life tables are regularly prepared, covering, for example, nonsmoker insured lives, smoker insured lives, super-select insured lives, annuitants, members of pension funds, actively employed persons, age retirees, and persons who have retired because of ill health. Large insurance companies often can prepare their own life tables on the basis of their own experience, and those tables reflect their own standards of underwriting. Only a small proportion of life tables are ever published.

Standard tables based on confidential data collected from groups of insurers are prepared and reviewed regularly by the various actuarial professional bodies. More recent standard tables tend to be published on the Internet.

Finding a suitable life table for use in a developing market is a problem faced by many actuaries of the twenty-first century and requires considerable judgment. Actuaries usually have to rely on insurance tables prepared for similar products in another market that is believed to have similar characteristics. If national life tables are available, they may be used as collateral information. The collection of local insurance mortality data is a high priority.

Temporary Initial Selection

The mortality of persons recently selected for life insurance is normally lower than that of other insured lives of the same attained age who were selected in earlier years. For this reason, since the mid-nineteenth century, when the first life tables based on the combined mortality experience of several insurers were constructed, actuaries usually have estimated mortality rates that take account of both age at selection and duration since selection. The mortality rate of persons selected at age x who have been insured for t years and are now aged $x + t$ is denoted by $q_{[x]+t}$ (the +0 is suppressed when $t = 0$).

In theory, therefore, separate life tables are required for each age at selection. The effects of temporary initial selection tend to disappear after several years, however, so that lives the same attained age that are selected at different ages eventually develop mortality rates that are indistinguishable. When the effect of temporary initial selection has worn off, the insured lives are said to be "ultimate lives" and their mortality is given by the "ultimate life table" with mortality rates $[q_y]$, where y is the attained age. In other words, once the temporary initial selection has disappeared (the duration t is greater than or equal to the select period), $q_{[x]+t} = q_{[x-1]+t+1} = q_{[x-2]+t+2} = \ldots = q_y$ where $y = x + t$.

For pragmatic reasons, British actuaries have tended to use very short select periods, whereas their North American colleagues have used longer periods (up to 15 years). If one uses common ultimate (l_y) values for the latter part of all the distinct life tables (corresponding to various ages at selection and durations in excess of the select period) and chooses appropriate radices ($l_{[x]}$), survivorship values can be represented concisely as in Table 1. Based on this table, for example, the probability that a select life aged 47 will die before age 50 is $1 - 32{,}670/32{,}975 = 0.00925$, the probability that a life now aged 47 who was selected at age 46 will die before age 50 is $1 - 32{,}670/33{,}020 = 0.01060$, and the probability that a life now aged 47 who was selected on or before his or her forty-fifth birthday will die before age 50 is $1 - 32{,}670/33{,}045 = 0.01135$.

Temporary initial selection also is observed in other situations. Persons who have retired more recently because of ill health, for example, tend to have mortality that is higher than that of the survivors of those who retired from ill health earlier, but again, the effect wears off with duration since retirement.

The technique is a convenient one that could be applied in a number of demographic situations, such as immigrant mortality, where the mortality of recent immigrants differs from that of the host population but gradually approaches the same level. Other possible applications include the study of the mortality of divorced and widowed persons, with the age at selection being the age at which the person became divorced or widowed.

Effects of Lifestyle and Medical Conditions

A number of life insurance companies formed in the nineteenth century distinguished between persons who abstained from alcohol and nonabstainers. Actuary Roderick Mckenzie Moore (1904), for example, was able to produce separate life tables for the two groups and investigate the effects of transitions between the two classes. Such a distinction normally would not be made in the twenty-first century, although "excessive" consumption might be taken into account at the underwriting stage.

Although the standard insurance life tables referred to above are usually for lives insured on normal terms, persons in less than perfect health can often obtain insurance on special terms. In determining the terms, company actuaries work alongside experienced medical officers, making use of a wealth of international data on the effect on mortality of many different medical conditions, personal habits (tobacco, alcohol, and drug consumption, exercise, etc.), and fitness, including weight to height measures. The data come from a wide range of sources: clinical trials, longitudinal studies of whole communities, special longitudinal studies for particular diseases, surveys, and cancer registries. A two-volume reference work entitled *Medical Risks—Trends in Mortality by Age and Time Elapsed* (Lew and Gajewski 1990), for example, provides an extensive description of many different conditions and advice on the relative mortality of persons suffering from those conditions. The major international life reinsurance companies produce their own electronic rating manuals to advise client insurers on the rating of impaired lives, and special investigations are undertaken from time to time by actuarial professional organizations.

TABLE 1

Extract from a British Insurance Life Table: Select Period Two Years

Select Age $[x]$	$l_{[x]}$	$l_{[x]+1}$	$l_{[x]+2}$	Age $[x]+2$
0	34,481	34,461	34,440	2
1	34,457	34,438	34,419	3
2	34,434	34,417	34,399	4
3	34,413	34,397	34,380	5
⋮	⋮	⋮	⋮	⋮
45	33,180	33,122	33,045	47
46	33,084	33,020	32,934	48
47	32,975	32,904	32,810	
48	32,852	32,774	32,670	50
⋮	⋮	⋮	⋮	⋮

SOURCE: Institute of Actuaries and Faculty of Actuaries (1975).

Improvements in Mortality

Improvements in mortality can undermine the financial viability of companies that sell life annuities. For this reason, actuaries have long been interested in measuring mortality improvements and estimating future mortality. Projected generation life tables are required, as annuities will be taken out at different ages in the same calendar year. The simplest commonly used approach has been to observe the annual rates of improvement in q values over time and then to extrapolate the q rates by using improvement factors at each age, although other approaches are also adopted. In most cases the actuaries' assumptions have led to underestimates of improvement.

Variation of Mortality with Age

Since the eighteenth century mathematical "laws" of mortality have been explored in an attempt to facilitate the otherwise very tedious life contingencies calculations essential for pricing and valuing life assurance and annuity contracts. The mathematician Abraham de Moivre was possibly the first to do this (in 1725), but the most celebrated early development was that of mathematician and Fellow of the Royal Society Benjamin Gompertz (1825), modifications of which have been proposed ever since. The model allows many quick approximate calculations that are remarkably accurate even with mortality tables that are not strictly of the Gompertz shape. Actuary T. N. Thiele, in 1872 proposed a model applicable over the whole age span, as did demographer

Larry Heligman and actuary John Pollard (1980). Actuaries David Forfar and David Smith (1987) applied the latter model in 1987 to all 26 English Life Tables to project the English Life Tables for 1991. The projected mortality rates for females turned out to be very good, but those for the males were less satisfactory.

A variety of models were studied by actuary Wilfred Perks in 1932, who noted the effects of heterogeneity, and variants of his models were used to graduate (smooth) British standard tables in the 1950s and 1960s. Other more generalized formulas that have been used in more recent British standard tables are discussed in Forfar et al. (1988).

Mortality Heterogeneity

In recent years some life insurance companies have begun marketing policies to super-select lives, persons with characteristics that tend to make their mortality extremely low even compared with those accepted for life insurance under normal conditions. In doing so, the companies are attempting to exploit the considerable mortality heterogeneity that exists in any national population. Actuaries are therefore becoming very interested in measuring heterogeneity and understanding its underlying causes.

Morbidity

Before the development of the welfare state in the early twentieth century there was little financial security for those who were sick and unable to work; they had to depend on charity or small payments to the destitute from the local parish. "Friendly Societies" began to proliferate, providing small benefits in times of need to members in return for small weekly contributions. In this way workers in particular occupations and regions were able to support each other. Actuaries were soon required to ensure that these mutual institutions were financially viable and, as a result, became involved in sickness investigations. The largest and most thorough of these studies was the Manchester Unity investigation of 1893–1897, and the tables derived by actuary Alfred Watson (1901) showing age-specific proportions sick were used extensively (with adjustments) well into the twentieth century.

Employers in most developed countries of the twenty-first century offer some level of income maintenance for short periods of sickness, for example, a certain number of days of full pay while sick, with the number of allowable days generally increasing with length of service. National sickness schemes also may pay basic income benefits. A need for private sickness and disability insurance remains, particularly for the self-employed, and insurers offer a wide range of products designed for specific markets. As with mortality, the actuarial professional bodies coordinate the collection and analysis of morbidity data and the preparation of standard tables of incidence and recovery. More recent standard tables tend to be published on the Internet. The major international reinsurers also provide underwriting manuals for their clients.

Competing Risks

The first detailed study of competing risks was done by the British actuary William Makeham (1874), although some of the ideas can be traced to eighteenth-century Swiss mathematician Daniel Bernoulli, who attempted to estimate the effect on a population of the eradication of smallpox. Makeham's approach was to extend the concept of the "force of mortality" (which was well known to actuaries of that time) to more than one decrement, and he noted the essential independence between the different decrements implied by his analysis.

Actuaries who have used multiple decrement tables ever since have almost invariably assumed independence between the "competing risks." Important applications include pension schemes, where active employees may be depleted by a number of different decrements (death, resignation, termination, ill-health retirement, and age retirement), and mortality analysis, where mortality rates for certain causes may be changed to take account of trends or to answer "what if" questions about possible future changes in mortality.

The formulas relating the decrement rates in a multiple decrement table to those in the associated single decrement tables or with other multiple decrement tables (e.g., tables with fewer decrements) depend on the manner in which the decrements operate. In cause of death analyses, for example, decrements in the related single cause tables often are assumed to be spread evenly over the year of age. Formulas derived under this assumption may not necessarily be transferable to other situations, such as pension funds, where certain events may be concentrated at birthdays. There is an extensive literature on this topic, and attempts have been made to deal with dependence between decrements.

Multiple decrement tables belong to a very special class of the Markov process, and more general Markov chain processes are often required in morbidity studies, because persons can recover from their illnesses.

Population Modeling: HIV/AIDS

The HIV/AIDS epidemic that started in the 1980s caused considerable alarm in the insurance industry, particularly in respect to policies providing death benefits, those providing income replacement during illness, and medical and health policies. Actuaries in various countries therefore began modeling the development of the disease in the community at large and the numbers at risk or already HIV-positive in the insuring subpopulation.

Crucial to the modeling of the insurance process were assumptions concerning the numbers of existing policyholders at risk and the numbers already infected and the numbers and sizes of new policies that would be issued to persons in those categories once the community and the insurers reacted to the epidemic. A major concern was the possibility of high-risk groups and those already HIV-positive selecting against the insurers (taking out a disproportionate amount of insurance). Because the diffusion of the disease differed from country to country and because legislation controlled the extent to which insurers were permitted to discriminate between different groups in their underwriting, a model developed in one country was not necessarily immediately transferable to another.

Improved community awareness and safer sexual practices in developed countries ultimately caused the spread of HIV/AIDS and the effects on insurers to be less serious than had been projected.

Population Modeling: Genetic Testing

Almost since the dawn of life insurance, insurance companies and their actuarial advisers have sought genetic information from those applying for life insurance by asking details about survivorship and cause of death of family members. With the recent rapid developments in genetics considerably more information about the likely survivorship and morbidity of an individual can be provided by a genetic test. A person who has taken a test may be aware that he or she is more likely to die younger or be subject to increased ill health. Serious ethical questions ensue. Should insurers be permitted to demand genetic tests? If not, should an individual who has taken a genetic test be required to reveal the results to the insurer under the basic insurance principle of utmost good faith (*uberrima fides*)? If such information is available only to the proposer, there is a serious risk of selection against the insurer, to the detriment of the company and others insured with it.

There are also serious privacy issues. Genetic information about an individual also provides information about that individual's relatives. Such indirect genetic information also can be used to select against an insurer. For example, a person may submit to a genetic test and learn that he or she bears an undesirable gene. Knowing this, that person might advise a sibling to take out insurance, and the sibling could justifiably claim not to have undergone a test.

Even in situations where no genetic test has been undertaken, an insured life may take one and, after learning that he or she does not have deleterious genes, discontinue the insurance, leaving the insurer with a higher than average proportion of policyholders with genes associated with increased morbidity and premature death.

Human rights supervisors, privacy officials, insurers, actuaries, insurance regulators and legislators are grappling with these issues, and actuaries are endeavoring to model the underlying genetic processes in the population and in the insuring subpopulation.

See also: *AIDS; Genetic Testing; Gompertz, Benjamin; Life Tables; Lotka, Alfred; Mortality, Age Patterns of; Risk.*

BIBLIOGRAPHY

Benjamin, Bernard, and John H. Pollard. 1993. *The Analysis of Mortality and Other Actuarial Statistics.* Oxford: Institute of Actuaries and Faculty of Actuaries.

Continuous Mortality Investigation Committee, Institute of Actuaries and Faculty of Actuaries. 1998. "The Mortality of Holders of Permanent (Whole Life and Endowment) Policies of Assurance 1991–94." *Continuous Mortality Investigation Reports* 16: 1–34.

———. 1998. "The Mortality of Smokers and Non-Smokers 1991–94." *Continuous Mortality Investigation Reports* 16: 83–94.

———. 1998. "The Mortality of Impaired Insured Lives." *Continuous Mortality Investigation Reports* 16: 95–112.

———. 2000. "An Analysis of the PHI Experience of Individual Companies in the United Kingdom: I. Claim Inception Rates." *Continuous Mortality Investigation Reports* 18: 109–150.

———. 2000. "An Analysis of the PHI Experience of Individual Companies in the United Kingdom: II. Claim Termination Rates." *Continuous Mortality Investigation Reports* 18: 151–180.

Forfar, David O., and David M. Smith. 1987. "The Changing Shape of English Life Tables." *Transactions of the Faculty of Actuaries* 40: 98–134.

Forfar, David O., et al. 1988. "On Graduation by Mathematical Formulae." *Journal of the Institute of Actuaries* 115: 1–149.

Gompertz, Benjamin. 1825. "On the Nature of the Function of the Law of Human Mortality and on a New Mode of Determining the Value of Life Contingencies." *Philosophical Transactions of the Royal Society* 115: 513–585.

Heligman, Larry, and John H. Pollard. 1980. "The Age Pattern of Mortality." *Journal of the Institute of Actuaries* 107: 49–80.

Institute of Actuaries and Faculty of Actuaries. 1975. *A1967-1970 Tables for Assured Lives.* Oxford: Institute of Actuaries and Faculty of Actuaries.

———. 1979. *A(90) Tables for Annuitants.* Oxford: Institute of Actuaries and Faculty of Actuaries.

Lee, Ronald. 2000. "The Lee-Carter Method for Forecasting Mortality, with Various Extensions and Applications." *North American Actuarial Journal* 4: 80–93.

Lew, Edward A., and Jerzy Gajewski. 1990. *Medical Risks: Trends in Mortality by Age and Time Elapsed.* New York: Praeger.

Macdonald, A. S. 1999. "Modelling the Impact of Genetics on Insurance." *North American Actuarial Journal* 3(1): 83–101.

Makeham, William. 1874. "On an Application of the Theory of the Composition of Decremental Forces." *Journal of the Institute of Actuaries* 18: 317–322.

Moore, Roderick M. 1904. "On the Comparative Mortality among Assured Lives of Abstainers and Non-Abstainers from Alcoholic Beverages." *Journal of the Institute of Actuaries* 38: 213–259.

Panjer, Harry H. 1988. "AIDS: Survival Analysis of Persons Testing HIV Positive." *Transactions of the Society of Actuaries* 40: 517–530.

Pollard, John H. 1987. "Projection of Age-specific Mortality Rates." *Population Studies of the United Nations* 21/22: 55–69.

———. 1991. "Fun with Gompertz." *Genus* 47: 1–20.

Subramanian, Krupa, Jean Lemaire, John C. Hershey, Mark V. Pauly, Katrina Armstrong, and David A. Asch. 1999. "Estimating Adverse Selection Costs from Genetic Testing for Breast and Ovarian Cancer: The Case of Life Insurance." *Journal of Risk and Insurance* 66: 531–550.

Watson, Alfred W. 1901. "An Account of an Investigation of the Sickness and Mortality Experience of the I.O.O.F. Manchester Unity Friendly Society, during the Years 1893–1897." Review (Editorial) 369. *Journal of the Institute of Actuaries* 38: 334.

INTERNET RESOURCES.

Faculty and Institute of Actuaries. 2002. <http://www.actuaries.org.uk>.

Society of Actuaries. 2002. <http://www.soa.org>.

JOHN H. POLLARD

ADOLESCENT FERTILITY

In those developed countries where substantial numbers of young women give birth as teenagers, adolescent fertility has been a long-standing concern and is increasingly becoming a concern in the developing world.

To monitor adolescent childbearing, demographers commonly rely on two measures. The adolescent fertility rate is the number of births per 1,000 women aged 15 to 19 and is computed from vital statistics reports or birth history data from fertility surveys. The proportion of women aged 20 or older who have had a child by specified ages, usually 15, 18, and 20, is computed from fertility surveys.

Fertility Rates and Trends

Adolescent childbearing declined in the 1980s and 1990s in much of the world, although substantial numbers of women still gave birth in their teenage years. In sub-Saharan Africa, according to fertility surveys conducted in the 1990s, the percentage of women aged 20 to 24 who gave birth before age 20 ranged from a low of approximately 40 percent in Ghana to a high of around 70 percent in Chad, Mali, Niger, and Uganda with most francophone (French-speaking) countries having elevated rates by comparison to the anglophone (English-speaking) countries. In Latin America and the Caribbean, where data from fertility surveys were available for only nine countries, the percentage ranged from a low of 30 percent in Peru to over 50 percent in Nicaragua. In Asia, in the six countries for which fertility surveys were conducted in the 1990s, Bangladesh stood out: Just over 60 percent of young women in Bangladesh gave birth as teens. This is a considerable decline, however, from the previous generation, when over three-quarters of surveyed women aged 40 to 44 had had a child before age 20. In India and China, of women aged 20 to 24, 49 percent and 14 percent, respectively, reported giving birth as teenagers in surveys from the early 1990s. There were only five Middle Eastern/North African countries for which data were available for the 1990s; in Egypt, just under one-quarter of 20- to 24-year-olds were mothers by age 20, compared with 17 percent in Jordan and Morocco, 26 percent in Turkey, and 45 percent in Yemen.

Within the industrialized world in the 1990s, the percentage of women aged 20 to 24 who had had children as teenagers ranged from 3 percent in Japan to 22 percent in the United States. The latter figure was one of the highest levels in the developed world. The proportion of U.S. women who give birth as teenagers is unusually large in comparison to other wealthy countries—mostly a consequence of less use and less effective use of contraception. It is also worth noting that the U.S. adolescent fertility rate declined less than in Europe between the early 1980s and the late 1990s.

Adolescent fertility rates in the 1990s range from a low of 4 births per year per 1,000 women aged 15 to 19 in Japan to a high of over 200 in Niger and Uganda. Within the industrialized world, there is also considerable variation. In addition to Japan, low rates—under 10—are found in western (Belgium, Netherlands, and Switzerland), northern (Denmark, Finland, and Sweden), and southern Europe (Italy, Spain, and Slovenia). High rates—over 50—are found in some countries of eastern Europe (Armenia, Georgia, Moldova, and Ukraine) and in the United States. In 2000 the U.S. fertility rate for age 15 to 19 was 56.5 (50 among whites, 93 among blacks, and 99 among Hispanics). Within the developing world, adolescent fertility is highest in sub-Saharan Africa, but there are also countries in South Asia and Latin America with teen birth rates of over 100.

The late-twentieth-century decline in adolescent childbearing was especially pronounced in certain sub-Saharan African countries (namely Cameroon, Kenya, Senegal, and Tanzania), the Middle East/North Africa, Asia, and the industrialized countries. In Latin America, adolescent fertility declined in some countries—notably Bolivia, Guatemala, and Nicaragua—but rose in others, such as Brazil and Colombia. Moreover, where declines occurred in Latin America, they were less rapid than declines in the fertility of older women. This pattern was in contrast to many industrialized countries where the adolescent fertility rate fell faster than the overall fertility rate. In monitoring trends in adolescent childbearing, demographers observed that the reported age-specific fertility rate of women aged 15 to 19 declined more than the proportion giving birth before age 20, indicating that while women in many countries were still becoming mothers at a young age they apparently were having fewer births as teenagers. Indeed, there are countries—for example, Burkina FASO, Central African Republic, Ivory Coast, and Bolivia—where the proportion of women giving birth before age 20 has remained stable or even increased slightly since the 1970s but where the adolescent fertility rate has declined. Potential reasons for this include a rise in the age at first marriage and a delay in the age at first birth, and an increase in contraceptive use after the first birth.

Within Marriage Childbearing

There is a perception that most teenage childbearing takes place prior to marriage. In fact, throughout the developing world—and in contrast to the situation in developed countries—the majority of young women who give birth as teenagers do so within marriage. Indeed, one reason why adolescent childbearing has declined in many developing countries is that the proportion of women marrying during their teenage years has fallen. While substantial proportions of young women give birth out of wedlock in sub-Saharan Africa and Latin America, premarital childbearing has not changed or has increased only slightly in most countries in these two regions. (There are some noteworthy exceptions in sub-Saharan Africa, such as Ivory Coast, Kenya, Namibia, Tanzania, and Zambia.) What has increased in many sub-Saharan countries and in the United States, although not in Latin America, is the percentage of births to teenage girls that are premarital.

Consequences of Adolescent Childbearing

Many observers take it for granted that having a child during the teenage years is problematic. But the research on the health, social, and economic consequences of adolescent childbearing reveals a complex set of associations. Adolescent mothers are at much greater risk of poorer health outcomes than are somewhat older mothers, but this is largely a consequence of teen mothers on average being poorer, less well nourished, and less likely to get adequate obstetric care. Indeed cephalopelvic disproportion, a major cause of obstructed labor in developing countries and a condition that is much more prevalent among young mothers, is extremely uncommon in developed countries even among teen mothers because nutrition is adequate, physical growth is almost completed by the mid-teenage years, and there is access to adequate delivery services, including cesarean section.

Research on the social and economic consequences of teenage childbearing has been conducted almost exclusively in the United States. The findings are still far from definitive, in large part because of the presence of selection bias—namely, that those who give birth as teens differ systematically in many respects from those who delay. Outcome measures that have been focused on by researchers in the United States include earnings, poverty status, completion of high school, employment, and subsequent fertility. There is a consensus that, although early childbearing has a significant effect on some social and economic outcomes, researchers in the past overstated the deleterious effects of teen childbearing.

The social environment in the developing world is quite different from that of the United States, where most teen childbearing is unplanned or unwanted and occurs outside of marriage and where the opportunity costs of teen motherhood are greater. In many poor countries, particularly in rural areas, early childbearing may benefit a young woman because it increases her status within the family. Nonetheless, there is some evidence from the developing world that as levels of schooling and the demand for skilled labor rise, adolescent mothers, who are often less well educated, may become increasingly disadvantaged.

See also: *Fertility, Age Patterns of; Fertility, Nonmarital.*

BIBLIOGRAPHY

Alan Guttmacher Institute. 1998. *Into a New World: Young Women's Sexual and Reproductive Lives.* New York: Alan Guttmacher Institute.

Mensch, Barbara S., Judith Bruce, and Margaret E. Greene. 1998. *The Uncharted Passage: Girls' Adolescence in the Developing World.* New York: Population Council.

Ribar, David C. 1999. "The Socioeconomic Consequences of Young Women's Childbearing: Reconciling Disparate Evidence." *Journal of Population Economics* 12: 547–565.

Singh, Susheela. 1998. "Adolescent Childbearing." *Studies in Family Planning* 29(2): 117–136.

Singh, Susheela, and Jacqueline E. Darroch. 2000. "Adolescent Pregnancy and Childbearing: Levels and Trends in Developed Countries." *Family Planning Perspectives* 32(1): 14–23.

Zabin, Laurie Schwab, and Karungari Kiragu. 1998. "Health Consequences of Adolescent Sexuality and Fertility Behavior in Sub-Saharan Africa." *Studies in Family Planning* 29(2): 210–232.

Barbara S. Mensch
Susheela Singh

ADOPTION

Adoption has been practiced in many societies through the centuries, usually in situations where the birth parents are unable to raise a child or where natural reproduction has failed to provide some desired fertility outcome. This entry focuses on adoption in modern, low-fertility societies.

Adoption is a legal procedure involving the permanent transfer of parental rights and duties in respect to a child from the birth parent(s) to another person. Legal adoption has been introduced in most industrialized societies over the past 150 years (in Massachusetts, legal adoption was introduced in 1851; in England and Wales, in 1926; in Ireland, in 1952). It involves at least three key parties: the adopted child(ren); the birth parent(s); and the adoptive parent(s) (sometimes termed the adoption triangle). Adoption provides a new family for children whose parent(s) are unable or unwilling to care for them, and it also meets the needs of childless adults.

Traditional Baby Adoption

Rising rates of non-marital fertility after World War II led to many unmarried mothers relinquishing their babies for adoption. In England and Wales in 1968, there were 24,831 adoptions—of which 14,461 (58%) involved "illegitimate" children adopted by non-relatives: more than one in five babies born outside marriage were adopted in the 1960s. By 1984 the number of such adoptions had fallen to 2,910. The widespread availability of reliable contraception, the legalization of abortion, and an increased acceptance of single parenthood resulted in few single mothers relinquishing their babies.

In other European countries, within-country adoption of non-relative children had virtually ceased by the end of the twentieth century: in the Netherlands, numbers fell from 747 in 1970 to 54 in 1995; in Norway, from 411 to 90. In Sweden in 1995, there were only 34 non-relative adoptions of Swedish children.

Special Needs Adoption and Permanency

In-country adoption continues in the United Kingdom and the United States, and it has expanded in the cases of older children in the public care system and those with serious physical, intellectual, or emotional problems. In the United States, the term *permanency planning* was widely used in the early 1970s in reference to this kind of adoption. The practice was formalized in the 1980 Adoption Assistance and Child Welfare Act. In 1998 some 36,000 children were adopted from the public care system, and 86 percent of adopters received public subsidies. Adoption allowances were also introduced in the United Kingdom in the 1980s. In both countries, government policy is to increase the number of such adoptions, and this has been accompanied by a rise in contested adoptions where courts have, in some instances, dispensed with the consent of birth parents.

Stepparent Adoption

The increase in divorce rates in many Western countries during the late twentieth century led to a rise in second marriages where stepparents (usually stepfathers) sought to adopt their partner's birth children. In England and Wales, the number of stepparent adoptions peaked in 1974 when there were 14,805 adoptions of children where one partner in the adopting couple was a parent of the adoptee. New legislation (the 1975 Children Act) sought to discourage such adoptions; the Houghton Committee Report, on which much of the act is based, argued that stepparent adoption should not be used as it often involved the birth mother adopting her own legitimate child, removing all parental rights from the birth father. By 1984 the number of stepparent adoptions had fallen to 2,650. Two decades after the 1975 Children Act, stepparent adoptions still accounted for about half of the 5,000 adoptions recorded each year in England and Wales. In the United States in 1982, stepparent adoptions made up 42 percent of the 127,441 adoptions.

Adoption Criteria

In most countries legal adoption is only permitted for married couples, but in the United Kingdom, the Adoption and Children Bill debated in Parliament in 2002 has been amended to allow unmarried couples in a stable union to adopt jointly; this would extend to gay and lesbian couples. Adoption by a single person is becoming more common and, in practice, this has allowed one of a cohabitating couple to adopt with the understanding that a partner would become a caregiver, albeit without (adoptive) parental rights. Prospective adopters must be of a minimum age, and an upper age limit (often as young as 40) is often imposed for those wishing to adopt an infant. Older couples have often turned to intercountry adoption if they did not want an older or handicapped child. Most agencies also have criteria in relation to income and housing conditions.

Transracial Adoption

Transracial adoption (TRA) in the United States and United Kingdom has almost always meant the adop-

TABLE 1

Intercountry Adoptions in Selected Receiving Countries, 1989 and 1998

	1989		1998	
Country	Total number	Adoptions per 1,000 births	Total number	Adoptions per 1,000 births
United States	7,948	2.0	15,774	4.2
France	2,383	3.0	3,777	5.3
Italy	2,332	3.8	2,263	4.4
Germany	1,088	1.6	1,819	2.4
Sweden	883	9.4	928	10.8
Switzerland	509	6.2	686	8.6
Netherlands	642	3.7	825	4.6
Norway	578	11.0	643	11.2
Denmark	468	9.4	624	9.9
United Kingdom	n/a	n/a	258	0.4

SOURCE: Kane (1993); Selman (2002).

tion of an African-American or West Indian, Asian, Native American, or non-white Hispanic child by a white family. TRA became common in the United States in the 1960s as fewer white babies were available for adoption, but from the mid-1970s opposition to the practice mounted. Adoption of Native American children was subsequently restricted by legislation. Transracial adoption of black children has remained controversial in the United States and the United Kingdom, with both strong supporters and strong opponents of the view that black children should only be adopted by black parents, even if there is a lack of available black adopters and the alternative to being placed with white adopters is to remain in an institution. In the United States, the 1994 Multiethnic Placement Act made consideration of race in adoptive placements impermissible.

Intercountry Adoption

Intercountry adoption, which can be seen as a form of migratory behavior, originated in American philanthropy toward devastated countries after World War II. Later the Korean and Vietnam Wars resulted in many adoptions to the United States, Sweden, and other countries. The decline in infants available for domestic adoption made intercountry adoption an attractive option for childless couples; in Northern Europe, it was often the only option. Reports of child trafficking and large payments for newborn babies led to international concern, culminating in The Hague Convention on Protection of Children and Co-operation in Respect of Intercountry Adoption, which was concluded and signed by 63 states in May 1993. By 2002 the Convention had been ratified by 37 countries. However, scandals continued—including accusations of child-trafficking in Guatemala and of profiteering by officials in Romania. At the end of the twentieth century, the incidence of intercountry adoption was highest in mainland Europe, although the number of such adoptions was greatest in the United States (see Table 1).

Global numbers of intercountry adoption reached some 20,000 a year in the late 1980s and then began to decline. The fall of the Ceausescu regime in 1989 led to many adoptions from Romania in 1990–1991, and in the mid- and late 1990s a growing number of very young children were adopted from China (almost all of them girls) and Russia. By the end of the century, the total intercountry adoption movement was approaching 35,000 a year. The number of foreign children adopted in the United States rose further from 15,774 in 1998 to 19,327 in 2001. Table 2 shows the major sources of children (a large majority of them infants) in the 1980s and 1998.

Low Fertility Countries as States of Origin

Although intercountry adoption often is characterized as the movement of children from poor, overpopulated countries, some states of origin have had low fertility levels (e.g., Germany after World War II). In the late 1990s, three of the four most important sources of children—Russia, China, and South Korea—had fertility below replacement level, as did Romania, and had fertility rates lower than some states receiving children from these countries. Many other Eastern European countries such as Belarus, Ukraine, and Kazakhstan, which became major providers of infants for the United States from 1998, also have low fertility rates.

In Search of Origins

In most low-fertility countries, legal adoption has been marked by secrecy and stigma. Before the last quarter of the twentieth century, most countries refused adopted persons access to information about their origins. The United States has a long tradition of sealed records, and even in 2000 a majority of its states did not allow the adoptee access to identifying information.

In England and Wales, the 1975 Children Act gave the right of access to their original birth records to all adopted persons over the age of 18. This right

TABLE 2

Intercountry Adoptions to Western Countries by Major Source Countries, 1980–1989 and 1998

	1980–1989 (annual average)			1998	
Country	Number of adoptions	Adoptions per 1,000 births in 1989	Country	Number of adoptions	Adoptions per 1,000 births
South Korea	6,123	5.4	Russia	5,064	5.4
India	1,532	<0.1	China	4,855	0.24
Colombia	1,484	2.5	Vietnam	2,375	1.4
Brazil	753	0.5	South Korea	2,294	3.4
Sri Lanka	682	1.0	Colombia	1,162	1.2
Chile	524	3.0	Guatemala	1,143	2.9
Philippines	517	0.4	India	1,048	0.04
Guatemala	224	0.8	Romania	891	4.4

SOURCE: Selman (2002)—adoptions to 10 receiving countries; Kane (1993)—adoptions to 13 receiving countries.

has been exercised widely, and it is estimated that a majority of those adopted by non-parents will seek information about their origins over their lifetime. In 1991 an Adoption Contact Register was established, enabling adopted persons and birth relatives to indicate an interest in meeting each other.

In New Zealand, the 1985 Adult Adoption Information Act gave adopted persons the right to their original birth certificate at age 20. Birth parents also have a right to ask for information about their children, although either party can veto the transmission of information.

By the beginning of the twenty-first century, adoption was much more open. In the United States, adoption of infants increasingly involves birth mothers meeting with (and even choosing) their child's adoptive parents. Research by Harold Grotevant and Ruth McRoy indicates that contact between birth parents and adoptees may continue after placement, and appears to have no detrimental effect.

See also: *Infertility; Reproductive Technologies.*

BIBLIOGRAPHY

Altstein, Howard, and Rita Simon, eds. 1991. *Intercountry Adoption: A Multinational Perspective.* New York: Praeger.

Avery, Rosemary, ed. 1997. *Adoption Policy and Special Needs Children.* Westport, CT: Auburn House.

Grotevant, Harold, and Ruth McRoy. 1998. *Openness in Adoption: Exploring Family Connections.* London: Sage.

Howe, David, and Julia Feast. 2000. *Adoption, Search, and Reunion: The Long Term Experience of Adopted Adults.* London: The Children's Society.

Kane, Saralee. 1993. "The Movement of Children for International Adoption: An Epidemiological Perspective." *The Social Science Journal* 30(4): 323–339.

Kirton, Derek. 2000. *"Race," Ethnicity and Adoption.* London: Open University.

Mueller, Ulrich, and Barbara Perry. 2001. "Adopted Persons' Search for and Contact with their Birth Parents." *Adoption Quarterly* 4(3): 5–62.

Selman, Peter, ed. 2000. *Intercountry Adoption: Developments, Trends, and Perspectives.* London: BAAF.

———. 2002. "Intercountry Adoption in the New Millennium: The Silent Migration Revisited." In *Population Research and Policy Review* 21: 205–225.

Simon, Rita J., Howard Altstein, and Marygold Melli. 1994. *The Case for Transracial Adoption.* Washington, D.C.: American University Press.

Triseliotis, John. 1973. *In Search of Origins.* London: Routledge.

Triseliotis, John, Joan Shireman, and Marian Hundleby. 1997. *Adoption: Theory, Policy and Practice.* London: Cassell.

INTERNET RESOURCES.

Hague Conference. 2002. <http://www.hch.net/e/conventions/menu33e.html>.

National Adoption Information Clearinghouse (NAIC). 2002. "Adoption: Numbers and Trends: Adoption from Foster Care." <http://www.calib.com/naic/index.htm>.

Selman, Peter. 1999. "In Search of Origins: Estimating Lifetime Take-up of Access to Birth Records in England and Wales." Minneapolis: International Conference on Adoption Research. <http://fsos.che.umn.edu/mtarp/Papers.htm>.

PETER SELMAN

AFRICAN-AMERICAN POPULATION HISTORY

In the course of four and a half centuries after 1492 some 9.5 million Africans arrived in the Western Hemisphere. Until the 1820s more Africans crossed the Atlantic than did Europeans, and Africans and their descendants outnumbered Europeans and their descendants in most of the new American colonies until the early nineteenth century. The balance would shift with the arrival of over 48 million Europeans in the period from 1830 to the 1920s, although African forced migration continued until the early 1860s.

The Destinations

Africans were not brought in equal numbers to all regions of the Americas but tended to be concentrated in zones that had few American Indian laborers and had rich virgin lands that could be used to grow commercial export products for European consumption. In light of the fact that all the Africans were involuntary migrants and were purchased for work purposes, it is no surprise that they were concentrated in the plantation agricultural zones that produced sugar, cotton, and coffee for European markets. The two biggest centers of African slave residence were the West Indies, which absorbed some 4.4 million African slave immigrants—the last arriving in Cuba in the 1860s—and Brazil, which took in some 3.9 million Africans until the slave trade ended in that region in 1850. North America probably absorbed some 361,000 Africans before the trade ended there in 1808, with most of the forced migrants coming in the late eighteenth century. The other 834,000 Africans who arrived in America went to continental Spanish America and the Guyanas.

Despite this concentration of Africans in key export centers, there was no region of the Americas, from Hudson Bay to the Rio de la Plata, that did not contain Africans and their descendants. In colonial Spanish America, which had a competing group of American Indian laborers, Africans tended to be concentrated in urban areas and often made up half the local populations. Everywhere else they lived primarily in the rural areas and even worked in gold mines in Brazil and the northeastern South American interior.

Population Growth

As a result of the fact that the slave trade carried primarily adults and males to the Americas, most resident African populations in the New World experienced negative growth rates. As the slave trade declined or was abolished, most of those slave populations finally began to achieve positive growth rates. With fewer adults and males arriving, the native-born populations, with their balanced sex ratios, began to replace themselves in sufficient numbers to cause the resident slave populations to grow. This occurred in the West Indies and in Brazil as well, despite the steady out-migration of slave women and children through manumission.

To estimate the population of Africans and their descendants in the Americas at the end of the eighteenth century, one must include both slaves and "free persons of color," as manumitted slaves and Africans were called in most American slave societies. Combining these two groups gives a very rough population estimate of over 4.3 million persons of African descent at that time. Slaves numbered close to 3 million persons, of whom 1.1 million lived in the West Indies, another 1 million resided in Brazil, 271,000 in lived in mainland Spanish America, and 575,000 resided in the United States. There were almost 1.3 million free persons of color at that time, of whom 212,000 resided in the Caribbean, 400,000 in Brazil and 650,000 in Mainland Spanish America, and some 32,000 in the United States

Although all native-born slave populations had positive reproductive rates and those rates became dominant with the end of the slave trade, the United States was unique in the rapidity of the growth of its slave population. By the 1860s the United States had 3.9 million slaves and 488,000 free colored persons. By the time of the first national census of Brazil in 1872 that country had a free colored population of 4.2 million persons along with 1.5 million slaves, for a total of 5.7 million Afro-Brazilians. Cuba and Puerto Rico by then had 412,000 slaves and 474,000 free colored persons. Counting just these three slave regions in the middle of the nineteenth century gives a population of 5.8 million slaves and 5.2 million free persons of color. Clearly these 11 million Afro-Americans do not account for the total number in the Americas, considering that the descendants of slaves in mainland Spanish America probably numbered another million.

Racial Categories

Until the end of slavery or the establishment of republican governments in most regions of the Americas careful records were kept on people of African origin and descent. However, that systematic examination of race changed, with most census takers no longer listing color or race in their enumerations of populations. It thus becomes extremely difficult from the late nineteenth century onward to estimate the size of the African-American populations. Added to the problem of a lack of enumerations is the question of the definition of groups. Miscegenation between the races was common to all American societies from the very beginning. Thus, to the original African group were added mulattoes and other admixtures of whites, Africans, and American Indians. In most American societies it was assumed that this mixed element formed a new racial category, distinct from whites and Africans. Only in the United States were these people of mixed origins exclusively associated with the "black" population.

Therefore, defining who is "black" or of African-American descent has become a complex social and political problem. Are people with mixed origins white or black? Are they European or African-American in origin? Finally, in almost all the American republics that did list color in the census, color is almost always self-defined and is much influenced by local societal definitions of color, class, and local patterns of racial prejudice. Thus, the size of the populations of African origin is almost impossible to determine with precision.

This situation is reflected in the few attempts made to categorize this population throughout the Americas. An estimate for all the Americas in 1992 gave a minimum figure of 64 million persons and a maximum of 124 million persons of African descent, which represented, respectively, 9 percent and 17 percent of the total American hemispheric population. An earlier attempt in 1983 estimated that whites in the Americas made up roughly 36 percent of the total population, Indians some 10 percent, and blacks just 6 percent, with the rest being of persons of mixed origin. Illustrative of this problem is the case of Colombia. A more recent study has argued that "there is no precise data on the size of the Afro-Colombian population. The government tends to minimize the number, putting it at about 30 percent of the total population, or approximately 10.5 million individuals" (Archbold 2000, p. 3).

For the two largest populations of African-Americans there are some reliable data. In the United States, which has the most rigid definition of who is African-American or black, the census of 2000 counted 34.6 million persons of this color, excluding black Hispanics, in the total population. When persons who list more than one race are included, the figure rises to 36.4 million. The National Household Survey of Brazil carried out in 1999 estimated that 39.9 percent of the population of 160 million Brazilians consisted of mulattoes (63.8 million persons) and 5.4 percent (8.6 million) consisted of blacks. Using a U.S. definition of the population of African origin would give Brazil approximately 72.4 million persons of this origin if mulattoes are to be classified as blacks rather than whites or as a class by themselves.

Migration within the Americas

Although the traditional plantation areas were zones with high densities of African populations, the abolition of slavery in most regions led to an outmigration of ex-slaves as early as the beginning of the nineteenth century. As long as there were economic opportunities in the labor market or farming land was available, ex-slaves refused to work on the traditional plantations. In many cases their initial migration was delayed by competition from the foreign-born workers who arrived in large numbers until the 1920s. However, even before the decline of this competitive migration, ex-slaves were moving to new regions and new countries in large numbers. It is estimated that between 200,000 and 250,000 black

West Indians permanently moved to Panama and the United States in the period from 1881 to 1921.

By the twentieth century those migrations would become more common everywhere. In the 1950s and 1960s over 300,000 black West Indians moved to Britain. In the United States the African-American population moved out of the South in large numbers after 1910 in what has come to be seen as a great internal migration. Whereas 90 percent of this African-American population resided in the southern states in 1900 and was 83 percent rural, by 1990 only 53 percent resided in the South and only 13 percent of these people were classified as rural residents. By the census of 1980 over 4 million southern-born blacks were residing outside the states of their birth. There were also migrations within Brazil beginning in the 1910s with major interregional movements of northeastern residents to the central and southern parts of the country, which had an impact on the color ratios in those formerly more European regions.

Conclusions

One can conclude that since abolition, the population of African descent in the New World has become both less concentrated and less rural than it was in the nineteenth century. It can be stated in very broad terms that the majority of the population of the Americas, according to very broad definitions of color, is primarily nonwhite and that a high proportion of that population can claim some relationship with the 9.5 million Africans who were brought to America by the Atlantic slave trade.

See also: *Racial and Ethnic Composition; Slavery, Demography of.*

BIBLIOGRAPHY

Archbold, Julio E. Gallardo. 2000. "Colombian Legislation: Regulations Governing Afro-Colombian Communities." In *Race and Poverty: Interagency Consultation on Afro-Latin Americans.* Washington, D.C.: Inter-American Dialogue, Inter-American Development Bank, World Bank.

Davis, Darién J., ed. 1995. *Slavery and Beyond: The African Impact on Latin America and the Caribbean.* Wilmington, DE: Scholarly Resources.

Eltis, David. 2001. "The Volume and Structure of the Transatlantic Slave Trade: A Reassessment." *William and Mary Quarterly* 58(1): 45.

Ferenczi, Imre, and Walter F. Wilcox. 1919. *International Migrations.* New York: National Bureau of Economic Research.

Gregory, James N. 1995. "The Southern Diaspora and the Urban Dispossessed." *Journal of American History* 83(1): 112.

Henriques, Ricardo. 2001. *Desigualdade Racial no Brasil: Evolução das Condições de Vida na década de 90.* Rio de Janeiro: IPEA, Texto Para Discussao no. 807.

Klein, Herbert S. 1986. *African Slavery in Latin America and the Caribbean.* New York: Oxford University Press.

———. 1999. *The Atlantic Slave Trade.* New York: Cambridge University Press.

Nobles, Melissa. 2000. *Shades of Citizenship: Race and the Census in Modern Politics.* Stanford, CA: Stanford University Press.

Oviedo, Rodolfo Monge. 1992. "Are We or Aren't We?" *NACLA Report on the Americas* 25(4): 19.

Peach, G. C. K. 1967. "West Indian Migration to Britain." *International Migration Review* 1(2): 34.

Tolnay, Stewart E. 1998. "Educational Selection in the Migration of Southern Blacks, 1880–1990." *Social Forces* 77(2): 487–488.

U.S. Bureau of the Census. 2001. *Profiles of General Demographic Characteristics 2000.* Washington, D.C.: Census Bureau.

Herbert S. Klein

AGE MEASUREMENT

In most countries, throughout the year following their seventh birthday a child who was asked "How old are you?" would say he or she is seven years old. In demographic terminology, this response represents the child's age last birthday or age in completed years. Other possible definitions of age include "age

TABLE 1

Age Heaping: Population Counts (in '000) by Age for the Range 52–65 Years, in the 1960 Census of the Philippines

Age	52	53	54	55	56	57	58	59	60	61	62	63	64	65
Count	129	93	96	163	88	72	93	72	279	31	50	40	34	102

SOURCE: Shryock and Siegel (1971).

at the nearest birthday" and "age next birthday"; these definitions are no longer used in censuses or surveys. The term *exact age* is applied to the time elapsed since birth: an infant born on April 20, 2000, attains age 2.03 years on May 1, 2002. An East Asian practice of reckoning age involves assigning age one at birth and then increasing it by one at each subsequent New Year. The East Asian age, thus calculated using the lunar calendar (the lunar year is shorter than the solar year by a few days), may exceed the corresponding Western age by as much as three years for the elderly beyond the age of 70 years. Given the East Asian age, the animal year of birth, and whether the birthday falls between the New Year's day and the census or survey date, the Western age can be calculated. In situations where a direct question on age is unlikely to produce useful answers, a person's age may be calculated as the difference between the year of the census or survey and the reported year of birth.

The United Nations' recommendation for the 1970 round of population censuses was to use the following definition of age: "the estimated or calculated interval of time between the date of birth and the date of the census, expressed in completed years" (United Nations 1967, p. 41). The recommendation indicates that information on age can be collected by asking a direct question on age, one on the date of birth, or both.

Errors in Age Data

The frequency distribution of age may show irregularities (see Table 1), which may be real, reflecting past patterns of mortality (e.g., age-selective war casualties), fertility (e.g., a baby boom, birth heaping in auspicious years and deficits in inauspicious years), or migration, or may reflect errors in the data resulting from omission, multiple inclusion, or inaccuracy in reported age. Notice the tendency in Table 1 for the counts to peak at ages ending in 0 and 5, and to a lesser extent in ages ending in 2 and 8. Such heaping patterns reflect digit preference, the tendency to report ages ending in certain digits.

The pattern of digit preference varies among societies, and it also depends on the procedure used in collecting age data. The use of a question on date of birth, in combination with a direct question on age, tends to reduce such irregularities in the age data. When age is estimated as the difference between the census or survey year and the reported year of birth, age heaping occurs because of the preference shown for years ending in certain digits (such as 1900, 1910, 1920, and so on). Similar problems arise when age data are obtained by attempting to pinpoint the year of birth with reference to a list of historical events.

Age heaping has an inverse association with literacy level. The tendency to prefer ages ending in 0 and 5 is, however, widespread. Certain age preferences are no doubt culturally determined (e.g., the tendency found in some countries to avoid the number 13).

The term *age shifting* refers to deliberately giving an inaccurate age or date of birth. The elderly are prone to exaggerate their age, particularly if old age brings with it higher status; young men may understate or overstate their age, if by doing so they stand to benefit in some way (e.g., avoid or, as the case may be, qualify for military duty).

Correction Methods Applicable to Age Data

The importance of obtaining accurate information on age stems partly from the fact that many demographic features—such as reproductive behavior and geographic mobility—show distinct age patterns. Deficiencies in age data may lead to misleading patterns of such characteristics. The use of age groups for cross-classifications partially overcomes the problem.

In choosing age groups, it is advisable to have the "preferred" ages (displaying marked heaping) located toward the middle of each interval rather than at the end points. By centering the age groups at distribution peaks, the adjacent, depleted ages are brought within the interval.

If interest centers on the age distribution itself, rather than in cross-tabulations involving age as one of the variables, then techniques such as graduation can be used to produce age distributions smoothed over the observed irregularities.

Requirements for Improved Age Reporting

There are essentially three requirements for correct age reporting.

1. Availability of information: A respondent unsure of his or her age is unlikely to give the correct response to a query about age. In populations with complete birth registration, the age data tend to be more accurate, other things being the same. Also, the data are of better quality in population segments of higher literacy levels.
2. Use of appropriate methods of data collection: As mentioned, following a direct question on age by one on the date of birth may improve the data quality. Also, when the enumerators are free to adjust the responses (e.g., to hide digit preferences), the final age data may reflect to a large extent variation in the procedures used for adjustment.
3. Use of appropriate data processing and reporting procedures: The quality of the collected data may be excellent, but the reported age distribution still may be inaccurate, if, for example, only the year of birth, not the exact date of birth, is used at the tabulation stage.

See also: *Data Assessment; Estimation Methods, Demographic.*

BIBLIOGRAPHY

Carrier, Norman, and John Hobcraft. 1973. *Demographic Estimation for Developing Societies.* London: London School of Economics.

Prassat, Roland. 1985. *The Dictionary of Demography,* ed. Christopher Wilson. New York: Blackwell.

Scott, Christopher, and George Sabagh. 1970. "The Historical Calendar as a Method of Estimating Age." *Population Studies* 24: 93–109.

Shryock, Henry S., Jacob S. Siegel, and Associates. 1971. *The Methods and Materials of Demography,* Volume 1. Washington, D.C.: U. S. Government Printing Office.

United Nations. 1967. "Manual IV-Methods of Estimating Basic Demographic Measures for Incomplete Data." *Population Studies* 39.

———. 1967. "Principles and Recommendations for the 1970 Population Censuses." *Statistical Papers, Series M,* 44.

Krishnan Namboodiri

AGE STRUCTURE AND DEPENDENCY

Every individual is some particular age. Populations are collections of individuals, and rather than being some particular age, populations are characterized by the frequency distribution of the ages of the individuals who constitute them. This is called the population age distribution or age structure. The age structure can be summarized in various ways, for example, by the average or median age of the population. A population with a low median age is called "young," and one with a high median age is called "old." One can also define life cycle stages, such as youth, working age, and old age, and describe the age structure by the percentage of the population in each of these categories, for which various age boundaries are used. Thus one can speak of the proportions of the population below age 15 or 18 or 20; proportions between one of these ages and ages up to 60 or 65; and proportions above ages 60 or 65. With reference to these same life cycle stages, so-called dependency ratios may be calculated. The ratio of the elderly to the working age population is the old age dependency ratio, the ratio of youth to the working age population is the child or youth dependency ratio, and the sum of these two is the total dependency ratio.

Some of these measures are shown in Table 1 for the years 1950 to 2000, along with United Nations projections to the year 2050, for the more developed countries (DC) and the less developed countries (LDC), the countries being classified according to their economic status in 2000. In every year, the DCs have a higher median age than the LDCs, with a smaller proportion of children and a higher proportion of the elderly. Evidently, aging has already affected the LDCs as well as the DCs; the phenomenon is not restricted to the industrial nations. The aging of the DC populations is shown by the projected increase in their median age by about 18 years from 1950 to 2050, and by the corresponding increase for the LDC populations by about 14 years.

TABLE 1

Age Structure for Developed and Less Developed Countries, 1950–2050

	1950	1975	2000	2025	2050
Median Age (yrs)					
DC	28.6	30.9	37.4	44.1	46.4
LDC	21.4	19.4	24.3	30.0	35.0
Percent less than age 15					
DC	27.3	24.2	18.3	15	15.5
LDC	37.6	41.1	32.8	26	21.8
Percent age 60 and older					
DC	11.7	15.4	19.4	28.2	33.5
LDC	6.4	6.2	7.7	12.6	19.3

SOURCE: United Nations (2002).

Stable Population States

The age structure of a population is shaped by the past history of births, the past age distributions of deaths, and the age characteristics of net migrations. Consider first the case in which net migration is always zero at all ages (a closed population, on net), and age-specific fertility and mortality rates have been unchanging for a long time—about a century or more. In this case, it can be shown that the population will converge to a so-called stable state, in which the percentage age distribution is constant over time, and the population and every age group grow at the same constant exponential rate. Furthermore, this stable population age distribution is independent of the population age distribution that existed a sufficiently long time ago—again, about a century. That is, the particular features and shape of the initial age distribution tend to be forgotten as time passes, and the eventual age distribution depends only on the constant age-specific fertility and mortality rates. Depending on those rates, a stable population can have a constant growth rate within a wide band of particular values, and the rate can be positive, negative, or zero. A stationary population is a stable population with a zero growth rate.

Members of a population who are now age x were born x years ago and have survived for x years. In a stable population, the number of births grows at the exponential population growth rate. In a growing population, the number of births x years ago will be smaller than the number of births today, and the higher the population growth rate, the smaller will be the generation born x years ago relative to the generation born in the current year. The opposite will be true if the growth rate is negative and the population is shrinking. Indeed, the rate of population growth is the most important determinant of the age distribution of a closed, stable population. The age distribution, however, is also affected by mortality, which determines the proportions of births that survive to each age x. The lower the mortality rate, the higher will be the proportions surviving from birth to older ages.

Nonstable and Irregular Population Distributions

For a given level of mortality, higher fertility will always be associated with faster population growth and therefore with a younger stable age distribution in a closed population. Mortality differences, however, have two contradictory effects. On the one hand, lower mortality makes a stable population older by increasing the proportions surviving from birth to older ages. On the other hand, lower mortality tends to make a stable population younger, because it raises the population growth rate (for a given level of fertility). When the initial level of mortality is high, the net outcome of lower mortality is to make a population younger. When the initial level of mortality is low, lower mortality tends to make a population older. For intermediate initial levels, the effects of lower mortality are mixed, sometimes leading to higher proportions of both youth and of elderly and sometimes hardly changing the age distribution at all. These different effects of mortality decline are observed in real-world situations as well as in the hypothetical stable populations. For example, Table 1 shows that the LDC population in 1975 had a younger median age than it did in 1950, as well as a higher proportion of children and lower proportion of elderly. Mortality declined rapidly from 1950 to 1975, illustrating how falling mortality can make a population younger.

Many actual population age distributions are highly irregular rather than smooth and geometric like those of stable populations. Irregular distributions can come about in several major ways. The populations of a number of industrial countries, for example, experienced a baby boom from the late 1940s through the mid-1960s, followed by subsequent baby busts. These changes in fertility created large bulges and hollows in the population age distributions as the affected birth cohorts reached higher ages. The changing relative sizes of cohorts had important consequences for average wages, unemployment rates, and prospects for promotion, and they eventually will exert differential fiscal pressures through public pension and health-care systems. Population age distributions can also be heavily marked by traumatic events such as major wars or, for example, China's disastrous famine resulting from the Great Leap Forward (an economic plan launched in the late 1950s). Such crises cause heavy mortality that is sometimes concentrated at certain age and sex groups, and they also lead to sharp reductions in fertility and therefore in the size of generations born during and immediately after the crisis. When a population age distribution is strongly distorted by influences such as these, the distortions simply age with the population, moving up from younger to older ages as time passes. For example, the effects of both World War I and World War II are still clearly apparent in the age pyramids (as the conventional graphic representation of age distributions are labeled) of many European countries. A third cause of irregular age structure is age-focused patterns of immigration and emigration. These are more frequently seen in a sharp differential at the local rather than the national level. Often such patterns occur in towns with universities, prisons, army bases, or retirement communities. A fourth cause is emigration of the younger population from some rural areas, which leaves behind an elderly population. Some characteristic age pyramids are shown in Figure 1.

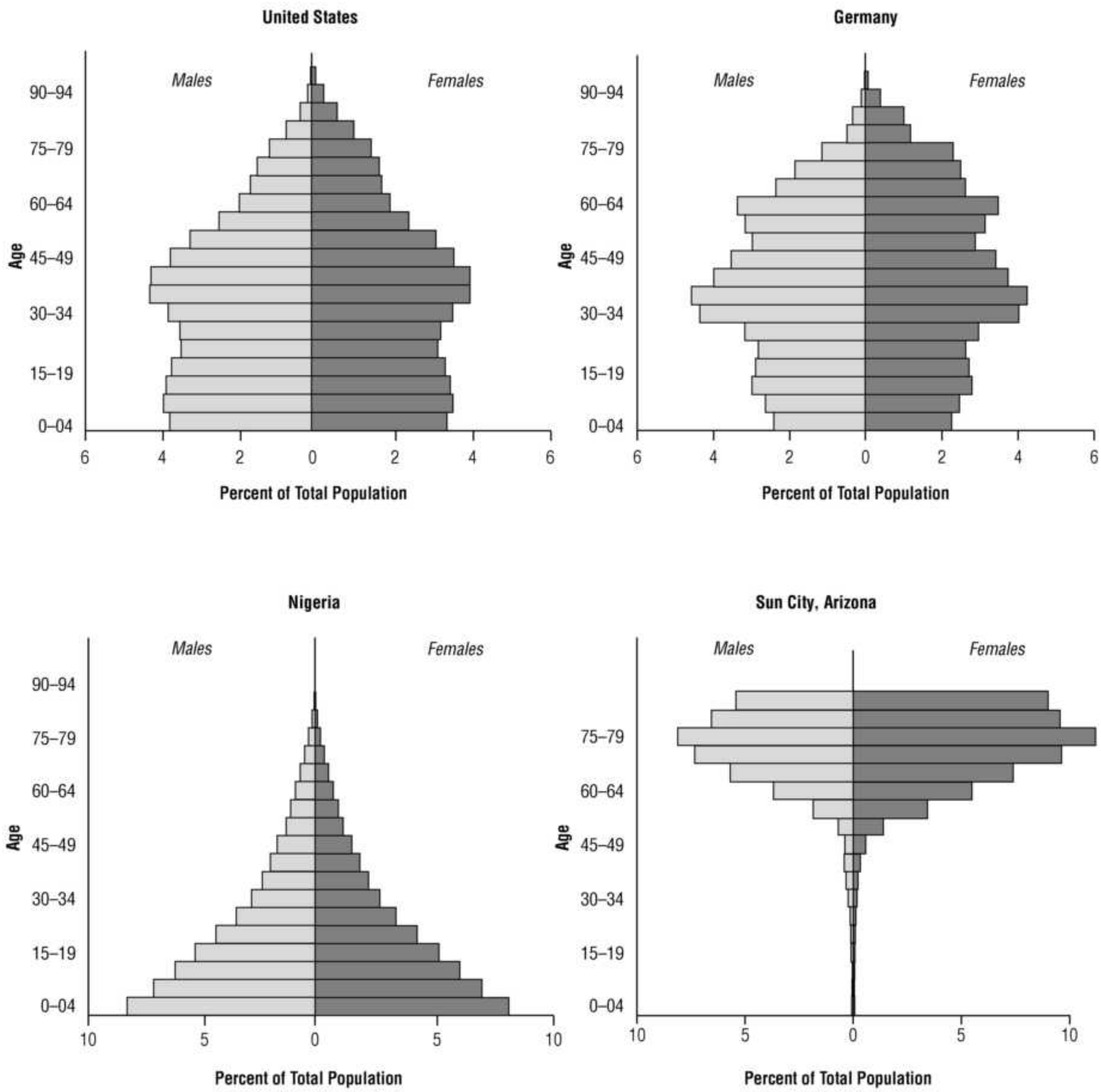
Not only do distorted age structures tend to persist over time as the population ages; they also can be transmitted to the stream of new births through the processes of reproduction, as echoes. If some generations are unusually large, because of an earlier baby boom, for example, then when the members of those generations enter their peak reproductive ages they will themselves generate an unusually large number of births, given typical levels of fertility. In this way they create another bulge in the age distribution, albeit a somewhat smaller one than the first. Formal analysis shows that populations with nonstable age distributions but which are subject to constant age-specific fertility and mortality will tend to move in cycles about one generation (25 to 30 years) long as they converge to stability. This result can be generalized to populations that are constantly subjected to random perturbations. Historical time series of baptisms often show evidence of such cycles. Sometimes, however, there is negative feedback in the renewal process, so that large generations of young adults experience adverse economic conditions and consequently have lower fertility and give birth to smaller, rather than larger, generations. In this way cycles longer than one generation may be generated; these are known as Easterlin cycles.

Consequences of Population Age Distributions

In many contemporary societies, there is particular interest and concern about the process of population aging and rising old age dependency ratios, because these factors will affect the cost per worker of supporting the elderly retired populations. Some analysts suggest that governments should seek to raise fertility in order to reduce and postpone population aging. Others propose to alleviate population aging through increased immigration, because immigrants are typically younger than natives and have higher fertility. But analysis shows that any gains from such a policy would be short lived and smaller than most people expect, because immigrants grow old themselves and require support. Only constantly accelerating rates of immigration achieve much effect, and such policies cannot be sustained for long. As an example, the U.S. Bureau of the Census reported the old age dependency ratio and the median age in 1995 to be .21 and 34.3 years, respectively. The Census Bureau projected these quantities to the year 2050 under low and high immigration assumptions that differed by more than a million immigrants per year. With low immigration, the Census Bureau projected that, by 2050, the old age dependency ratio would rise to .38 and the median age to 38.8 years. With a million more immigrants per year, these figures were projected to be only slightly lower at .35 and 37.6 years. The additional 55 million immigrants would have a big effect on population size but only a small effect on population aging.

FIGURE 1

Population Age Pyramids, Select Populations, 2000



SOURCE: Germany, Nigeria, and United States. Ages 0–59 are estimates from United Nations Population Division, *World Population Prospects: The 2000 Revision, Volume II: The Sex and Age Distribution of Populations* (2001), Annex Table 2; Ages 60 and over are estimates from World Population Aging 1950–2050, United Nations Population Division (2002), Annex Table III.2; Sun City, AZ: "American Factfinder," U.S. Census Bureau, table P12. Sex by Age, from Census 2000 Summary File 1.

Population age distributions have a range of socioeconomic consequences, because people's behaviors, abilities, and entitlements all vary with age. These variations reflect biological changes over the life cycle, but in addition they reflect somewhat arbitrary institutional age categories and individual choices in response to various preferences and incentives. On the biological side, it appears that health and vitality at the older ages have been increasing over time, so that working life could be extended to older ages. This option, however, is apparently not commonly viewed as desirable, because actual ages at retirement have declined by five to ten years over the twentieth century in industrial countries. These declines are due in part to the desire for more leisure as incomes rise, pensions becoming more common, and financial institutions making saving easier. It is also clear, however, that the structures of both public and private pensions provide strong incentives for early retirement, and that this has contributed to the decline. This trend slowed or slightly reversed in the 1990s in many countries.

The boundary age for dependency in youth also reflects a number of factors, most notably the length of time spent in formal education, that influence the age at which the workforce is entered. These age boundaries for youth and old age correspond roughly to directions of flows of intergenerational transfers, through the family and through the public sector. The public sector in industrial countries provides pensions and health care for the elderly and education for youth. The size of these public transfer programs for the young and the old swamps the transfers to those of working age. Private transfers in most industrial countries consist mainly of parental support of children and assistance from the elderly to their adult children and grandchildren through transfers made prior to death and through bequests.

As the population age distribution changes, pressure on those who make these transfers is relaxed or intensified. Population aging often goes with reduced fertility, resulting in not only a reduced need for public and private transfers to children but also a greatly increased need for transfers to the elderly for health care and pensions. A generalized fiscal dependency ratio can be calculated as follows. The numerator is determined by weighting each population age group by the costliness of public transfers it receives, with the denominator equal to the level of taxes that age group pays. Holding these weights fixed, one can then see how the fiscal dependency ratio changes over time for demographic reasons alone. For the United States, for example, the federal fiscal support ratio has been projected to increase by 56 percent from 2010 to 2075. This means that in order to provide the same set of age-specific benefits, age-specific tax rates financing intergenerational transfers would have to be raised by 56 percent. Alternatively, if age-specific tax rates financing transfers were held constant, then benefits received as transfers would have to be scaled back by 36 percent.

See also: *Aging of Population; Cycles, Population; Generational Accounting; Intergenerational Transfers; Oldest Old.*

BIBLIOGRAPHY

Coale, Ansley J. 1972. *The Growth and Structure of Human Populations: A Mathematical Investigation.* Princeton: Princeton University Press.

Lee, Ronald. 1994. "The Formal Demography of Population Aging, Transfers, and the Economic Life Cycle." In *The Demography of Aging,* ed. Linda Martin and Samuel Preston. Washington, D.C.: National Academy Press.

United Nations Department of Economic and Social Affairs, Population Division. 2002. *World Population Aging, 1950–2050.* New York: United Nations.

RONALD LEE

AGING AND LONGEVITY, BIOLOGY OF

Most strains of mice live an average of 1,000 days; dogs live approximately 5,000 days; and humans, in low mortality countries, live about 29,000 days (around 80 years). The average duration of life of a species and the age-specific rate of increase in the risk of death is calibrated to each species' unique pattern of growth, development, and reproduction. These linkages between longevity and growth and development are the cornerstone of the scientific understanding of the biology of aging and death and the duration of life of humans and other sexually reproducing species. This entry presents a brief discussion of the biology of aging with emphasis on its implications for human longevity.

Causes of Aging

In its simplest form, aging may be thought of as the accumulation of random damage to the building blocks of life—especially to DNA, certain proteins, carbohydrates, and lipids. The damage begins from conception, occurs in a largely random fashion throughout the body, and accumulates with time, eventually exceeding the body's self-repair capabilities. The damage gradually impairs the functioning of cells, tissues, organs, and organ systems, resulting in the increased vulnerability to disease and a rise in the physical, physiological, and psychological manifestations of aging.

There are many agents of damage including, ironically, the life-sustaining processes involved in converting the food we eat and fluids we drink into usable energy. The primary energy generators of cells are the mitochondria. As they perform their usual function, the mitochondria emit oxidizing molecules known as free radicals that exist for only a fraction of a second. Although free radicals contribute to several important biological processes (e.g., cell communication, immune response), they are also a destructive force. Most of the damage caused by these highly reactive molecules is fixed by the body's impressive mechanisms for surveillance, maintenance, and repair. However, unrepaired damage accumulates and causes injury to the mitochondria and other parts of the cell and extracellular environment.

The process of aging makes us ever more susceptible to the common fatal diseases that we tend to associate with growing older, such as the increased risk of heart disease, stroke, and cancer. Even if medical interventions were to eliminate the major remaining killer diseases, the aging process would continue unabated—making the saved population ever more susceptible to a new set of diseases expressed at even later ages. Aging contributes to a wide variety of non-fatal diseases and disorders such as arthritis, loss of vision and hearing, muscle and bone loss, and a reduction in skin elasticity. It should be noted that aging is not a genetically programmed process that plays itself out along a rigid time frame. Instead, aging can be viewed as an inadvertent by-product of living beyond the biological warranty period for living machines, which in the case of sexually reproducing species means surviving beyond the end of the reproductive life span.

Forecasting Life Expectancy

How much higher can human life expectancy rise? This question has been the subject of debate among actuaries and demographers for centuries; it has taken on a new practical significance in modern times because it affects the future solvency of the age-entitlement programs found in all modern welfare states. There is a wide range of estimates: Their lower bound accords with the view that life expectancy for human populations (males and females combined) is unlikely to exceed the mid to high 80s; others claim that there is no biological reason why life expectancy cannot rise indefinitely in the future. The sections that follow present the basic arguments of the three main schools of thought that have contributed to this debate.

Extrapolation Models

Scientific forecasts of the survival of individuals and populations began with the practical work of actuaries employed by life insurance companies. Benjamin Gompertz (1779–1865), in an article published in 1825, first identified a common age pattern to the dying-out process. The formula developed by Gompertz showed that the force of mortality among humans increases exponentially from about age 20 to 85. Interestingly, Gompertz's formula provides an accurate characterization of the timing of death not just for humans but also for a variety of other species. When the U.S. Social Security program was created in the 1930s, actuaries needed to make forecasts of the annual number of beneficiaries that would draw benefits from the program. They did so by simple extrapolation: If, for example, life expectancy at birth had increased by two years in the previous two decades, it was projected to increase by another two years in the subsequent two decades.

During the next five decades, using this model, the Social Security Administration (SSA) consistently underestimated the speed with which mortality was declining. The SSA actuaries also believed that the average achievable life expectancy was constrained by biological limits to life, and that there was reason to assume that the population of the United States was approaching those limits. This view was supported by the demographic predictions at that time that the rise in life expectancy at birth would soon begin to tail off.

Toward the end of the twentieth century, the opposite problem occurred—the SSA began to overestimate the rise in life expectancy. The actuaries, as before, chose as the basis for their forecast a relatively narrow time period. In the earlier projection this introduced a conservative bias, but in the 1970s declines in death rates at middle and older ages were exceptionally rapid. Extrapolation of such rapid gains turned out to be unrealistic.

The extrapolation model, with its implication that life expectancy for humans will continue to rise far into the future, is frequently used. In a 2002 study, Jim Oeppen and James Vaupel remark that the historic rise in life expectancy is one of the most regular biological events ever observed, and argue that there is reason to believe this trend will continue throughout the twenty-first century. They project that life expectancy for humans in low mortality populations will rise to 100 years by the year 2060.

The advantages of the extrapolation method are that it is parsimonious, observation-based, and easily adjusted to reflect new developments in population health and aging. Ample evidence in the scientific literature suggests that when used over relatively short time frames, it has been a highly reliable predictor of trends in life expectancy.

Extrapolation also has weaknesses. Much of the rise in life expectancy in the twentieth century came from declining death rates before age 50. Future rises will have to come mainly from declining death rates at middle and older ages—the prospects for which may not be soundly gauged based on what happened in the earlier period. The absence of biological information as an input to projecting mortality is another problematic feature of extrapolation.

Biodemographic Views of Aging

An alternative approach to forecasting mortality draws on insights from the biodemography of aging. Biodemography is an effort to merge the scientific disciplines of biology (including evolutionary biology, genetics, and molecular biology) and demography and actuarial science in order to understand the biological forces that lead to consistent and predictable age patterns of death among sexually reproducing species. Although the intellectual roots of biodemography date back to the nineteenth century with the search for the "law of mortality," it is only in modern times that biodemographic reasoning has been used to inform mortality forecasts.

According to evolutionary theory, there is a fundamental link between the force of natural selection and the timing of reproduction among sexually reproducing species. The timing of death in populations is thought to be calibrated to the timing of genetically fixed programs for development, maturation, and reproduction. Further, the onset and length of the reproductive window (i.e., for females, the time between menarche and menopause) is thought to influence the rate of increase in the death rate from biological causes—a theoretical underpinning of evolutionary theory that has since been empirically demonstrated.

The main forces that influence the death rates of humans at high life-expectancy levels are those associated with the regulation and pathogenesis of intrinsic disease processes; biochemical changes that contribute to senescence; and biodemographic forces that influence the speed with which life expectancy rises.

In their 1996 study, Bruce Carnes, S. Jay Olshansky, and Douglas Grahn reasoned that the demonstrated linkage between the timing of reproduction and senescence could be used to inform and improve forecasts of human life expectancy. If each species has fixed programs for growth and development, there should be relatively fixed age patterns of intrinsic (biologically-caused) mortality: a species-specific "intrinsic mortality signature." This biodemographic perspective yields a practical upper bound on human life expectancy of 88 years for females and 82 years for males (85 years for males and females combined). Exceeding that boundary, according to this argument, would require modifying the biological rate of aging itself—a technological feat that, although theoretically possible in the future, is currently beyond the reach of science.

Extreme Forecasts of Life Expectancy

According to some claims, advances in the biomedical sciences will be so dramatic in the coming decades of the twenty-first century that life expectancies of 150 years or higher may be attained in the lifetimes of people living in 2002. It has even been suggested that it is currently possible to modify the rate of human aging, and that immortality is a realistic goal for the twenty-first century. The suggestion that medical science is on the verge of discovering the secret to the fountain of youth and that humanity is about to extend life dramatically has been made repeatedly throughout history, with each proclamation contradicted by subsequent experience. What has encouraged many people in the early years of the third millennium to be newly optimistic about the prospects of greatly extending average human life expectancy is that scientists now have pieced together important elements of the puzzle of aging. Also, investigators can claim legitimately that they have experimentally increased the duration of life of a variety of organisms. If it is possible to extend the life of experimental animals, the argument goes, then it should also be possible to make humans live longer.

Advances in the biomedical sciences may well continue to postpone death ("manufacture survival time") by treating the primary fatal manifestations of aging, such as cardiovascular diseases and cancer, but no scientific evidence to date suggests that the rate of aging of any animal has yet been modified. Highly optimistic projections of life expectancy have been supported by evidence of a falling risk of death from major diseases of old age and by the apparent effects of substances like the human growth hormone (GH) on some manifestations of aging. (The latter results have been wrongly interpreted by the proponents of extreme forecasts of life expectancy as a reversal of aging. However, the benefits disappear once GH treatment is stopped; there is even some evidence from animal models to suggest that GH has a life-shortening effect.) In short, there is no theoretical or scientific evidence to support the claims of anticipated dramatic increases in human life expectancy based on existing scientific knowledge.

Conclusion

Questions about the biology of aging and the average longevity of populations have always been of great fascination to scientists and the lay public. The ongoing research of gerontologists from a broad range of scientific disciplines has, in the early twenty-first century, produced a more complete understanding of the underlying biological forces that contribute to aging and the duration of life. Moreover, scientists have succeeded in experimentally extending the lifespan of several non-human organisms, leading some to believe it is only a matter of time before the same will be done for humans.

The significant advances that have been made in understanding the biology of aging are rarely incorporated into the assumptions governing estimates of future longevity. This may have the effect of making contemporary demographic forecasts of human life expectancy overly optimistic—that is, unless advances in the biomedical sciences proceed at a faster pace than in recent decades.

See also: *Biodemography; Biology, Population; Evolutionary Demography; Gompertz, Benjamin; Life Span; Oldest Old.*

BIBLIOGRAPHY

Bourgeois-Pichat, Jean. 1978. "Future Outlook for Mortality Decline in the World." *Population Bulletin of the United Nations* 11: 12–41.

Carnes, Bruce A., and S. Jay Olshansky. 1993. "Evolutionary Perspectives on Human Senescence." *Population and Development Review* 19(4): 793–806.

———. 1997. "A Biologically Motivated Partitioning of Mortality." *Experimental Gerontology* 32: 615–631.

Carnes, Bruce A., S. Jay Olshansky, and D. Grahn. 1996. "Continuing the Search for a Law of Mortality." *Population and Development Review* 22(2): 231–264.

Cassel, Christine K., H. J. Cohen, E. B. Larson, et al., eds. 2002. *Geriatric Medicine.* New York: Springer.

Chopra, Deepak. 2001. *Grow Younger, Live Longer: 10 Steps to Reverse Aging.* New York: Harmony Books.

de Grey A. D. N. J., B. N. Ames, J. K. Andersen, et al. 2002. "Stock G. Time to Talk SENS: Critiquing the Immutability of Human Aging." *Annals New York Academy of Science* No. 959.

Deevey, E. S. Jr. 1947. "Life Tables for Natural Populations of Animals." *Quarterly Review of Biology* 22: 283–314.

Finch, C. E., M. C. Pike, M. Witten, 1990. "Slow Mortality Rate Accelerations During Aging in Some Animals Approximate That of Humans." *Science* 24: 902–905.

Fossel, M. 1997. *Reversing Human Aging.* New York: Quill Publishing.

Gruman, G. J. 1966. "A History of Ideas About the Prolongation of Life." *Transactions of the American Philosophical Society* 56(9): 1–102.

Johnson T. E. 1990. "Increased Life Span of Age-1 Mutants in Caenorhabditis elegans and Lower Gompertz Rate of Aging." *Science.* 249: 908–912.

Kannisto, V., J. Lauritsen, A. R. Thatcher, and James Vaupel. 1994. "Reduction in Mortality at Advanced Ages." *Population and Development Review* 20: 793–810.

Klatz, Ronald. 1998. *Grow Young with HgH: The Amazing Medically Proven Plan to Reverse Aging.* New York: Harper Perennial Library.

Le Bourg, E. 2000. "Gerontologists and the Media in a Time of Gerontology Expansion." *Biogerontology* 1: 89–92.

Medawar, Peter B. 1952. *An Unsolved Problem of Biology.* London: Lewis.

Melov S., J. Ravenscroft, S. Malik, et al. 2000. "Extension of Life-Span with Superoxide Dismutase/Catalase Mimetics." *Science* 289: 1,567–1,569.

Miller, Richard. 2002. "Extending Life: Scientific Prospects and Political Obstacles." *The Milbank Quarterly* 80(1): 155–174.

Oeppen, J., and James W. Vaupel. 2002. "Broken Limits to Life Expectancy." *Science* 296: 1,029–1,030.

Olshansky, S. Jay. 1988. "On Forecasting Mortality." *The Milbank Quarterly* 66(3): 482–530.

Olshansky, S. Jay, and Bruce A. Carnes. 1997. "Ever Since Gompertz." *Demography* 34(1): 1–15.

Olshansky, S. Jay, Bruce A. Carnes, Christine Cassel. 1990. "In Search of Methuselah: Estimating the Upper Limits to Human Longevity." *Science* 250: 634–640.

Olshansky, S. Jay, Bruce A. Carnes, and A. Désesquelles. 2001. "Prospects for Human Longevity." *Science* 291(5508): 1,491–1,492.

Olshansky, S. Jay, Bruce A. Carnes, and R. Butler. 2001. "If Humans Were Built to Last." *Scientific American* (March).

Olshansky, S. Jay, L. Hayflick, and Bruce A. Carnes. 2002. "Position Statement on Human Aging." *Scientific American* (June).

Roizen, Michael F. 1999. *Real Age: Are You As Young As You Can Be?* New York: Cliff Street Books.

Rose, M. R. 1984. "Laboratory Evolution of Postponed Senescence in *Drosophila melanogaster*." *Evolution* 38: 1,004–1,010.

Vaupel, James W., and A. E. Gowan. 1986. "Passage to Methuselah: Some Demographic Consequences of Continued Progress Against Mortality." *American Journal of Public Health* 76: 430–433.

Wachter, Kenneth W., and C. E. Finch, ed. 1997. *Between Zeus and the Salmon: The Biodemography of Longevity.* Washington, D.C.: National Academy Press.

Williams, George C. 1957. "Pleiotropy, Natural Selection, and the Evolution of Senescence." *Evolution* 11: 298–311.

S. Jay Olshansky
Bruce A. Carnes

AGING OF POPULATION

The aging of population (also known as demographic aging and population aging) is a term that is used to describe shifts in the age distribution (age structure) of a population toward people of older ages. A direct consequence of the ongoing global fertility transition (decline) and of mortality decline among people of older ages, population aging is expected to be among the most prominent global demographic trends of the twenty-first century. Population aging is progressing rapidly in many industrialized countries, but developing countries whose fertility declines began relatively early also are experiencing rapid increases in the proportion of elderly people. This pattern is expected to continue, eventually affecting the entire world.

Population aging has many important socioeconomic and health consequences, including an increase in the old-age dependency ratio. It presents challenges for public health (in particular, the increasing burden of health care costs on national budgets) as well as for economic development (such as the shrinking and aging of the labor force and the nonviability of pay-as-you-go social security systems).

Defining and Measuring

Because the study of population aging often is driven by concern about the burden it imposes on retirement systems, the aging of population often is measured by increases in the percentage of people in the retirement ages. The definition of retirement ages varies, but a typical lower cutoff number is 65 years. A society is considered relatively old when the proportion of the population age 65 and over exceeds 8 to 10 percent. By this standard the proportion of elderly people in the United States was 12.6 percent in 2000, compared with only 4.1 percent in 1900; it is projected to increase to 20 percent by the year 2030.

A related measure of population aging is the elderly dependency ratio (EDR): the number of individuals of retirement age divided by the number of those of working age. For convenience working age may be assumed to start at 15 years, although increasing proportions of individuals pursue their education beyond that age, remaining financially dependent (on the state or, increasingly, their parents) or borrowing against their own future incomes. The ratio of the elderly dependent population to the economically active (working) population also is known as old-age dependency ratio, age-dependency ratio, or elderly dependency burden and is used to assess intergenerational transfers, taxation policies, and saving behavior.

Another indicator of the age structure is the aging index (sometimes referred to as the elder–child ratio), which is defined as the number of people age 65 and over per 100 youths under age 15. In 2000 only a few countries (Germany, Greece, Italy, Bulgaria, and Japan) had more elderly persons than youths (that is, an aging index above 100). By 2030, however, the aging index is projected to exceed 100 in all developed countries, and the indexes for several European countries and Japan are expected to exceed 200. In the United States the index was 57 in 2000; by 2030 it is projected to rise to 109. Aging indexes are much lower in developing countries than in the developed world, but the proportional rise in the aging index in developing countries is expected to be greater than that in developed countries.

These indicators of population aging are headcount ratios (HCRs); that is, they simply indicate the number of individuals in large age categories. These indicators fail to take into account the age distribution within the large categories, in particular among the elderly. When the fertility and mortality trends responsible for population aging have been fairly regular over time, population growth is positively correlated with age: The oldest age groups are growing fastest. This implies that if the proportion of the population over age 65 is increasing, within that 65-and-over population the proportion over age 80, for example, is also increasing. Health, financial situation, and consumption patterns may vary greatly between 65-year-olds and 80-year-olds, but this heterogeneity in the elderly population is concealed in simple ratios.

Increasing attention is paid to the "oldest olds" (typically defined as persons age 80 and over), a category that is expanding rapidly. The number of centenarians, a longtime subject of curiosity, is growing even faster: Estimated at 180,000 worldwide in 2000, it could reach 1 million by 2030.

The second class of indicators of population aging include the standard statistical measures of location: the median, mean, and modal ages of the population. The median age—the age at which exactly half the population is older and half younger—is the most widely used indicator. For the year 2000 the median age in the United States was 36 years, a typical value for most developed countries. The median age for Africa was 18 years. Because it is more sensitive to changes at the right-hand tail of the age distribution (the oldest old ages), the mean age of population may be preferred to the median age in studying the dynamics of population aging.

Because population aging refers to changes in the entire age distribution, any single indicator may be insufficient to measure it. The age distribution of a population is often very irregular, showing scars of past events (wars, depressions, etc.), and cannot be described by only one number without a significant loss of information. Changes in the age distribution also may occur in a very irregular fashion over the age range, hence much information would be lost in a single-index summary.

A more adequate approach to describing population aging is through a set of percentiles. Alternatively, a graphical approach may be used that involves analyzing population pyramids. Demographers commonly use population pyramids to describe both age and sex distributions of populations. Youthful populations are represented by pyramids with a broad base of young children and a narrow apex of older people, and older populations are characterized by more uniform numbers of people in the age categories.

Demographic Determinants

To understand the demographic factors that cause population aging, demographers often refer to the *stable population model*. This model assumes that age-specific fertility and mortality rates remain constant over time, resulting in a population with an age distribution that eventually ceases to change: It becomes "stable." Conversely, the model suggests that in a population closed to migration any change in age structure, population aging in particular, can be caused only by changes in fertility and mortality rates.

The influence of changes in fertility rates on population aging may not be obvious at first sight. With everything else held constant, however, a fertility decline reduces the size of the most recent birth cohorts relative to the previous birth cohorts, reducing the size of the youngest age groups relative to that of the older ones.

The effects of changes in mortality rates on population aging appear more intuitive but are in fact ambiguous. Reductions in mortality rates do not necessarily contribute to population aging. More specifically, declines in the mortality rates of infants, children, and persons younger than the population's mean age tend to lower that mean age. Clearly, a reduction of neonatal mortality—death in the first month of life—adds individuals at age zero and thus should lead to the same alleviation of population aging that an increase in childbearing does.

Population aging thus is related to the demographic transition, the processes that lead a society from a demographic regime characterized by high rates of fertility and mortality to one characterized by lower fertility and mortality rates. In the course of this transition, the age structure is subjected to different influences. In the typical sequence the transition begins with successes in preventing infectious and parasitic diseases that most benefit infants and young children. The result is an improvement in life expectancy at birth. Fertility, however, tends to remain unchanged, thus producing large birth cohorts and an expanding proportion of children relative to adults. Other things being equal, this initial decline in mortality generates a younger population age structure.

After initial and sometimes very rapid gains in infant and child mortality have been achieved, further mortality declines increasingly benefit people of older ages and eventually are accompanied by fertility declines. Both changes contribute to a reversal of the early effect of mortality decline on the age structure, and this synergy is known as the double aging process. Most developed countries today are experiencing such a process, but further analysis suggests that their history of declining mortality is the dominant factor in current aging.

Mortality declines continue in these countries: Indeed, the decrease in mortality rates among those age 85 years and over has accelerated since the 1950s. This latest phase of mortality decline, which is concentrated in the older age groups, is becoming an important determinant of population aging, particularly among women.

The rate of population aging may be modulated by migration. Immigration marginally slows population aging (in Canada and Europe, for example) to the extent that immigrants are younger than the population average and have higher fertility than do the native-born. However, emigration of working-age adults accelerates population aging, a phenomenon that can be observed in some Caribbean countries. Population aging in those countries also is accelerated by the immigration of elderly retirees from other countries and the return migration of former emigrants who are above the average population age.

Dynamics

The current level and pace of population aging vary widely by geographic region and usually within regions as well, but virtually all nations were experiencing growth in the number of elderly residents at the beginning of the twenty-first century (for selected regions and countries, see Table 1). The proportion of the world population age 65 and over increased from 5.2 percent in 1950 to 6.9 percent in 2000. In Europe, however, the proportion was 14.7 percent in 2000. The highest proportions used to be found in Northern Europe (e.g., 10.3 percent in Sweden in 1950), but by 2000 they were in Southern Europe (e.g., 18.1 percent in Italy).

The proportions of elderly people are lower outside of Europe, with the notable exception of Japan, where this figure increased from 4.9 percent in 1950 to 17.2 percent in 2000. The age structure of the United States continues to be influenced by the large birth cohorts of the baby boom (people born from 1946 through 1964) who are not yet age 65. The proportion of the elderly population in the United States, which was 12.3 percent in 2000, remains low compared to the average in other developed countries.

Population aging has the following notable features:

1. The most rapid growth occurs in the oldest age groups: the oldest old (80-plus or 85-plus years) and centenarians (100-plus years) in particular. In other words, population aging is becoming "deeper," with a disproportionately rapid accumulation of particularly old and frail people.
2. Population aging is particularly rapid among

women, resulting in "feminization" of population aging (because of lower mortality rates among women). For example, in the United States in the population 65 years and older in 2000 there were 20.6 million women and 14.4 million men, or a ratio of 143 women for every 100 men. The female-to-male ratio increases with age, reaching 245 for persons 85 and over.

3. Another consequence of lower female mortality is the fact that almost half of older (65-plus years) women (45%) in 2000 were widows, living without spousal support.
4. Population aging also causes changes in living arrangements, resulting in increasing numbers of older people living alone (about 30% of all noninstitutionalized older persons in 2000 lived alone in the United States).
5. Because older persons usually have lower income and a higher proportion of them live below the poverty line, population aging is associated with poverty, particularly in developing countries.

Twenty-First Century Projections

Population aging in the future will depend on demographic trends, but most demographers agree that the fertility and mortality changes that would be required to reverse population aging in the coming decades are very unlikely to occur. According to the 2000 United Nations medium population projections, population aging in the first half of the twenty-first century should exceed that of the second half of the twentieth century. For the world as a whole, the elderly (65-plus) will grow from 6.9 percent of the population in 2000 to a projected 19.3 percent in 2050 (Table 1). In other words, the world average would be higher in 2050 than the current world record.

All regions are expected to see an increase, although it should be milder in some regions, such as Africa, where the projected increase is from 3.3 percent in 2000 to 6.9 percent in 2050. However, in Latin America and the Caribbean the increase is projected to be from 5.4 percent in 2000 to 16.9 percent in 2050, higher than the current European average. The projected increase is even more spectacular in China: from 6.9 percent in 2000 to 22.7 percent in 2050.

Although population aging thus is becoming a worldwide phenomenon, the most developed countries probably will continue to be the forerunners. The United Nations projections for 2050 suggest that there will be 29.2 percent of elderly persons in the European population as a whole but more than 30 percent in a number of individual European countries (such as Italy) and perhaps as much as 36.4 percent in Japan. Again, the projected increase appears less dramatic in the United States: from 12.3 percent in 2000 to 21.1 percent in 2050.

TABLE 1

Percentage of Population at Ages 65 and Older

Major Area, Region, and Country	1950	Percent 2000	2050
World	5.2	6.9	19.3
Africa	3.2	3.3	6.9
Latin America and the Caribbean	3.7	5.4	16.9
China	4.5	6.9	22.7
India	3.3	5.0	14.8
Japan	4.9	17.2	36.4
Europe	8.2	14.7	29.2
Italy	8.3	18.1	35.9
Germany	9.7	16.4	31.0
Sweden	10.3	17.4	30.4
United States	8.3	12.3	21.1

Note: Estimated and projected percentages of the elderly (65 + years) in selected areas, regions, and countries of the world: 1950, 2000, and 2050. ("Medium projection.")

SOURCE: United Nations (2001).

There is uncertainty in any projection, but it is important to note that previous population projections underestimated rather than overstated the current pace of population aging. Before the 1980s the process of population aging was considered to be a consequence of fertility decline alone, and it was predicted that the pace of population aging would decrease after stabilization of fertility rates at a low level. The rapid decline in old-age mortality that was observed in developed countries in the last decades of the twentieth century significantly accelerated population aging. At the beginning of the twenty-first century, old-age mortality trends are becoming the key demographic component in projecting the size and composition of the world's future elderly population.

Current and future uncertainties about changing mortality may produce widely divergent projections of the size of tomorrow's elderly population. For example, the U.S. Census Bureau's middle-mortality series projection suggests that in the United States there will be 14.3 million persons age 85 and over in the year 2040, whereas the low-mortality (high life expectancy) series implies 16.8 million. Alternative projections, using assumptions of lower death rates and higher life expectancies, have produced estimates ranging from 23.5 million to 54 million persons age 85 and over in 2040.

Social and Economic Implications

Although population aging represents a success story for humankind (survival to old ages has become commonplace), it also poses profound challenges to public institutions that must adapt to a changing age structure.

The first challenge is associated with the marked increase in the older retired population relative to the shrinking population of working ages, which creates social and political pressures on social support systems. In most developed countries rapid population aging places strong pressure on social security programs. For example, the U.S. social security system may face a profound crisis if radical modifications are not enacted. Cuts in benefits, tax increases, massive borrowing, lower cost-of-living adjustments, later retirement ages, and combinations of these elements are being discussed as the painful policies that may become necessary to sustain pay-as-you-go public retirement programs such as Medicare and Social Security. Privatization and shift to a funded scheme in retirement programs are also considered as potential options to cope with population aging.

Population aging also presents a great challenge for health care systems. As populations age, the prevalence of disability, frailty, and chronic diseases (Alzheimer's disease, cancer, cardiovascular and cerebrovascular diseases, etc.) is expected to increase dramatically. Some experts are concerned that human society may become a "global nursing home" (Eberstadt 1997).

The aging of the population is a global phenomenon that requires international coordination of national and local actions. The United Nations and other international organizations have developed recommendations that are intended to mitigate the adverse consequences of population aging. These recommendations include reorganization of social security systems; changes in labor, immigration, and family policies; promotion of active and healthy lifestyles; and more cooperation between governments in resolving the socioeconomic and political problems posed by population aging.

On the positive side, the health status of older people within a given age group has been improving over time. More recent generations have a lower disease load. Older people can live vigorous and active lives until a much later age than they could in the past and, if encouraged to be productive, can be economic contributors to society. Moreover, current intensive biomedical anti-aging studies may further extend the healthy and productive period of human life in the future.

See also: *Age Structure and Dependency; Fertility, Below-Replacement; Life Span; Mortality Decline; Oldest Old; Second Demographic Transition.*

BIBLIOGRAPHY

Administration on Aging. 2001. *A Profile of Older Americans: 2001.* Washington, D.C.: U.S. Department of Health and Human Services.

De Grey, Aubrey D. N., Leonid Gavrilov, S. Jay Olshansky, L. Stephen Coles, Richard G. Cutler, Michael Fossel, and S. Mitchell Harman. 2002. "Anti-aging Technology and Pseudoscience." *Science* 296: 656–656.

Eberstadt, Nicholas. 1997. "World Population Implosion?" *Public Interest* 129: 3–22.

Gavrilov, Leonid A., and Natalia S. Gavrilova. 1991. *The Biology of Life Span: A Quantitative Approach.* New York: Harwood Academic.

Kinsella, Kevin, and Victoria A. Velkoff. 2001. *An Aging World: 2001.* U.S. Census Bureau, Series P95/01–1. Washington, D.C.: U.S. Government Printing Office.

Lutz, Wolfgang, Warren Sanderson, and Sergei Scherbow. 2001. "The End of World Population Growth." *Nature* 412: 543–545.

Preston, Samuel H., Christine Himes, and Mitchell Eggers. 1989. "Demographic Conditions Responsible for Population Aging." *Demography* 26: 691–704.

Preston Samuel H., Patrick Heuveline, and Michel Guillot. 2001. *Demography: Measuring and Modeling Population Processes.* Oxford: Blackwell.

United Nations. 2001. *World Population Prospects: The 2000 Revision.* New York: United Nations.

Leonid A. Gavrilov
Patrick Heuveline

AIDS

Acquired Immune Deficiency Syndrome (AIDS) was first noticed and described in the United States in 1981, initially in homosexual men. Further cases in hemophiliac patients were reported in 1982. The publication of accounts of this new disease in the newsletter *Morbidity and Mortality Weekly Reports* triggered responses from physicians in other developed countries who had recently come across similar constellations of symptoms, which indicated a breakdown of the immune system in individuals who had no known exposure to radiation or immunosuppressant drugs.

Origins of HIV

The Human Immunodeficiency Virus (HIV) that is the cause of AIDS was first isolated by Luc Montagnier at the Pasteur Institute in Paris in 1983. HIV is a retrovirus, which means that it stores its genetic information as RNA, stimulating the production of DNA copies of its genome when it enters a host cell. A systematic testing of stored serological samples carried out in the late 1990s in a search for the origins of this disease revealed the earliest documented occurrence of HIV dating from 1959. This was in a blood sample taken from a male subject "L70," one of a number of hospital patients from Western and Central Congo seen in Leopoldville in that year.

HIV is believed to have arisen as a result of ancestral viruses crossing the species barrier, from chimpanzees and monkeys to man. Such crossovers are believed to have occurred at least twice, with the more virulent strain, HIV-1, originating from a simian immunodeficiency virus (SIV) of chimpanzees, and HIV-2 coming from an SIV usually found in sooty mangabey monkeys. Modeling studies based on the genetic diversity of the HIV viruses, reported by B. Korber and colleagues, estimate that the species crossover occurred between 1920 and 1940. It is believed that the virus was present in isolated human populations in rural Central Africa from this time, and began to spread more widely in the 1960s and 1970s, as a result of wars, tourism, and social changes linked to modernization, which all contributed to increased population mobility.

In the 1980s and 1990s HIV/AIDS was identified in every region of the world. UNAIDS, the Joint United Nations Programme on HIV/AIDS, has estimated that 42 million adults and children worldwide were infected with HIV by the end of 2002. Of this number 29 million (70%) were living in sub-Saharan Africa. Table 1 shows the estimated numbers of infected persons in each of the world's major regions at the end of 2002.

Etiology and Disease Progression

HIV spreads by direct contact through body fluids. This may occur during sexual intercourse, or as a result of mother-to-child transmission during pregnancy, delivery, or breastfeeding. The virus may also be transferred in blood used for transfusions, or in blood products, such as the clotting factor supplied to hemophiliacs. Finally, it can be spread by unsterilized hypodermic needles and surgical instruments, so outbreaks among injectable drug users (IDU) are common where injecting equipment is shared. In the 1990s it was speculated that the species transfer may have occurred as a result of live polio vaccine being cultivated in infected primate livers, but this theory has been discounted, as no traces of the virus were found in stored vaccine samples. However, mass vaccination campaigns could have helped to spread the virus in the 1960s, if needles were reused during the campaigns, or left behind and subsequently reused in poorly equipped hospitals. The virus is very fragile: it cannot survive outside of the human host cell and cannot be spread by insect bites, by casual touching, or by sharing of food utensils or clothes.

Both HIV-1 and HIV-2 target specific cells of the immune system: the T-cells, which are the human body's main immunological defense against infection. Primary infection with HIV in an adult usually results in rapid multiplication of the virus in the lymph system, and a rapid decline in T-cells. An immune response is usually provoked within four to six weeks, and after this time antibodies to HIV can be detected in the blood. The disease then enters a latent phase, which has a median duration of around

TABLE 1

Selected Characteristics of the HIV/AIDS Epidemic, by World Region, End of 2002

	Epidemic started	Adults & children living with HIV/AIDS	Adults & children newly infected with HIV	Adult prevalence rate*(%)	Percent of HIV positive adults who are women	Main modes of transmission for adults living with HIV/AIDS**
Sub-Saharan Africa	late '70s early '80s	29.4 million	3.5 million	8.8	58	Hetero
North Africa and Middle East	late '80s	550,000	83,000	0.3	55	Hetero, IDU
South and South-East Asia	late '80s	6.0 million	700,000	0.6	36	Hetero, IDU
East Asia and Pacific	late '80s	1.2 million	270,000	0.1	24	IDU, Hetero, MSM
Latin America	late '70s early 80's	1.5 million	150,000	0.6	30	MSM, IDU, Hetero
Caribbean	late '70s early 80's	440,000	60,000	2.4	50	Hetero, MSM
Eastern Europe and Central Asia	early '90s	1.2 million	250,000	0.6	27	IDU
Western Europe	late '70s early '80s	570,000	30,000	0.3	25	MSM, IDU
North America	late '70s early '80s	980,000	45,000	0.6	20	MSM, IDU, Hetero
Australia and New Zealand	late '70s early '80s	15,000	500	0.1	7	MSM
Total		**42 million**	**5 million**	**1.2**	**50**	

*The proportion of adults aged 15 to 49 living with HIV/AIDS
**Hetero - heterosexual transmission; IDU - transmission through injecting drug use; MSM - sexual transmission among men who have sex with men

SOURCE: UNAIDS (2002a).

nine years in the absence of treatment in developing and developed countries alike. During this latent phase the number of T-cells declines steadily. Eventually, the immune system is so compromised that it is no longer able to respond adequately to a range of infections and cancers, such as Kaposi's sarcoma, that usually pose little threat to healthy individuals. Once such clinical manifestations of AIDS occur, death follows rapidly: in the studies reviewed by J. T. Boerma and colleagues, survival times of five to nine months were reported in developing countries, 9 to 26 months in developed countries.

In infants, the disease usually progresses much more rapidly, because the immature immune system cannot respond adequately in the primary infection phase. Median survival time of infected infants in the absence of treatment is around two years.

HIV mutates rapidly both within an infected individual and across individuals as the infection spreads in a population. The resulting diversity of forms makes it difficult to develop an effective vaccine, and ensures the rapid emergence of drug resistant forms.

Epidemiological Evidence

On a national basis, AIDS epidemics are characterized as generalized if HIV prevalence exceeds 1 percent in the adult population aged 15–49. In developing countries, almost all the evidence for HIV prevalence levels in the general population comes from the anonymous screening of blood samples obtained from pregnant women in antenatal clinics. As a consequence there is very little direct evidence on HIV prevalence among men. Subject to the resulting uncertainties in assessing prevalence levels, UNAIDS estimates that only 5 of the 45 countries of sub-Saharan Africa did not have generalized epidemics by 2000. Adult prevalence had already reached over 20 percent in Southern Africa, and lay between 10 percent and 20 percent in most of Eastern and Central Africa. Western African countries, especially those where HIV-2 is the predominant strain, generally had lower rates, between 2 percent and 5 percent. In the first years of the twenty-first century, HIV prevalence was either stagnant or increasing all over Africa, except for Uganda, where the epidemic appeared to have passed a turning point, with a decline in prevalence from 14 percent in the early 1990s to around 8 percent at the end of the decade.

The other region with a generalized epidemic is the Caribbean, where adult prevalence was over 1 percent by 2001 in nine countries. Southeast Asia as a whole had a prevalence of 0.6 percent in 2001, but in three countries, Cambodia, Myanmar, and Thailand, adult prevalence was over 1 percent, though in Thailand a strong downward trend was evident by this time in the general population. The future course of the epidemic in Asia will be largely determined by trends in the most populous countries, India and China, in both of which HIV infection is concentrated in the high-risk groups (sex workers and IDU) and in particular regions. (Six states in India recorded prevalence levels over 1 percent in 2001; Yunan province in China recorded an increase from 6 percent to 10 percent between 2000 and 2001 in prevalence among sex workers.)

The sub-populations most strongly affected by the epidemic vary widely by region, as shown in Table 1. In high-income industrialized countries by 2002, most of the persons living with HIV were men who had sex with men (MSM) or IDU. Eastern Europe and Central Asia have epidemics that are concentrated among IDU—but these are among the fastest growing epidemics in populations that are difficult to monitor.

There is evidence, summarized by M. Caraël and K. Holmes, that male circumcision is an important risk reduction factor. Consistent condom use has been shown to be effective in reducing sexual transmission in MSM epidemics in industrialized countries. Paradoxically, it does not emerge as a protective factor in community studies in Africa since condoms are mainly used by those who are already infected or believe themselves to be at very high risk. Co-infection with other sexually transmitted diseases has been found to significantly enhance the transmission of HIV.

Population mobility is likely to have been an important factor in the initial spread of HIV, and is implicated in the rapid spread of HIV in Southern African countries in the late 1990s. These countries had a tradition of male labor migration to mines and commercial farming estates that encouraged the formation of temporary partnerships and the growth of commercial sex.

Demographic Impacts of AIDS in Africa

In the epidemics driven by MSM or IDU, the number of males infected exceeds that of females by a factor of two to ten. However, in heterosexually spread epidemics, the number of infected females generally exceeds that of infected males. Several factors account for this: males tend to have more sexual partners than females; HIV transmission from male to female is more efficient than from female to male; and most of all, there are more females than males at risk of infection because of the age difference between sexual partners and the steeply tapering youthful age distribution.

In Africa, where generalized epidemics began in the 1980s, strong evidence of an impact on national mortality trends was detected in the 1990s. Almost all African countries lack national vital registration systems, so cause of death data are not available, and most of the evidence for trends in age-specific mortality rates comes from census and survey data, either from direct questions about household deaths in the year preceding the survey, or indirect enquiries about the survival of relatives. Griffith Feeney has used mortality data from a variety of secondary sources to show that adult mortality in Zimbabwe more than doubled between 1982 and 1997, spanning the time when HIV prevalence rose from virtually zero to almost 30 percent.

In the context of the HIV epidemic, the most widely used indirect estimation techniques, such as the child survival and orphanhood methods, yield mortality estimates that are biased downward, because of the high correlation between the survival of parents and children. Reports of household deaths may also be incomplete as households tend to dissolve upon the death of the head. However, using new analytical techniques based on reported survival of siblings, Ian Timaeus has demonstrated significant rises in adult mortality in the most severely affected countries. For example, five Eastern and Southern African countries that included sibling survival questions in Demographic and Health Survey rounds in the late 1990s recorded large increases in the probability of dying between age 15 and age 60: from an average of 28 percent, five years before the survey, to 45 percent in the survey year. Estimated HIV prevalence at the time of the surveys in these countries averaged 24 percent. By contrast, in five West African countries, with an average HIV prevalence of 2 percent, similar analyses of DHS sibling survival data collected in the 1990s indicated a continuing modest improvement in this index of adult mortality, from 26 percent to 22 percent over a similar 5-year period.

The most compelling evidence about the scale of the impact on mortality comes from longitudinal community based studies, in which repeated serological testing is accompanied by demographic surveillance. Studies of this type were established in East African countries in the early 1990s and subsequently in Southern Africa. They have shown that mortality rates among HIV infected adults are 10 to 15 times the rates observed among uninfected individuals. The relative risk of mortality among HIV-positive individuals has been shown to increase with epidemic maturity, as the balance between individuals who were recently infected and those who have been living with the disease for some time shifts in favor of the latter, who are closer to developing full-blown AIDS. Duration of survival post-infection in adults is strongly related to age at infection, with much quicker progression to AIDS among those infected at a later age.

Community-based studies rarely provide direct comparisons of mortality in HIV-infected and uninfected children, because of the problems of ascertaining the HIV status of a newborn infant. Maternal HIV antibodies cross the placental barrier much more readily than the virus itself, and the commonly available, relatively inexpensive serological tests detect the presence of antibodies rather than virus. However, such studies have also shown that the mortality among children of HIV-infected mothers is between 2.5 and 4 times that observed among children of uninfected mothers. Hospital-based studies (reported by L. Kuhn and Z. A. Stein) have shown that in the absence of antiretroviral therapy, mother-to-child transmission of the virus occurs in about 30 percent of cases, suggesting that mortality rates for HIV infected children could be 5 to 10 times the rates observed among uninfected children.

Although there is strong evidence on the scale of excess mortality among HIV infected persons, considerable uncertainty remains concerning the number and distribution of deaths due to HIV. Official estimates of historical and current deaths in the worst affected countries are based on models fitted to incomplete time series of prevalence data from a limited number of sentinel sites that perform anonymous tests on pregnant women. The predominantly urban character of sentinel clinics means that they tend to be based in communities with relatively high HIV prevalence.

HIV also has an impact on fertility, with HIV-positive women experiencing significantly lower fertility rates than uninfected women. Biological explanations for this effect include increased fetal losses and stillbirths, increased menstrual irregularities and decreased spermatogenesis in male partners. Social mechanisms are probably even more important, as women who are suspected of being HIV-positive will find it harder to remarry following widowhood and divorce, both of which occur more frequently among the HIV positive. Community-based studies have shown that the overall reduction in fertility in HIV-positive women can range from 10 percent to 40 percent, with older HIV positive women experiencing proportionately larger reductions. Since HIV lowers fertility, estimates of HIV prevalence based on anonymous surveillance of pregnant women attending prenatal clinics tend to underestimate HIV prevalence among women in the community.

Evidence of an impact of HIV on the population age structure is harder to find, because of countervailing demographic tendencies. The increased mortality due to HIV slows population growth, which would tend to make the population structure older. However, since adults are disproportionately affected compared to children, their early death tends to make the age structure younger. At a subnational level, internal migration, which is very high among young adults, often masks or exacerbates the impact on the age structure.

In the worst-affected countries of Southern Africa, where HIV prevalence was estimated to have passed 20 percent by the year 2000 (Botswana, Lesotho, Malawi, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe), life expectancy is projected to fall below 40 years. These countries may well experience periods of negative population growth in the first few decades of the twenty-first century. This is particularly likely to occur in populations that have already experienced significant fertility declines by the time the HIV epidemic took hold. Estimates and projections of the effect on population size in the worst-affected countries, made by the United Nations Population Division, are shown in Figure 1. South Africa is an example of a country in which AIDS is likely to cause negative population growth—as seen in the projections in Figure 2.

Socioeconomic Consequences

It has been estimated (by Alan Whiteside and Clem Sunter) that AIDS has caused annual per capita economic growth to fall by 0.5 to 1.2 percentage points in about half the countries of sub-Saharan Africa. Absenteeism and illness in the work force mean that employers face increasing costs in recruitment, training, insurance, and sick pay.

A 2001 report from the UN Food and Agriculture Organization estimates that 7 million farm workers have died from AIDS-related causes since 1985, and 16 million more are expected to die by 2020, with a consequent decrease in agricultural production. Children of families in which the adults are too sick to work are often taken out of school to work on family farms and to care for their relatives, and orphans tend to have low school attendance rates because the families who care for them cannot afford an extra set of school fees. Teachers are disproportionately affected by AIDS—in 1999, according to UNAIDS, over 15,000 teachers died in sub-Saharan Africa. Because of the age profile of AIDS deaths, it is the most productive part of the labor force that will be lost, and families will lose parents who have not yet finished bringing up their children.

The health sector has come under severe stress in many African countries. Public expenditure surveys in 1997 showed that in 7 out of 16 countries health spending on AIDS exceeded 2 percent of GDP, and accounted for between 25 percent and 70 percent of the total public health expenditure. This generally represents spending on treatment of opportunistic infections, since most African countries cannot afford antiretroviral therapy, except possibly in the one-off doses that are used at delivery to prevent mother-to-child transmission.

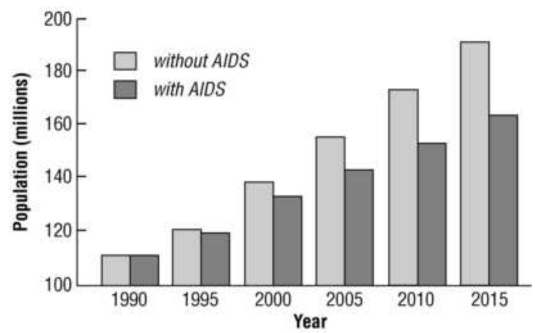
Policy Responses

UNAIDS has estimated that US$10 billion per year will be needed in low- and middle-income countries to combat AIDS in the first decade of the twenty-first century.

Official silence and outright denial have paralyzed efforts to control the epidemic in many countries. Uganda, one of the few countries to admit the problem and encourage public discussion early on, is the only African country in which there is clear evidence of a decline in prevalence. Policy responses that have been advocated include education to raise awareness and promote behavioral change; encouragement of voluntary counseling and testing; the promotion and social marketing of condoms and the treatment of other STDs to lower transmission probabilities. Thailand is also widely recognized as a success story in the fight against AIDS; there, the key strategy was the 100 percent condom use campaign in brothels. Thailand has also recorded a marked decrease in the proportion of men having sex with commercial sex workers.

FIGURE 1

Total Population Size with and without AIDS in the Nine Most Affected Countries*, Estimates and Projections, 1990–2015



*Botswana, Kenya, Malawi, Mozambique, Namibia, Rwanda, South Africa, Zambia, Zimbabwe.

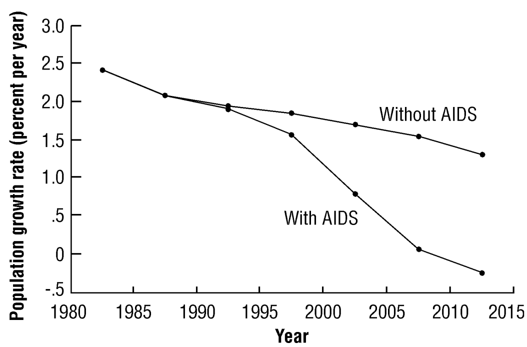
SOURCE: United Nations Population Division (1999). *World Population Prospects: The 1998 Revision, Volume 3*, New York: United Nations.

Treatment with antiretrovirals is in great demand by people suffering with HIV, but is very expensive and unlikely to do much to stem the spread of the epidemic in the poorest countries of sub-Saharan Africa. Vaccines and microbicides offer more hope as preventive strategies, but major research efforts are still needed in the development of these medical interventions. Antiretroviral drugs, such as nevirapine, have had proven success when administered in single doses to pregnant women and their newborn infants, but since such treatment does not affect disease progression in mothers, they cannot slow the overall development of the epidemic, or the growth in the number of AIDS orphans.

The demographic consequences of the AIDS epidemic are relatively easy to project if age and sex specific infection rates can be accurately forecast. Unfortunately, there is little agreement among epidemiologists on robust and widely applicable meth-

FIGURE 2

South Africa: Population Growth Rate with and without AIDS, Estimates and Projections, 1980–2015



Note: Rates are 5-year averages plotted at mid-point of range.

SOURCE: United Nations Population Division (2001). *World Population Prospects: The 2000 Revision, Volume 1.* New York: United Nations.

ods for projecting long-term trends in infection, and the data requirements for the more sophisticated projection tools make them unsuitable for most countries in sub-Saharan Africa. Relatively simple models based on fitting parametric curves to observed time series of HIV prevalence in antenatal clinics have been used successfully by UNAIDS for short-term projections. Because these simple models are not structured by sex and age, they are of limited use in making long-term demographic projections. In the absence of effective interventions, most analysts agree that a continuation of the trends observed in the late 1990s could lead to adult prevalence levels of over 25 percent in many African countries in the first decade of the twenty-first century.

See also: *Black Death; Diseases, Infectious; Emerging Infectious Diseases; Epidemics; Mortality Reversals.*

BIBLIOGRAPHY

Boerma, J. T., A. J. Nunn, and J. A. Whitworth. 1998. "Mortality Impact of the AIDS Epidemic: Evidence from Community Studies in Less Developed Countries." In *Demographic Impact of AIDS,* ed. M. Caraël and B. Scwartlander. *AIDS* 12 (Supplement 1): 3–14.

Caraël, M., and K. Holmes, eds. 2001. "The Multicentre Study of Factors Determining the Different Prevalences of HIV in Sub-Saharan Africa." *AIDS* 15 (Supplement 4): 1–132.

Collaborative Group on AIDS Incubation and Survival including the Cascade EU Concerted Action. 2000. "Time from HIV-1 Seroconversion to AIDS and Death before Widespread Use of Highly-active Antiretroviral Therapy: A Collaborative Re-analysis." *Lancet* 355: 1,131–1,137.

Feeney, Griffith. 2001. "The impact of HIV/AIDS on Adult Mortality in Zimbabwe." *Population and Development Review* 27: 771–780.

Food and Agriculture Organization, Committee on World Food Security. 2001. *The Impact of HIV/AIDS on Food Security.* Rome: Food and Agriculture Organization.

Korber, B., B. Gaschen, K. Yusim, R. Thakallapally, C. Kesmir, and V. Deours. 2001. "Evolutionary and Immunological Implications of Contemporary HIV-1 Variation." In *The Changing Face of HIV and AIDS,* special issue of *British Medical Bulletin,* ed. Robin A. Weiss, Michael W. Adler, and Sarah L. Rowland-Jones. Oxford: Oxford University Press.

Kuhn, L., and Z. A. Stein. 1995. "Mother-to-Infant HIV Transmission: Timing, Risk Factors and Prevention." *Paediatric and Perinatal Epidemiology* 9: 1–29.

Marx, P. A., P. G. Alcabes, and E. Drucker. 2001. "Serial Human Passage of Simian Immunodeficiency Virus by Unsterile Injections and the Emergence of Epidemic Human Immunodeficiency Virus in Africa." *Philosophical Transactions of the Royal Society of London, Series B* 356(1410): 911–920.

Morgan D., C. Mahe, B. Mayanja, J. M. Okongo, R. Lubega, and J. A. G. Whitworth. 2002. "HIV-1 Infection in Rural Africa: Is There a Difference in Median Time to AIDS and Survival Compared with that in Industrialized Countries?" *AIDS* 16: 597–603.

Morgan, D., and J. A. G. Whitworth. 2001. "The Natural History of HIV-1 Infection in Africa." *Nature Medicine* 7(2): 143–145.

Timæus, Ian. 1998. "Impact of the HIV Epidemic on Mortality in Sub-Saharan Africa: Evidence from National Surveys and Censuses." In *Demographic Impact of AIDS,* ed. M. Caraël and B. Scwartlander. *AIDS* 12(Supplement 1): 15–27.

UNAIDS. 2002a. *AIDS Epidemic Update—December 2002.* Geneva: UNAIDS.

UNAIDS. 2002b. Report on the Global HIV/AIDS Epidemic 2002. Geneva: UNAIDS.

UNAIDS. 2002c. "Improved Methods and Assumptions for Estimation and Projection of HIV/AIDS Epidemics: Recommendations of the UNAIDS Reference Group on HIV/AIDS Estimates, Modelling, and Projections." *AIDS* 16(Special Issue): W1–W14.

Whiteside, Alan, and Clem Sunter. 2000. *AIDS, the Challenge to South Africa.* Cape Town, South Africa: Human & Rouseau Tafelberg.

Zaba, Basia, and Simon Gregson. 1998. "Measuring the Impact of HIV on Fertility in Africa." In *Demographic Impact of AIDS,* ed. M. Caraël and B. Scwartlander. *AIDS* 12(Supplement 1): 41–50.

INTERNET RESOURCE.

UNAIDS. 2003. "HIV/AIDS Information and Data." <http://www.unaids.org/hivaidsinfo/>.

Basia Zaba

ALCOHOL, HEALTH EFFECTS OF

In the year 2000, total per capita alcohol consumption was 9.5 liters in the countries in the European Union, 7.7 liters in Australasia, 7.0 liters in Eastern Europe, 6.7 liters in North America, 4.1 liters in Latin America, and 2.3 liters in the rest of the world. Compared with the figures for 1990, consumption decreased in the richer regions and increased in the poorer regions. These estimates are based on 58 countries with reliable data. Alcohol from home production and other non-registered sources is not included, although these can be important sources of alcohol in poor countries. Although wide differences exist, there is a general trend toward homogenization of per capita alcohol consumption and of the relative shares of beer, wine, and spirits worldwide.

Distribution of Alcohol Consumption

The distribution of alcohol consumption in a population is typically skewed, with a minority (e.g., 10%) accounting for the bulk (e.g., 50%) of the total consumption. On average men consume much more alcohol than women do. By age, consumption peaks among young adults and then gradually decreases, except among alcoholics, who usually increase their consumption with age (progressively or with fluctuations). Some manage to become ex-drinkers or moderate drinkers. The proportion of abstainers varies greatly by country, ranging from as low as about 10 percent in countries with high alcohol consumption to practically 100 percent in countries that shun alcohol.

Effects on Health and Mortality

Alcohol intake influences the risk of death, disease, injuries, and mental illness. In general populations the relationship between alcohol intake and total mortality is curvilinear. Abstainers have slightly higher mortality than do moderate drinkers, and heavy drinkers have much higher mortality than do the other two groups. On average mortality among drinkers equals that among abstainers at the level of 40 grams per day of alcohol for men and 20 grams per day for women. (One drink contains approximately 12 grams of alcohol.) The relationship between alcohol intake and the overall occurrence of diseases, hospital admissions, and leaves of absence is also curvilinear.

Mortality among alcoholics after treatment is from two to six times the level of the general population. Such death rates shorten the lifespan of this group by 6 to 18 years. Excess mortality is due partly to tobacco use and unhealthy living habits.

Heavy alcohol intake increases strongly the incidence of liver cirrhosis, respiratory and gastrointestinal tract cancer, hemorrhagic stroke, hypertension, and injuries. Less strong but clear increases can be found for chronic pancreatitis and cancers of the liver, colon, and rectum. Heavy drinking also causes cardiomyopathy, peripheral neuropathy, myopathy, and hepatitis. Alcohol drinking is not related to the incidence of ischemic stroke and peptic or duodenal ulcers.

Alcohol weakens sensorimotor coordination. Thus, alcohol use, especially at levels producing intoxication, increases the risk of accidents, violence, and self-harm. The probability of becoming involved in a serious or fatal traffic accident increases with rising blood alcohol concentration. Some but not all studies show an exponential increase in that risk.

Several studies have found an increased risk of (female) breast cancer among drinkers compared with abstainers, but the low relative risk and the multitude of potential confounding factors make it difficult to draw any firm conclusions about causality.

The risk of spontaneous abortion, intrauterine growth retardation, premature birth, and fetal alcohol syndrome is increased by alcohol intake. The available data are not sufficient to indicate whether there is a safe limit for cognitive developmental deficits. The only absolutely safe course is to abstain during pregnancy.

Research strongly supports the view that moderate alcohol intake decreases the risk of coronary heart disease. Compared with abstainers, the lowest relative risk of coronary heart disease is 22 percent lower at the level of consumption of 29 grams per day, according to high-quality studies. Most of the decrease in coronary heart disease risk is due to an increase in high-density lipoprotein (HDL) cholesterol. A moderate intake of alcohol seems to decrease the risk of dementia, diabetes, and gallstones. Blood pressure is likely to increase with an alcohol intake exceeding 25 grams per day. Heavy drinkers show increased atherosclerosis, an increased risk of tachyarrhythmias, and decreased variability of heart rhythm.

Moderate drinkers have better emotional and social adjustment and fewer psychiatric hospital admissions than abstainers. These differences may, however, be due to the inclusion of people with mental problems in the group of abstainers. Alcohol is likely to be harmful for the mentally ill because it may aggravate their symptoms and interfere with drug treatment.

Some observations suggest that wine may be especially beneficial for health, but others disagree. The differences in health effects between alcohol consumed as beer, wine, and spirits might be explained by varying drinking patterns related to different beverages.

No definite safe or optimal levels of alcohol intake can be ascertained because self-reports of alcohol intake tend to be underestimates. Potential benefits and harm from alcohol intake vary between individuals, depending on their drinking patterns and other risk factors. For a moderate intake level and pattern of use, the evidence suggests that the health benefits outweigh the risks.

See also: *Diseases, Chronic and Degenerative; Tobacco-Related Mortality.*

BIBLIOGRAPHY

Bruun, Kettil, Griffith Edwards, Martti Lumio, Klaus Mäkelä, Lynn Pan, Robert E. Popham, Robin Room, Wolfgang Schmidt, Ole-Jorgen Skog, Pekka Sulkunen, and Esa Österberg. 1975. *Alcohol Control Policies in Public Health Perspective,* Vol. 25. Forssa: Finnish Foundation for Alcohol Studies.

Chick, Jonathan. 1999. "Can Light or Moderate Drinking Benefit Mental Health?" *European Addiction Research* 5(2): 74–81.

Corrao, Giovanni, Vincenzo Bagnardi, Antonella Zambon, and Sarino Arico. 1999. "Exploring the Dose-response Relationship between Alcohol Consumption and the Risk of Several Alcohol-related Conditions: A Meta-analysis." *Addiction* 94(10): 1551–1573.

Corrao, Giovanni, Luca Rubbiati, Vincenzo Bagnardi, Antonella Zambon, and Kari Poikolainen. 2000. "Alcohol and Coronary Heart Disease: A Meta-analysis." *Addiction* 95(10): 1,505–1,523.

Poikolainen, Kari. 1996. "Alcohol and Overall Health Outcomes." *Annals of Medicine* 28(5): 381–384.

Productschap. 2002. *World Drink Trends 2002.* Schiedam, Netherlands: Productschap voor Gedistilleerde Dranken.

Rimm, Eric B., Paige Williams, Kerry Fosher, Michael Criqui, and Meir J. Stampfer. 1999. "Moderate Alcohol Intake and Lower Risk of Coronary Heart Disease: Meta-analysis of Effects on Lipids and Haemostatic Factors." *British Medical Journal* 319(7224): 1,523–1,528.

Kari Poikolainen

ANCIENT WORLD, DEMOGRAPHY OF

The study of classical antiquity traditionally has been concerned with the history of Greek and Roman civilization and its sphere of influence in the Mediterranean and beyond from the early first millennium B.C.E. to the seventh century C.E. and covers sociopolitical formations that range from Greek city-states to the Roman Empire. Owing to the paucity of quantifiable evidence, demographic conditions in the ancient world are at best sporadically documented and can be reconstructed only in the most basic terms. Tombstone inscriptions, skeletal remains, and literary accounts are the most widely available sources of demographic information. In addition several hundred census returns, birth certificates, and death declarations from Greco-Roman Egypt have survived on papyrus scrolls.

Mortality

Ancient populations were characterized by high birth rates and death rates. Mean life expectancy at birth is conventionally put in a range from 20 to 30 years, although these limits may have differed in particularly hazardous (e.g., malarial) or healthy (e.g., high-altitude) environments. Age records from some 300 census returns from Roman Egypt (first to third centuries C.E.) have been used to reconstruct an age distribution that is consistent with model life tables that suggest a mean life expectancy at birth of around 22 to 25 years. Corroborating evidence has been derived from select cemetery populations, a Roman schedule used to calculate annuities known as "Ulpian's Life Table," and tombstones in Roman North Africa. Literary texts suggest comparably low levels of life expectancy even among the Roman elite. However, demographic readings of most of these sources remain controversial: Age records in epitaphs are distorted by age and gender preferences, and skeletal samples may not mirror the age structure of actual past populations. An alternative reading of the Egyptian census data points to significant differences between urban and rural populations, with particularly high attrition rates in large cities.

Local mortality levels were determined largely by the prevalence of endemic diseases. Seasonal mortality patterns that are discernible in large samples of tombstones reveal great regional diversity but hint only vaguely at the nature of the underlying disease environment. Attested seasonal fluctuation in adult death rates is generally more pronounced than is the case in more recent pre-modern Mediterranean populations and suggests unusually high vulnerability to infectious diseases past childhood and correspondingly high levels of overall morbidity and mortality.

The principal causes of death defy quantification but are amply documented in ancient medical literature and other textual sources: Next to ubiquitous gastrointestinal diseases, malaria and tuberculosis played a major role. Malaria in particular gradually expanded in low-lying parts of Greece and Italy. Leprosy began to spread from Egypt during the Roman period, whereas cholera and louse-borne typhus seem to have been unknown. Smallpox first appeared in epidemic form (possibly in Athens in 430 B.C.E. and probably throughout the Roman Empire in the 160s through 180s C.E.) but may have become endemic in late antiquity. Plague, confined to the southeastern hinterlands of the Mediterranean for most of this period, erupted in a massive pandemic in the 540s C.E.

Fertility

Birth rates cannot be directly established on the basis of ancient sources; under prevailing levels of life expectancy, the total fertility rate must have averaged 5 to 6 (that is, five to six live births per woman surviving to menopause). The total marital fertility rate for Roman Egypt has been put at about 8 to 9 and was probably similar in other parts of the ancient world. According to Egyptian census returns, 95 percent of freeborn children were born in wedlock. These documents provide the only quantitative evidence of fertility. The documented maternal age distribution of childbirths implies a natural fertility regime with a peak in the twenties and continuing substantial fertility during the thirties and into the forties and no sign of parity-related birth control. In principle, early and nearly universal marriage for women must have necessitated some degree of fertility control within marriage. Mean birth intervals of three to four years in Roman Egypt corroborate this assumption. Cultural preferences for extended breast-feeding (for up to three years) may have contributed to extended birth spacing. A broad array of putative contraceptives and abortifacients were discussed in ancient literature, and at least some of the recommended chemical agents may have been efficient. In addition postpartum measures such as child exposure and infanticide appear to have been widely (although not universally) condoned and were not curbed until late antiquity. The extent to which families practiced intrusive forms of birth control, exposure, or infanticide remains unknowable and controversial.

In the literary tradition, elite families are most commonly associated with family limitation employed to preserve their socioeconomic standing. Evidence of high (i.e., male-dominated) sex ratios has been taken to indicate a high incidence of sex-specific infanticide but may only reflect biased recording practices. Whereas the best quantitative data, from Roman Egypt, indicate neither deliberate family limitation nor female infanticide, qualitative accounts for Greece and Rome raise the possibility of a more widespread application of postnatal measures in general and discrimination against female offspring in particular.

Marriage

Greeks and Romans of all classes practiced strict serial monogamy. (Although socially and legally condoned forms of concubinage and other sexual relations of married men facilitated a limited degree of de facto polygyny, overt polygamy appears to have been confined to the Macedonian aristocracy.) Child marriage was not common. Anecdotal evidence for the age at first marriage in Greece points to 14 to 15 years for women and perhaps 30 years for men. Tombstone inscriptions for commoners throughout the western half of the Roman Empire suggest a median of about 20 years for women and about 30 years for men, whereas literary texts report earlier marriage among the aristocracy. The census data from Roman Egypt yield medians of 17 to 18 and 25 years for women and men, respectively. Women began marrying around age 12, and almost all had married by the late twenties; among men, two-thirds had married by age 30, and 90 percent by age 50. The documented prevalence of early female and late male marriage foreshadows the Mediterranean marriage pattern observed in recent centuries and reveals broad continuity over time.

Divorce could be initiated by either sex and normally was not stigmatized or constrained by legal or religious injunctions. Remarriage was common for men but rare for women over age 30. In Roman Egypt two-thirds of men but only one-third of women were still married at age 50. Before the rise of Christianity, celibacy did not have favorable connotations.

Marriages were commonly virilocal (residence of a married couple with the husband's family) and often entailed the transfer of bridal dowries, which are best documented for elite circles. Slaves were legally incapable of entering marriages but often formed de facto unions among themselves. The intensity of endogamy varied along a west-east gradient. Although consanguineous unions were rare in Roman culture (with exceptions among the elite), marriage of first cousins is well attested for Greece and the Levant. Occasional half-sibling unions are also known from the Greek world. Roman Egypt in the second and third centuries C.E. stands out for the almost unique and still unexplained practice of full brother-sister marriage that accounts for one-sixth of all unions known from census returns.

Household Structure

There was no term for the nuclear family. In addition to parents and children, the Greek *oikos* and the Roman *familia* or *domus* included other individuals under the control of the head of the household, such as coresident kin and slaves. Although literary and legal texts emphasize the social and legal inclusivity of the Roman family, funerary commemoration in the western half of the Roman Empire tends to focus on the nuclear family. By contrast, evidence from the eastern Mediterranean points to more complex households. The Egyptian census data reveal a split between conjugal and complex households (composed of extended or multiple families) of 51 percent against 26 percent in the cities and 37 percent against 43 percent in the countryside and a greater presence of lodgers and slaves in urban households. High mortality constricted family size. The only known average is 4.3 members in Roman Egypt. Adoption was a well-established practice, but its incidence is unknown except for the fact that it was common among the Roman elite.

Partible inheritance in Greece and Rome encouraged the fragmentation of estates. In Athens daughters would receive dowries in lieu of an inheritance, but under Roman law they could also formally inherit. Women generally could own property but were to varying degrees subject to supervision by their male guardians. However, the patriarchal character of ancient households envisaged in the legal tradition was in practice often qualified by high mortality and other dislocations.

Population Size

The population totals reported in ancient literature are frequently shaped by rhetorical stylization and ignorance. Many are merely symbolic figures, and reliable references are rare. In classical antiquity the Mediterranean and adjacent regions experienced significant population growth, with more rapid expansion in the west than in the more developed Near East. After prolonged growth following an initial slump, by the fourth century B.C.E. the Greek population in the Aegean and in settlements in Sicily, southern Italy, and the Black Sea area may have approximated five million, divided among up to 1,500 separate communities, most of them with no more than a few hundred or thousand citizens. Athens, the largest and best-known Greek city-state, had an adult male citizen population of around 25,000 to 40,000 and a total population of perhaps 150,000 to 250,000 residents, including aliens and slaves. Periodic census counts from the third to the first century B.C.E. provide a rough idea of the demographic development of the Roman citizenry. A dramatic jump from 910,000 adult male citizens in 69 B.C.E. to a total of 4,063,000 in 28 B.C.E. has been interpreted as a sign of improved coverage or of a switch to the recording of all Romans instead of adult men only. Whereas the latter reading suggests an Italian population of 5 million to 6 million, the former implies a total closer to 13 million to 14 million. Although comparative evidence from later periods lends credibility to the lower estimate, which is now favored by most scholars, this issue has not been fully resolved. The gross population of the Roman Empire may have peaked at 60 million to 70 million in the second century C.E., with 50 to 60 percent residing in the European provinces and 20 to 25 percent each in western Asia and North Africa. The empire included perhaps 2,000 cities, headed by the capital city of Rome with about one million residents.

Although from the late second century C.E. onward recurrent epidemics may have depressed population numbers, the eastern part of the empire in particular remained densely populated into late antiquity. Only the disintegration of the western half of the empire in the fifth century and the onset of plague in the sixth century appear to have caused substantial demographic contraction. Roman levels of population density generally were reattained in Europe by the High Middle Ages, but this did not occur until the nineteenth century in Greece and the former Asian and African parts of the empire.

Population Thought

Demographic thought was poorly developed and never formally set out in theoretical terms; stereotypical moralizing and philosophical abstraction dominate the record. In the fourth century B.C.E the Athenian philosopher Plato considered eugenics and a fixed population size essential ingredients of his model of an ideal state. In a strongly pronatalist vein, most other sources stress the desirability of large populations as an index of military strength and general vigor. As a logical corollary, the ancient rhetorical tradition is permeated by concerns about supposedly declining birth rates and the resultant demographic contraction. This anxiety also manifested itself in Roman legislation enacted by the first emperor, Augustus (27 B.C.E–14 C.E.), to encourage nuptiality and reproduction by granting privileges to prolific couples and discriminating against the celibate and the childless, particularly among the elite. Demographic thinking in early modern Europe was profoundly influenced by this pronatalist stance. In late antiquity, Christianity brought a more systematic condemnation of fertility control and novel sympathy for celibacy.

See also: *Disease and History; Historical Demography; Paleodemography.*

BIBLIOGRAPHY

Bagnall, Roger S., and Bruce W. Frier. 1994. *The Demography of Roman Egypt.* Cambridge, Eng.: Cambridge University Press.

Beloch, Julius. 1886. *Die Bevölkerung der Griechisch-Römischen Welt.* Leipzig: Duncker & Humblot.

Brunt, Peter A. 1971. *Italian Manpower 225 B.C.–A.D. 14.* Oxford: Clarendon Press.

Eyben, Emiel. 1980/1981. "Family Planning in Graeco-Roman Antiquity." *Ancient Society* 11/12: 5–82.

Frier, Bruce W. 1994. "Natural Fertility and Family Limitation in Roman Marriage." *Classical Philology* 89: 318–333.

———. 2000. "Demography." In *The Cambridge Ancient History,* 2nd ed., Vol. 11, ed. Alan K. Bowman, Peter Garnsey, and Dominic Rathbone. Cambridge, Eng.: Cambridge University Press.

Hansen, Mogens H. 1985. *Demography and Democracy: The Number of Athenian Citizens in the Fourth Century* B.C. Herning, Denmark: Systime.

Parkin, Tim G. 1992. *Demography and Roman Society.* Baltimore: Johns Hopkins University Press.

Pomeroy, Sarah B. 1997. *Families in Classical and Hellenistic Greece: Representations and Realities.* Oxford: Clarendon Press.

Sallares, Robert. 1991. *The Ecology of the Ancient Greek World.* London: Duckworth.

Saller, Richard P. 1994. *Patriarchy, Property and Death in the Roman Family.* Cambridge, Eng.: Cambridge University Press.

Saller, Richard P., and Brent D. Shaw. 1984. "Tombstones and Roman Family Relations in the Principate: Civilians, Soldiers, and Slaves." *Journal of Roman Studies* 74: 124–156.

Scheidel, Walter. 1996. *Measuring Sex, Age and Death in the Roman Empire: Explorations in Ancient Demography.* Ann Arbor, MI: Journal of Roman Archaeology.

———. 2001. *Death on the Nile: Disease and the Demography of Roman Egypt.* Leiden, Netherlands: Brill.

———. 2001. "Progress and Problems in Roman Demography." In *Debating Roman Demography,* ed. Walter Scheidel. Leiden, Netherlands: Brill.

———. 2001. "Roman Age Structure: Evidence and Models." *Journal of Roman Studies* 91: 1–26.

WALTER SCHEIDEL

ANIMAL ECOLOGY

Animal ecology concerns the relationships of individuals to their environments, including physical factors and other organisms, and the consequences of these relationships for evolution, population growth and regulation, interactions between species, the composition of biological communities, and energy flow and nutrient cycling through the ecosystem. From the standpoint of population, the individual organism is the fundamental unit of ecology. Factors influencing the survival and reproductive success of individuals form the basis for understanding population processes.

Two general principles guide the study of animal ecology. One is the balance of nature, which states that ecological systems are regulated in approximately steady states. When a population becomes large, ecological pressures on population size, including food shortage, predation, and disease, tend to reduce the number of individuals. The second principle is that populations exist in dynamic relationship to their environments and that these relationships may cause ecological systems to vary dramatically over time and space. One of the challenges of animal ecology has been to reconcile these different viewpoints.

Populations depend on resources, including space, food, and opportunities to escape from predators. The amount of a resource potentially available to a population is generally thought of as being a property of the environment. As individuals consume resources they reduce the availability of these resources to others in the population. Thus, individuals are said to compete for resources. Larger populations result in a smaller share of resources per individual, which may lead to reduced survival and fecundity. Dense populations also attract predators and provide conditions for rapid transmission of contagious diseases, which generate pressure to reduce population size.

Changes in population size reflect both extrinsic variation in the environment that affects birth and death rates and intrinsic dynamics that result in oscillations or irregular fluctuations in population size. In some situations, the stable state may be a regular oscillation known as a limit cycle. Ecological systems also may switch between alternative stable states, as in the case of populations that are regulated at a high level by food limitation or at a low level by predators or other enemies. Switching between alternative stable states may be driven by changes in the environment.

Population Increase

In the absence of the effects of crowding, all populations have an immense capacity to increase. This capacity may be expressed as an exponential growth rate, r, which describes the growth of a population in terms of its relative, or percentage, rate of increase, like continuously compounded interest on a bank account. The constant r is often referred to as the Malthusian parameter. For a population growing at an exponential rate, the number of individuals (N) in a population at time t is $N(t) = N(0)e^{rt}$ where $N(0)$ is the number of individuals at time 0. Accordingly, the increase in a single time unit is e^r, which is the constant factor by which the population increases during each time period. The rate of increase in the number of individuals is then given by $dN/dt = rN$. The doubling time in years of a population growing exponentially is $t_2 = (\ln 2)/r$, or roughly $0.69/r$.

Estimated exponential annual growth rates of unrestrained populations range from low values of 0.077 for sheep in Tasmania and 0.091 for Northern elephant seals, to perhaps 1.0 for a pheasant population, 24 for the field vole, 10^{10} for flour beetles in laboratory cultures and 10^{30} for the water flea *Daphnia.* Human populations are at the lower end of this range, but a realistic exponential growth rate of 0.03 (or slightly above 3% per year) for some human populations is equivalent to a doubling time of about 23 years and a roughly thousand-fold increase in 230 years. Clearly, no population can maintain such a growth rate for long. (Expansion at the estimated annualized rates just cited for the field vole, flour beetle, and water flea is necessarily utterly fleeting.)

The exponential growth rate of a population can be calculated from the schedule of fecundity at age x (b_x) and survival to age x (l_x) in a population. These "life table" variables are related to population growth rate by the Euler, or characteristic, equation,

$$1 = \int_{x=0}^{\infty} e^{rx}\, l_x b_x \, dx,$$

whose solution requires matrix methods. When the life table is unchanging for a long period, a population assumes a stable age distribution, which is also an intrinsic property of the life table, and a constant exponential rate of growth. Thus, assuming constant birth and death rates, the growth trajectory of a population may be projected into the future. However, because populations are finite and births and deaths are random events, the expected size of a pop-
ulation in the future has a statistical distribution that may include a finite probability of 0 individuals, that is, extinction. As a general rule, the probability of extinction decreases with increasing population size and increasing excess of births over deaths.

Population Regulation

Balancing the growth potential of all populations are various extrinsic environmental factors that act to slow population growth as the number of individuals increases. High population density depresses the resources of the environment, attracts predators, and, in some cases, results in stress-related reproductive failure or premature death. As population size increases, typically death rates of individuals increase, birth rates decrease, or both. The result is a slower growth rate and a changed, usually older, population. The predominant model used by animal ecologists to describe the relationship of population growth rate to population size (or density) is the logistic equation, in which the exponential growth rate of the population decreases linearly with increasing population size:

$$r = r_0\left(1 - \frac{N}{K}\right),$$

where r_0 is the exponential growth rate of a population unrestrained by density (i.e., whose size is close to 0) and K represents the number of individuals that the environment can support at an equilibrium level, also referred to as the carrying capacity of the environment. Accordingly, the rate of growth of the population is expressed as

$$\frac{dN}{dt} = r_0 N\left(1 - \frac{N}{K}\right).$$

Notice that when $N < K$, the growth rate is positive and the population grows. When $N > K$, the density-dependent term $(1 - N/K)$ is negative and the population declines. When $N = K$, the growth rate is 0 and a stable, steady-state population size is achieved. This depressing impact of density on the population growth rate is known as negative feedback.

The differential form of the logistic equation may be integrated to provide a function for the trajectory of population size over time,

$$N(t) = \frac{K}{1 + \left[\dfrac{K - N(0)}{N(0)}\right]e^{-rt}}.$$

The curve is sigmoid (S-shaped), with the rate of growth, dN/dt reaching a maximum (the inflection point) at $N = K/2$. Because this is the density at which individuals are added to the population most rapidly, the inflection point also represents the size of the population from which human consumers can remove individuals at the highest rate without causing the population to decline. Thus, the inflection point is also known as the point of maximum sustainable yield.

Density dependence can take on a variety of forms. One of these is a saturation model where the exponential growth rate remains constant and positive until a population completely utilizes a nonrenewable resource such as space, and population growth stops abruptly. The approach of a population to an equilibrium level determined by density-dependent processes can be altered by environmentally induced changes in the intrinsic rate of population growth or in the carrying capacity of the environment.

Difficulties in finding mates and maintaining other social interactions at low densities, including group defense against predators, may also cause the population growth rate to decrease as density declines (the Allee effect), and, below a certain density threshold, may even result in population decline to extinction. This type of response is a *positive* feedback, one that promotes population instability. For example, after commercial hunting had reduced populations of the passenger pigeon to low levels, the decline in social interactions in this communally nesting species is thought to have doomed it to extinction.

Populations have inherent oscillatory properties that can be triggered by time lags in the response to changing density and which cause populations to fluctuate in a perpetual limit cycle, with alternating population highs and lows. In these cases higher values of r can send a population into unpredictable chaotic behavior, increasing the risk of extinction. In a population with continuous reproduction, regular population cycles occur when there is a lag, often equal to the period of development, in the response of a population to its own density effects on the environment. When the time lag is of period τ, limit cycles develop when $r\tau$ exceeds $\pi/2$, and the period of the cycle is 4 to 5 times τ.

Metapopulations

Most natural populations consist of many subpopulations occupying patches of suitable habitat surrounded by unsuitable environments. Oceanic islands and freshwater ponds are obvious examples. But fragmentation of forest and other natural habitats resulting from clearing land for agriculture or urban development is increasingly creating fragmented populations in many other kinds of habitats. These subpopulations are connected by movement of individuals, and the set of subpopulations is referred to as a metapopulation. Metapopulations have their own dynamics determined by the probabilities of colonization and extinction of individual patches. A set of simple metapopulation models describes changes in the proportion of patches occupied (p). When the extinction probability (e) of an individual patch is independent of p, the rate of loss of subpopulations is simply pe. The rate of colonization is proportional to the number of patches that can provide potential colonists and the proportion of empty patches that are available to receive them. Hence, colonization is equal to $cp(1-p)$, where c is the rate of colonization.

The metapopulation achieves a steady state of number of patches occupied when colonization balances extinction, that is $pe = cp(1-p)$, or $\hat{p} = 1-e/c$. In this model, as long as the rate of colonization exceeds that of extinction, the metapopulation will persist. In more complex models, particularly when the probability of population extinction is reduced by continuing migration of individuals between patches (which keeps the sizes of subpopulations from dropping perilously low), the extinction rate and colonization rate both depend on patch occupancy p. In this case, the solution to the metapopulation model has a critical ratio of colonization to extinction, below which patch occupancy declines until the metapopulation disappears. Thus, changes in patch size or migration between patches can cause an abrupt shift in the probability of metapopulation persistence.

Predator-Prey Interactions

The dynamics of populations are influenced by interactions with predator and consumer populations. Because these interactions have built-in lag times in population responses, they often result in complex dynamics. Among the most spectacular fluctuations in size are those in populations of snowshoe hares and the lynx that prey on them. Population highs and lows may differ by a factor of 1,000 over an oscillation period of about ten years. Oscillation periods in other population cycles of mammals and birds in boreal forest and tundra habitats may be either approximately four years or nine to ten years.

The biologists Alfred Lotka and Vito Volterra independently developed models for the cyclic behavior of predator-prey systems in the 1920s. The most basic model expresses the rate of increase in the prey population in terms of the intrinsic growth capacity of the prey population and removal of prey individuals by predators, which is proportional to the product of the predator and prey population sizes. The growth of the predator population is equal to its birth rate, which depends on how many prey are captured, minus a density-independent term for the death of predator individuals. The joint equilibrium of the prey and predator populations is determined by the predation efficiency and the relative rates of birth and death of the prey and predator, respectively. However, the equilibrium is neutral, which means that any perturbation will set the system into a persisting cycle. More complex models of predator-prey interactions include a balance between various stabilizing factors, such as density-dependent control of either population, alternative food resources for predators, and refuges from predators at low prey densities, and destabilizing factors, such as time lags in the response of the predator and prey to each other. For the most part, these models predict stable predator and prey populations under constant conditions.

Both empirical and experimental studies have shown that the rate of predation is nonlinear, violating one of the assumptions of the Lotka-Volterra model. When predation is inefficient at low prey densities and predator populations are limited by density-dependence at high predator densities, there may be two stable points. One of these is at a high prey population level limited by the prey population's own food supply, the other at a low prey population level limited by predators. When a prey population, such as a crop pest, is released from predator control following depression of the predator population by extrinsic factors such as climate, disease, pesticides, and so on, the prey may increase to outbreak levels and become a severe problem. Thus, agricultural practices that incidentally depress the populations of natural control organisms can have unwanted consequences.

A special kind of predator-prey model is required to describe the interactions between parasites, including disease-causing organisms, and their hosts. These models need to take into account the fact that parasites generally do not kill their hosts, that the spread of parasites among hosts may depend on population density and the presence of suitable vectors, and that hosts may raise defensive immune reactions. Immune reactions create a time lag in the responses of parasite and host populations to each other and may result in strong fluctuations in the prevalence of parasitic diseases.

Conclusion

The study of animal populations tells us that for any given set of conditions the size of a population is limited by the resources available to it. The human population is no exception. At high densities, the stresses of poor nutrition and social strife all too often signal a reduced quality of life.

The study of animal populations has provided guidelines for the management of nonhuman populations, including those of domesticated animals, game birds and mammals, fish stocks, species of conservation concern, pests, and disease organisms. In general, fragmentation and simplification of systems lead to exaggerated population fluctuations and the development of alternative stable states, and they may thus increase the probability of epidemics, pest outbreaks, and extinction. Hunting, overfishing, and overgrazing have led to severe reduction in some food sources and deterioration of habitat quality. Controls on populations are so complex that manipulation of environmental factors in complex systems often results in unforeseen consequences. In a classic case, nineteenth-century hunting of sea otters on the Pacific coast of North America resulted in the explosion of populations of their sea urchin prey, which in turn seriously harmed the kelp beds that serve as important nurseries for fish stocks. Many such examples show how difficult it is to replace natural controls with human management, although the need to maintain a high quality of life for the human population in an increasingly stressed environment makes it imperative that we learn to do this wisely.

See also: *Biogeography; Biology, Population.*

BIBLIOGRAPHY

Anderson, Roy M., and Robert M. May. 1991. *Infectious Diseases of Humans. Dynamics and Control.* Oxford: Oxford University Press.

Ballou, Jonathan D., Michael E. Gilpin, and Thomas J. Foose, eds. 1995. *Population Management for Survival and Recovery. Analytical Methods and Strategies in Small Population Conservation.* New York: Columbia University Press.

Begon, Michael, Martin Mortimer, and David J. Thompson. 1996. *Population Ecology: A Unified Study of Animals and Plants,* 3rd edition. Oxford: Blackwell Science.

Caswell, Hal. 2001. *Matrix Population Models: Construction, Analysis, and Interpretation,* 2nd edition. Sunderland, MA: Sinauer Associates.

Gotelli, Nicolas J. 2001. *A Primer of Ecology,* 3rd edition. Sunderland, MA: Sinauer Associates.

Hanski, Ilkka A., and Michael E. Gilpin, eds. 1997. *Metapopulation Biology, Ecology Genetics, and Evolution.* San Diego, CA: Academic Press.

Nisbet, Roger M., and William S. C. Gurney. 1982. *Modelling Fluctuating Populations.* New York: Wiley.

Pielou, Elizabeth C. 1997. *Mathematical Ecology.* New York: John Wiley.

Pimm, Stuart L. 1991. *The Balance of Nature?* Chicago: University of Chicago Press.

Tilman, David. 1982. *Resource Competition and Community Structure.* Princeton, NJ: Princeton University Press.

Robert E. Ricklefs

ANIMAL RIGHTS

The debate over animal rights revolves around a simple question: Do any nonhuman animals have rights? Like many simple questions, this one quickly becomes complex. What are rights? Do human beings have them? If so, what rights do people have, and why do people have them?

These questions have divided theoreticians over the past three centuries and more. Some of these thinkers (for example, the philosophers John Locke and Immanuel Kant) maintain that humans have rights. Others (for example, the philosophers David Hume and Jeremy Bentham) maintain that humans do not. The debate has been as intense as it has been protracted. Not surprisingly, adding animals to the mix only complicates matters.

The Terms of the Debate

Some things are clear. The debate concerns the moral rights of animals, not their legal rights. To ask what legal rights animals have is a straightforward empirical question that can be answered by using standard empirical methods (for example, consulting state and federal legislative databases). In 2002 the German Parliament voted to include respect for animal rights in the Constitution; that same year, the United States Congress passed legislation that explicitly excludes rodents and birds from the protection provided by the animal welfare act.

To ask what moral rights animals have, by contrast, is to ask a normative question that no amount of empirical inquiry can answer. Only normative reasoning can answer normative questions. The answers with the best arguments on their side are the ones that should be accepted; they are the ones that tell people how they should live. Understandably, who has the best arguments is the question that fuels the debate.

Fundamental Rights

The fundamental right in dispute is the right to be treated with respect. To have this right is to occupy a singularly important position, one that limits what other people are morally free to do. Those who have this right (to borrow Kant's terminology) are never to be treated merely as means to other persons' ends.

What Kant's injunction means in practice is that harm done to those who possess this right cannot be justified merely by showing that as a result of that harm someone else is better off. In other words, the obligation to respect the rights of the individual are morally more important than any obligation to benefit others, even society as a whole.

Philosophers have defended a variety of criteria that explain why people have rights, both the right to be treated with respect and other, derivative rights, including the rights to life and bodily integrity. The standard view (the one favored by the majority of thinkers) limits rights to moral agents.

Moral Rights and Moral Agents

Moral agents are rational; they have the capacity to bring reason to bear on their moral decision making. Moral agents also are autonomous; they are free to choose between right and wrong. This is why moral agents are morally responsible for their acts.

According to the standard view, then, there is an elegant symmetry between being morally responsible on the one hand and having moral rights on the other hand. Only those who are morally responsible (that is, only moral agents) have moral rights. Once proponents of the standard view add that, at least among terrestrial beings, only human beings are moral agents, their conclusion follows: Only humans have rights.

There are problems with the standard view, however. At least as far back as the philosopher Porphyry (233–306 C.E.) critics have pointed out that many human beings (all young children and the seriously mentally disadvantaged of any age, for example) are not moral agents. Thus, given the standard view, these humans lack moral rights.

This is no small deficiency. Bereft of rights, these human beings do not occupy the same moral position occupied by moral agents. Since they are bereft of rights, there is nothing about the moral status of these human beings that prevents anyone from taking their lives or injuring their bodies in pursuit of benefits for others, whether the beneficiaries are the few or the many.

It is hard to imagine how any friend of humanity could accept this repugnant conclusion. Certainly serious proponents of children's rights or the rights of the mentally disadvantaged cannot accept it. Their challenge is to find an acceptable alternative to the standard view.

An Alternative View

A plausible alternative begins with a characterization of moral patients. Moral patients are individuals who, though they lack the capacities necessary for moral agency, can be the object of direct moral wrongdoing. Young children who are physically abused by their parents are an example. They cannot do anything wrong, but grievous wrong can be done to them.

Some critics of the standard view use this judgment as a basis for revising that view. Only humans have rights, but human moral agents are not the only humans who have rights; human moral patients have rights too.

The revised standard view, then, is no less humanistic than the standard view (rights are restricted to humans only), but unlike the standard view, it avoids the repugnant conclusion. People are not free to take the life or injure the body of a young child, for example, just to secure benefits for themselves or others.

There is a problem with the revised standard view, however. Few even modestly informed people believe that all nonhuman animals are, as the philosopher René Descartes argued, mindless machines. On the contrary, most people agree with naturalist Charles Darwin: Not only do some nonhuman animals have a mental life, the mental life of some of them (nonhuman mammals, for example) is significantly more developed than what is found in many human beings.

Advocates of the revised standard view therefore face a serious dilemma. If they maintain that human moral patients have rights, it is difficult to see how they can consistently avoid accepting the same conclusion for nonhuman mammals. However, if these advocates insist that those animals lack rights, it is difficult to see how they can consistently maintain that human moral patients have them. Logically, it seems, advocates of the revised standard view cannot have it both ways.

Whether or not advocates can escape this dilemma, the challenge they face captures part, although not the whole, of the spirit of the animal rights debate. It is not difficult to propose a criterion for possessing rights that nonhuman animals cannot satisfy. The standard view does that. What is far more difficult (some would say impossible) is to find a criterion that all human moral patients satisfy but that every nonhuman animal fails.

Unless such a criterion is devised, the possibility that at least some nonhuman animals have rights cannot be summarily dismissed. Instead, the arguments for and against animal rights must be carefully examined with a view to discovering which among them are the best. That discovery would indicate which answers people should accept and how people should live.

The Significance of the Answers

Unlike many questions in philosophy, whose answers have no direct bearing on the "real world," the questions posed in the animal rights debate are fraught with practical significance. The answers people give have implications for what people should eat, wear, and do for entertainment; what careers people should pursue and what values they should teach their children; and what population policies they should favor and what development programs they should support. All this and much more, all of it touching on some of the most important areas of human life, is affected by how people answer that "simple" question: Do any nonhuman animals have rights? Paradoxically, few questions are more directly relevant to how people should live.

See also: *Environmental Ethics.*

BIBLIOGRAPHY

Cohen, Carl, and Tom Regan. 2001. *The Animal Rights Debate.* New York: Rowan and Littlefield.

Frey, R. G. 1980. *Interests and Rights: The Case against Animals.* Oxford, Eng.: Clarendon Press.

Pluhar, Evelyn. 1995. *Beyond Prejudice: The Moral Significance of Human and Nonhuman Animals.* Durham, NC: Duke University Press.

Regan, Tom. 1983. *The Case for Animal Rights.* Berkeley, CA: University of California Press.

———. 2001. *Defending Animal Rights.* Champaign, IL: University of Illinois Press.

Regan, Tom, and Peter Singer, eds. 1976–1989. *Animal Rights and Human Obligations.* Englewood Cliffs, NJ: Prentice-Hall.

Rollin, Bernard. 1981. *Animal Rights and Human Morality.* Buffalo, NY: Prometheus Books.

Sapontzis, Steven. 1987. *Morals, Reason, and Animals.* Philadelphia, PA: Temple University Press.

Singer, Peter. 1975. *Animal Liberation.* New York: Avon Books.

TOM REGAN

ANTHROPOLOGICAL DEMOGRAPHY

Anthropological demography is an intersection of two already heterogeneous disciplines. Each has taken that limited part of the intellectual equipment of the other that seems to serve it best. Paradoxically, the segment of anthropology that is most interested in technical demography (human evolution and ecology) finds among demographers the smallest interest in its own ultimate goals, while many cultural anthropologists whose interpretive skills might benefit demography are least interested in or even hostile to it as an empirical enterprise. Nevertheless, among the like-minded, there has been substantial progress.

Substantive and Theoretical Content

The intersection of anthropology and demography may be thought of in two ways: the first substantive, the second theoretical.

Substantive content. *Substantively,* the intersection has two foci:

1. The investigation of demographic topics and/or the application of demographic methods in traditional anthropological contexts. This intersection is occupied by some archaeologists, biological anthropologists, evolutionary ecologists, and a few ethnographers.
2. The application of anthropological methods or understandings of human behavior to demographic investigations in any investigative context. This intersection is occupied by a growing number of demographers seeking to improve generalizations based on sociological or economic theory, by reference to anthropological or culture theory.

The range of these two substantive foci can be quite broad. The first would certainly include ethnographic, archaeological, or biological anthropological studies of population and resources, fertility, mortality, migration, and nuptiality (marriage practices) in nonliterate societies. Such studies in literate societies would also be included if the investigations were explicitly anthropological in method (for example, using intensive ethnographic techniques such as participant observation). Studies in historical demography that focused on traditional concerns of ethnography, such as kinship, family, and household, would also fall within this category. On the fringes of these studies, however, lies a mass of traditional ethnographies dealing in qualitative detail with topics of salient interest in demography: nuptiality, especially the social relations created or maintained by marriage alliances; the recruitment of individuals into social groups in ways that condition reproductive relationships; the role of fertility in establishing social status, socialization, and the onset of sexual activity; gender relations; migration; care of the aged; and death. To the extent that such studies are rigorous and contribute to an understanding of demographic processes, per se, they belong in the first category. Otherwise, their contribution may be in the second.

Theoretical content. *Theoretically,* there are two interests that tend to differentiate some parts of anthropology from demography and sociology but that in an unexpected way ally it with economics. These interests are:

1. The behavior of *systems* or aggregates versus the behavior of *actors.* Demographers are typically interested in populations, although they are obliged sometimes to consider the constituent actors (as when seeking to change their behavior). Many ethnographers are most interested in individuals, although they are willing sometimes to consider individuals' commonalities (as when generalizing to cultural or institutional patterns).
2. A focus on *central tendency* versus a focus on *variation.* Many demographers are more interested in the former; many ethnographers are most interested in individual or at least subsocietal differences.

These interests are not independent of the subfields or historical practices of anthropology. They differentiate archaeology, biological anthropology, and traditional, structural-functional ("British") social anthropology; they thus differentiate a scientific anthropology on the one hand from more recent trends in interpretivist or activist cultural anthropology on the other. The first set of fields is concerned largely with systemic relationships and may concentrate more on broad averages. The second set is distinguished by its sharp questioning of the validity of systemic characterizations. While sharing with earlier social anthropologists and sociologists a recognition of the importance of institutional structures, many modern ethnographers are more concerned with issues of local knowledge and its exchange between individuals—or "culture"—and especially the agency or individual freedom to exercise choice within institutional and cultural boundaries. While disavowing the economist's assumptions of universal rationality and insisting on the primacy of local culture, the modern ethnographer is also concerned with how choices are made or interpersonally negotiated but in a cultural and moral marketplace. Modern ethnographers would also contest the kind of institutional determinism sometimes found in sociological approaches to social action, insisting on localized actor-driven interpretations of institutions. Thus, like economists, modern ethnographers are interested in how people make choices but according to particularistic rather than universalistic rules. Like sociologists they are interested in how institutions relate to individual behavior, but they are more interested in how individuals bend or break cultural rules than in how they follow them.

Demography in Anthropology

The relationships between archaeology, biological anthropology, and evolutionary ecology on the one hand and demography on the other are straightforward, but in them demography is more important to anthropologists than anthropology is to demographers.

Ideas about the interactions between population and resource base have been fundamental to archaeology, for example in the Marxist-oriented views about technological response to population pressure on resources espoused by V. Gordon Childe, later evident to demographers in the ethnographically motivated analyses of Ester Boserup and in the work of Mark N. Cohen. At the same time, some investigations suggested that plant domestication and population response may have also followed a more Malthusian scenario in which technological innovation is fortuitous, and population increases in response. The findings of archaeological demography are of great importance to demographic theory, especially to questions of population equilibrium. Archaeological attempts to discuss population-resource balance are limited, however, by their lack of technical demographic sophistication and difficulties of demographic measurement in archaeological contexts. Attempts to discern cause and effect between population pressure and technological innovation are limited by the absence of precise, fine-grained chronologies and by problems of potential infinite regress in which population change and technological change alternate over time with no clear causal precedence.

The centrality of these same issues of population and resources to biological anthropology and evolutionary ecology emerges from T. R. Malthus's own anticipation of the concepts of fitness and selection from randomly occurring variability that were later proposed by the nineteenth-century English naturalist Charles Darwin. For Malthus, innovation was fortuitous with respect to the population-resource balance; in the same way, for Darwin, the appearance of variability was fortuitous with respect to selection.

Biological anthropologists have two major demographic interests. The first is to describe the fundamental demographic parameters of the species under conditions unaffected by modern life. Much of this work is paleodemographic, depending on the evaluation of recovered skeletal material. The work may also be conducted through comparison with the primate cousins of humans. The second interest, which is more precisely part of evolutionary ecology, is to explain how the more than 99 percent of human history spent in hunting and gathering has led, by selection, to the underlying physiology and psychology of humans and indeed to the institutional structures and cultural components that are evident in demographic processes today. A major focus is on the evolution of life histories, that is, typical demographic profiles of individuals with their underlying physiological and psychological characteristics; this focus is shared with evolutionary psychology. Much of the demographic work done in modern paleodemography, biological anthropology, and evolutionary ecology is technically sophisticated. The practice of demography in these fields has advanced greatly since the withering critique delivered by William Petersen in 1975.

But it is the relationship between demography and ethnography that is at once the most promising to practicing demographers and the most problematic.

Demography and Ethnography

A focus on demographic issues or data as an integral or even an underlying part of ethnographic investigation is evident in the work of early British structural-functional scholars and was strongly advocated by Ludwik Krzywicki in 1934. Raymond Firth's work on Tikopia, originally published in 1936, was explicitly demographic, showing the pressure of expanding population on limited resources and its consequences in demographic processes. In the United States, similar concerns were evident in the ecological work of Julian H. Steward and Roy Rappaport and in the cultural materialism of Marvin Harris. Emphasis on the gathering of basic demographic data, even if only in a rudimentary census, was standard practice for most ethnographers until perhaps the 1980s, when the interests of social and cultural anthropology turned from empirical to interpretivist approaches. Paradoxically, it was just then that demographers, dissatisfied with the apparent failure of their own empirical approaches to achieve sustainable generalizations about fertility change, began to appeal to anthropology to provide explanations that would at least work in local contexts, even if they were not always generalizable. A harbinger of this trend was seen in demographic work on "excess" fertility in modern nonindustrial societies that included work by anthropologists and focused on structural-functional relations between social systems and demographic behavior.

Data collection approaches. In part, this appeal was for ethnographers to provide locally gathered and fine-grained data (the first substantive focus, above) or locally significant meanings or behavioral motivations (the second substantive focus). The need for such data and meanings was fueled by the policy-driven emphasis, in demography, on the introduction or implementation of fertility control in nonindustrial societies. In order to introduce such control, policymakers had to change the behavior of actors and needed advice on how to do so. Initially, demographers sought to identify universalistic criteria (in typically economic fashion). But they soon came to appreciate that they had to understand more local motivations for the maintenance of high fertility and to identify those factors that might persuade actors to lower it. This endeavor, however, is problematic. Whereas most demographers use data gathered at a population level, usually by survey or census methods, most ethnographers work at an individual, household, or at most the level of the local group (e.g., village). The outcomes of these different enterprises are often not comparable. The averages obtained from surveys and censuses may be stable, but such sources are limited in their depth. The richness of ethnographic data is unachievable by other methods, but the data are from small samples and can be quite unstable. Much demographic data gathered by ethnography had been unreliable or presented in forms incompatible with accepted demographic analytic techniques (as in the use of nonstandard age ranges).

In response to these challenges, some anthropologists began to do explicit and methodologically informed demographic investigations. Some demographers explicitly invoked and attempted to implement ethnographic techniques or to work with ethnographers. The principal outcome of such endeavors has been the emergence of the subfield of microdemography. In this subfield's simplest applications, ethnographers deliver a new empirical grist for the demographer's mill—"add fieldwork and stir" (Kertzer and Fricke, p. 2). At its best, microdemography seeks to situate and explicate demographic behavior in local terms.

At the same time, placing demographic behavior in social and cultural context continued, for example in "family systems theory," which relates kinship and family structures to demographic decision-making, or in taking account of overarching political-economic structures. Despite the conflict between structural-functional and intepretivist views within cultural anthropology itself, these approaches, taking into account the broad conditions under which most actors in a given social environment may exercise their agency, have been most productive. There is a strong similarity between these efforts and institutionally or value-oriented social demography. In parallel is a continuation of the emphasis on cultural milieu and communication between actors in the network-oriented research of some demographers.

One problem encountered by the joining of ethnography and demography and shared with the survey approach is a lack of temporal depth. Many of the problems that interest demographers are dynamic and occur across generations, often several generations. Only a series of compatibly designed and comparably implemented surveys or censuses can meet the demand for time depth. Even such surveys are usually impoverished for the purposes of institutional contextualization or interpretation, because they focus on the usual limited set of social and economic variables (education, income, etc.), and these usually only as of the date of survey, even when life-long or cross-generational reproductive histories are recovered. While rich and informative about individuals, ethnographic data cannot go much beyond life histories, so that transgenerational processes are unrecoverable, except by the taking of genealogies, which are notoriously biased and often recounted principally to legitimate current social structures. In consequence, both demographers and anthropologists have turned to history, either by using historical or ethnohistorical sources or by doing long-term revisitation fieldwork involving more than one generation of fieldworkers.

Defining culture. Despite these advances—implementation of technical demographic methods by some ethnographers, entry into fieldwork by some demographers, attempts to recover transgenerational temporal depth by ethnographers and demographers, and the focus on demographic matters by historians—serious problems remain. One of these is the problematic nature of culture as an explicator of behavior. An idea invented by anthropologists, and elaborated especially by the American school—associated with the anthropologist Franz Boas (1858–1942)—culture is a fuzzy concept, more definable as the complement of other things (biology, institutions, environment, etc.) than in its own right. Attempts to define it continue in anthropology. Inquiring and dissatisfied demographers, seizing on culture to extricate themselves from the failures of transition theory in explaining demographic change, have laid hold of a very slippery fish. Their colleagues in sociology and ethnography have not solved the puzzle of how environment, institutions, and values interact to condition individual behavior, and of course it is that individual behavior, aggregated into population statistics, that is the focus of demographic interest. The deficiencies of demographic theory are not ameliorated by the poverty of social theory.

Role of quantification. A third point of difficulty, beyond the limits of what is recoverable by ethnographic fieldwork and what can be utilized from the concept of culture, is the markedly different mindsets of most ethnographers and most demographers. All demographers are comfortable with mathematics and the use of numerical indicators as measures of or at least as proxies for conditioning variables and outcomes. While demographers are intense critics of the quality of their data, so that they constantly doubt particular facts, they believe in the existence of facts and that facts can be known at least approximately. They are also comfortable with statistical notions of indeterminacy and especially with precise descriptions of uncertainty.

By contrast, many ethnographers are uncomfortable with mathematics. They are disinclined to accept or are even hostile to the use of numerical indicators. While earlier ethnographers were uncritically accepting of the truth of informants' statements, modern ethnographers doubt the possibility of determining objective truth at all. Where demographers would rely on probabilities, ethnographers would retreat into literary vagueness. Yet the ethnographers have an important point in their insistence on the interpersonally negotiated nature of social "facts," and the mathematical "hard core" of demographic investigation is softer than the demographers think. Indeed, the shift of some demography from empirical computation to a search for social meanings that inform individual decisions may have exposed an underbelly of unknowability that bedevils all attempts to understand behavior. Petersen's critique of demography in the hands of anthropologists is well matched by Nancy Scheper-Hughes's 1997 attack on studies of the human condition in the hands of demographers.

Prospects

Despite these caveats, both anthropology and demography have benefited from the interaction between the two fields. Many more anthropologists are now sensitive to and often technically equipped to deal with demographic issues. Many more demographers are now alert to the need to define relevant decision-making units and personal goals in terms of local patterns of action, rather than in terms of familiar Western categories. Whether these advances can be sustained depends on the ability of demographers to broaden their theoretical horizons and on the determination of anthropologists to exercise empirical rigor. The alliance between demography and anthropology (aside from modern cultural anthropology) is well-grounded and durable but would be improved if the interests of demographers were more general and less tied to contemporary policy-driven issues. The flirtation between a demography unsatisfied in its own house and looking for some theoretical excitement in cultural anthropology can be rescued from mere flirtation under three conditions:

1. Recognition of the continuing analytical utility of institutional structures, even when they are evaded or modified by actors. Interpretivist ethnographers should recognize such structures, while functionalist ethnographers and social demographers should take them with a grain of salt.
2. A discriminating use of the concept of culture. Demographers must realize that culture may not live up to the allure of a first encounter. Nevertheless, the economists among them would profit by explicitly incorporating local preferences into their formulations. Ethnographers should seek to lay bare how choices are actually made rather than simply enlarge on how informants talk about their feelings.
3. A mutual understanding of goals and limitations. Critical and activist ethnographers must do a better job of the ethnography of demography in order to understand what it is demographers actually do, and why they do it, especially how they are driven to rely on and are then constrained by their data sources. Demographers must understand the intensely local and primarily political-humanistic agenda of interpretivist ethnography.

See also: *Caldwell, John C.; Caste; Culture and Population; Evolutionary Demography; Gender; Hunter-Gatherers; Indigenous Peoples; Nomads; Paleodemography; Prehistoric Populations; Primate Demography.*

BIBLIOGRAPHY

Bongaarts, John, and Susan C. Watkins. 1996. "Social Interactions and Contemporary Fertility Transitions." *Population and Development Review* 22: 639–682.

Boserup, Ester. 1965. *Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure.* Chicago: Aldine.

Caldwell, John C., Bruce Caldwell, and Pat Caldwell. 1987. "Anthropology and Demography: The Mutual Reinforcement of Speculation and Research." *Current Anthropology* 28: 25–34.

Childe, V. Gordon. 1964. *What Happened in History,* revised edition. New York: Penguin.

Clark, Sam, Elizabeth Colson, James Lee, and Thayer Scudder. 1995. "Ten Thousand Tonga: A Longitudinal Anthropological Study from Southern Zambia." *Population Studies* 49: 91–109.

Cohen, Mark N. 1977. *The Food Crisis in Prehistory: Overpopulation and the Origins of Agriculture.* New Haven, CT: Yale University Press.

Das Gupta, Monica. 1997. "Kinship Systems and Demographic Regimes." In *Anthropological Demography: Toward a New Synthesis,* ed. David I. Kertzer and Tom Fricke. Chicago: University of Chicago Press.

Firth, Raymond. 1968. *We, the Tikopia: Kinship in Primitive Polynesia,* 3rd edition. Boston: Beacon Press.

Fricke, Tom. 1997. "Culture Theory and Demographic Process: Toward a Thicker Demography." In *Anthropological Demography: Toward a New Synthesis,* ed. David I. Kertzer and Tom Fricke. Chicago: University of Chicago Press.

Gage, Timothy B. 1998. "The Comparative Demography of Primates: With Some Comments on the Evolution of Life Histories." *Annual Review of Anthropology* 27: 197–221.

Greenhalgh, Susan, ed. 1995. *Situating Fertility: Anthropology and Demographic Inquiry.* Cambridge, Eng.: Cambridge University Press.

Hammel, E. A. 1990. "A Theory of Culture for Demography." *Population and Development Review* 16: 455–485.

Harris, Marvin, and Eric B. Ross. 1987. *Death, Sex, and Fertility.* New York: Columbia University Press.

Hassan, Fekri A. 1981. *Demographic Archaeology.* New York: Academic Press.

Hill, Allan G. 1997. "'Truth Lies in the Eye of the Beholder': The Nature of Evidence in Demography and Anthropology." In *Anthropological Demography: Toward a New Synthesis,* ed. David I. Kertzer and Tom Fricke. Chicago: University of Chicago Press.

Hill, Kim, and Hillard Kaplan. 1999. "Life History Traits in Humans: Theory and Empirical Studies." *Annual Review of Anthropology* 28: 397–430.

Howell, Nancy L. 1986. "Demographic Anthropology." *Annual Review of Anthropology* 15: 219–246.

———. 2000. *Demography of the Dobe !Kung,* 2nd edition. New York: De Gruyter.

Kertzer, David I., and Tom Fricke, eds. 1997. *Anthropological Demography: Toward a New Synthesis.* Chicago: University of Chicago Press.

Krzywicki, Ludwik. 1934. *Primitive Society and Its Vital Statistics.* London: Macmillan.

Lesthaeghe, Ron, and Johan Surkyn. 1988. "Cultural Dynamics and Economic Theories of Fertility Change." *Population and Development Review* 14: 1–45.

Petersen, William. 1975. "A Demographer's View of Prehistoric Demography." *Current Anthropology* 16: 227–245.

Pollak, Robert A., and Susan C. Watkins. 1993. "Cultural and Economic Approaches to Fertility: A Proper Marriage or a Mésalliance?" *Population and Development Review* 19: 467–496.

Rappaport, Roy. 1967. *Pigs for the Ancestors.* New Haven, CT: Yale University Press.

Scheper-Hughes, Nancy. 1997. "Demography without Numbers." In *Anthropological Demography: Toward a New Synthesis,* ed. David I. Kertzer and Tom Fricke. Chicago: University of Chicago Press.

Schofield, Roger, and David Coleman. 1986. "Introduction." In *The State of Population Theory: Forward from Malthus,* ed. Roger Schofield and David Coleman. Oxford: Blackwell.

Skinner, G. William. 1997. "Family Systems and Demographic Processes." In *Anthropological Demography: Toward a New Synthesis,* ed. David I. Kertzer and Tom Fricke. Chicago: University of Chicago Press.

Steward, Julian H. 1936. "The Economic and Social Basis of Primitive Bands." In *Essays in Honor of A. L. Kroeber,* ed. R. H. Lowie. Berkeley: University of California Press.

Swedlund, A. C. 1978. "Historical Demography as Population Ecology." *Annual Review of Anthropology* 7: 137–173.

Wood, James W. 1990. "Fertility in Anthropological Populations." *Annual Review of Anthropology* 19: 211–242.

Zubrow, E. B., ed. 1976. *Demographic Anthropology.* Albuquerque: University of New Mexico Press.

EUGENE A. HAMMEL

ANTHROPOMETRY

Anthropometry is the science of human body measurement. Anthropometric data include measures of length, breadth, and weight of the body, circumferences of body parts, amounts of muscle and fat, the weight and size of body organs, and the size, shape, and density of bones. Many anthropometric measurements can be taken on the living, some may be taken on skeletal samples from historical burials or archaeological contexts, and other measurements are only feasible from autopsy after death. Anthropometric data are used in population research to understand the health, social, economic, and political conditions of groups of people, especially when conventional indicators (e.g., medical records, extent of schooling, gross domestic product, real wages) are not available. Such groups of people include most historical populations, slaves, archaeological populations, and many people alive today living in traditional cultures.

Kinds of Anthropometric Measures

Table 1 lists several kinds of anthropometric measures, their meaning, and methods of assessment. Height is a measure of the total history of growth of the individual. Centimeters of height accumulate over time and are the product of complex biological, behavioral, and ecological interactions. Weight represents total body mass and is a measure of recent events. Weight is more labile than height to short-term influences of diet, activity, and health. Weight may decrease over time, but height does not do so, at least during the first decades of life. The height and weight of any single individual is not of much use in population studies, but the heights and weights of many individuals from a defined group may reveal a great deal of information. Expected amounts and rates of growth in height and weight for healthy individuals at given ages from birth to maturity are well established.

These data may be used as references to compare the growth of members of the particular group under study. Significant deviations from the reference usually indicate some ecological disturbance to growth, such as poor nutrition, disease, abnormal lifestyle, psychosocial problems, and even war. Genetic disturbances to growth are well known, but usually affect individuals and not whole populations. Variations in physical growth and population structure are sensitive indicators of the quality of the environment and may be used as a mirror, reflecting rather accurately the material and moral conditions of that society.

Interpreting Anthropometric Data

Reference data are also available for virtually all anthropometric measures, and as is the case for height and weight, such references may be used to interpret the determinants of growth and development. The length of body segments (such as sitting height), thickness of skinfolds, and circumferences are used to characterize body proportions and body composition, especially the amount of muscle and fat. These measures provide more detailed evidence of health or disturbances to growth; for example, adults with short legs relative to total stature often experienced malnutrition and disease during infancy and childhood.

Radiographs reveal the degree of formation of the skeleton. The amount of skeletal maturation provides an indication of biological age, which is not identical to chronological age. Early maturers will have more advanced skeletal development than late maturers. Rate of maturation influences many biosocial capacities of the individual, including fertility. Rate of maturation may in turn be influenced by environmental quality. Finally, handgrip strength provides a measure of total physical fitness, especially as it relates to physical work capacity. In populations in which physical labor is important, greater size, skeletal maturity, and strength lead to greater productivity.

Anthropometric measurements can be collected relatively quickly and inexpensively. When properly collected, they are safe, painless, and minimally invasive. Still, taking measurements requires the cooperation, understanding, and informed consent of all participants. As children are often the subjects of growth studies it is necessary that the guardians of these children (parents, school authorities) be fully informed as to the nature of the measurements and the purpose of the research, and provide consent for the measurements. More generally, sensitivity by those conducting the research to the cultural values of the subjects is essential.

Anthropometric Data in Population Studies

An example of the use of anthropometric data in population studies comes from a survey of 8,000 years of human growth in Latin America. The data

TABLE 1

Anthropometric Measurements Commonly Taken in Research Studies

Anthropometric measure	Meaning	Method
Height	Total skeletal growth in length	Maximum length from soles of feet to vertex of head measured in the standing position (infants may be measured lying down)
Weight	Total mass of all body tissues and organs	Value of nude, or minimally clothed, body weight as assessed from a reliable balance or scale
Sitting height	Length of trunk and head. The subtraction of sitting height from stature provides an estimate of leg length	Maximum length from buttocks to vertex of head, measured with subject seated on table or chair
Head circumference	In infancy and early childhood it provides an estimate of brain growth	Maximum perimeter of head measured above the eyebrows
Skinfolds at various body sites (e.g., on the arm, back, abdomen, and leg)	Amount of adipose tissue stored at that site	Thickness of a double fold (a "pinch") of fat and skin at the site of interest
Circumference of arm, leg, abdomen, etc.	Amount of all tissue, especially fat, muscle, and bone, at the site of measurement	Usually the perimeter of relaxed arm, leg, etc. measured at the same place as the skinfold
Hand-wrist x-ray	Used to estimate maturity of the skeleton, a measure of biological age	The size and shape of the bones of the hand, wrist and forearm indicate the amount of progress toward biological maturity of the skeleton
Handgrip strength	Used to estimate overall physiological fitness of the individual	Subject maximally squeezes a dynamometer to assess muscular strength of the hand

Note: This is a partial list of commonly taken measures. Many other measurements can be, and often are, assessed in research and clinical studies. The choice of measurements is determined by the purposes of the study.

SOURCE: Compiled by author.

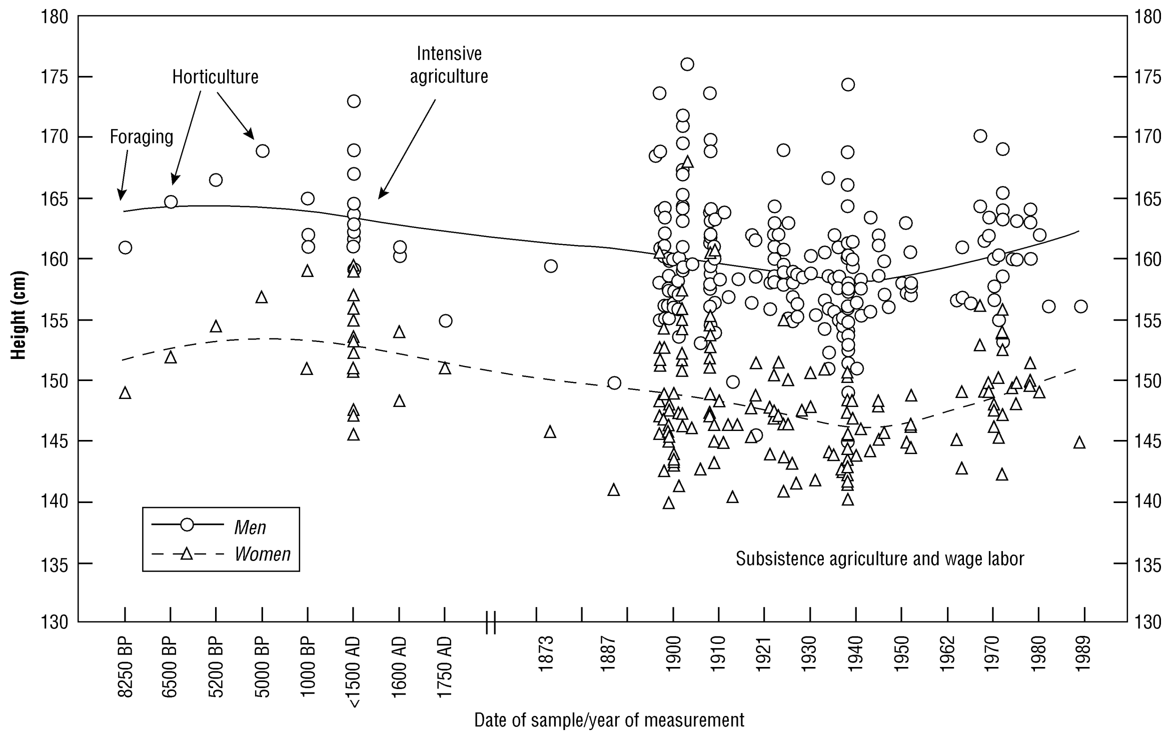
are for 597 samples of adult height for men and women, representing 32,922 individual measurements of stature on the living or estimates of stature from archaeological and cemetery samples. The people are Native Americans and low socioeconomic status mestizos (people of mixed Spanish and Native American heritage). The data and main trends in height are presented in Figure 1. The data were analyzed by plotting the mean value for each sample and then fitting a distance-weighted least square regression line, a type of average curve.

The oldest data in this set are for skeletal remains of a foraging people living along the coast of Ecuador. These people ate a wide variety of foods, including abundant fish and shellfish, and lived in relatively small social groups, with low population density. Their bones, teeth, and stature all indicate that they were relatively healthy. The next group includes the remains of horticulturists from Peru. They produced a wide variety of garden foods, and also hunted and gathered wild animal and plant foods. The density of the population was low to moderate, and the people seem to have been organized into tribal-type groups, with minimal social stratification. Their growth shows evidence of increasing adaptation to sedentary life and improvement of nutrition and health.

The data from 1,000 B.C.E. to 1750 C.E. come from people who practiced intensive agriculture. Several lines of evidence indicate that, overall, these people experienced reductions in stature, longevity, and health compared with the earlier periods. Agriculture may have produced a more monotonous and lower quality diet for the majority of people. The people also lived in larger and denser populations with more intensive and invasive social and political control, and strong social stratification. The social differences are expressed in stature, as the political elites were the tallest men and women in the samples. After 1500 C.E., average statures decline rapidly as a consequence of the European conquest and the social and biological insults that were imposed on the native people. During the historic period (after 1873) most Latin Americans lived by means of subsistence agriculture and wage labor. Politically, the general tendency was to have systems of local dicta-

FIGURE 1

Mean Statures of Latin American Men and Women during the Past 8250 Years



Note: The dates 8250 BP–1750 AD and 1873–1989 are not to scale. The fitted curves are trends in mean stature estimated by distance/weighted least squares regression

SOURCE: Bogin and Keep (1998)

torship, with economic exploitation by European and North American countries. The health and nutrition of Amerindians and rural mestizos suffered under this system. These conditions remained in place up through the first half of the twentieth century in much of Latin America. The worldwide economic depression of the 1930s intensified these already deleterious conditions for the biological, economic, and social well being of Native Latin Americans. The negative trend in stature until 1939 may be a consequence of these environmental conditions.

The positive trend in stature from 1940 to 1989 is associated with the worldwide economic recovery sparked by World War II. Latin America benefited from this recovery and did not suffer the ravages of the war in Europe, Asia, and the Pacific. Postwar economic growth continued, especially with foreign investment. This expanded economies, helped to increase the rate of urbanization, and the redistribution of the population via rural-to-urban migration. The positive trend for stature may be an outcome of these changes in the standard of living and demographic structure.

Conclusion

These brief examples, and many others like them, show how anthropometric data serve population studies as general measures for the quality of life, as quantitative economic indicators of the standard of living, and as summary measures of human welfare.

See also: *Biodemography; Data Collection, Ethical Issues in; Demographic Surveys, History and Methodology of; Nutrition and Calorie Consumption.*

BIBLIOGRAPHY

Bogin, Barry. 1999. *Patterns of Human Growth,* 2nd edition. Cambridge, Eng.: Cambridge University Press.

———. 2001. *The Growth of Humanity.* New York: Wiley-Liss.

Bogin, Barry, and Ryan Keep. 1998. "Eight Thousand Years of Human Growth in Latin America: Economic and Political History Revealed by Anthropometry." In *The Biological Standard of Living and Economic Development: Nutrition, Health, and Well Being in Historical Perspective,* ed. John Komlos and Joerg Baten. Munich: Fritz Steiner.

Tanner, James M. 1986. "Growth as a Mirror for the Conditions of Society: Secular Trends and Class Distinctions." In *Human Growth: A Multidisciplinary Review,* ed. Arto Demirjian. London: Taylor and Francis.

INTERNET RESOURCE.

National Center for Health Statistics. 2000. "CDC Growth Charts: United States." <http://www.cdc.gov/growthcharts/>.

Barry Bogin

ARCHAEOGENETICS

Archaeogenetics is the reconstruction of ancient demography from patterns of gene differences in contemporary populations. Population size, population movements, and subdivision into partially-isolated subpopulations leave characteristic signatures in the DNA of contemporary populations. New technologies for cheaply and rapidly examining DNA from human populations along with new theories and methods from population genetics have yielded important insights into human history. The literature in this field is of uneven quality: this article focuses on data and interpretations that are widely replicated and that have statistical support.

History of Human Numbers

Most theory about genetic diversity and population history describes neutral genes (the term "gene" here is used loosely to refer to any arbitrary DNA sequence). Much of the data in the literature derives from non-coding regions of the genome, because these are most likely to have been unaffected by natural selection. Genetic diversity in population studies refers to the average difference between two genes chosen at random: In the simplest case, it is simply heterozygosity, the probability that two random genes are different from each other.

Mutation introduces new diversity in a population, while genetic drift—the process by which each generation is effectively a sample with replacement of the gene pool of the previous generation—causes loss of diversity. The rate of diversity gain is the mutation rate; in humans, in the nuclear genome (that is, the DNA contained in the cell nucleus), the mutation rate is usually taken to be 10^{-9} per nucleotide position per year. The rate of loss of diversity is proportional to the reciprocal of the *effective size,* N_e, of the population. Effective size is the size of an ideal population with statistical properties equivalent to those of a real population. Many people in human populations have not yet reached reproductive age and many others are past the age of reproduction; neither of these groups influences the effective size. For humans, the effective size of a population is usually estimated to be one third of the census size.

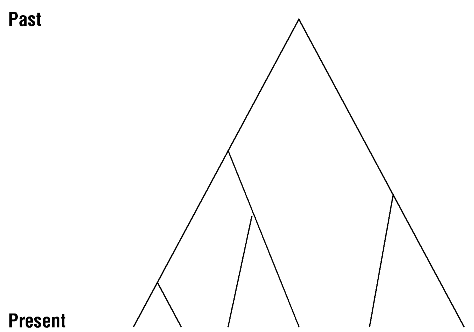
Effective size is the inverse of the rate of diversity loss, and since effective size may fluctuate over time, the average rate of diversity loss is the average of the reciprocal of effective size (that is, it is the harmonic mean rather than the ordinary mean). A population that fluctuates in size between 1,000 and 10,000, and thus has a mean size of 5,500, has a long-term effective size of about 1,800. Because of this, genetic diversity in a population is sensitive to long term minima and less sensitive to maxima.

Direct estimates from genes put long-term effective size for the human species in the range 10,000 to 20,000. Since there are approximately 6 billion humans alive today, this small effective size suggests that the number of human ancestors has been drastically smaller, consistent with a recent origin of our species from a small founding population. Fossil and archaeological evidence support such a founding event, and place it about 100,000 to 200,000 years ago.

In order to infer more about demographic history, it is necessary to introduce some results of coalescent theory, the theory of the history of a sample

FIGURE 1

A Simulated Tree of Descent of a Sample of 6 Genes from a Population That Has Been of Constant Size



Note: For many human nuclear genes these trees are one to two million years deep.

SOURCE: Author.

of genes from a population. Consider a sample of n genes drawn from a population. These n genes are tips of a tree of descent, called a *coalescent tree*: if one could follow their history backward in time, one would find that occasionally two of the genes are copies of the same gene in a parent in the previous generation—a *coalescent event.* Coalescent events reduce the number of ancestors of the sample: continuing backward, eventually one arrives at a single ancestor of all n genes—the *most recent common ancestor* (MRCA) of the sample.

A coalescent tree, with the vertical axis proportional to time, might look like Figure 1. There are six genes in the sample depicted, and as one follows them back in time the number of ancestors of the sample is six, then five after the first coalescence, then four, three, two, and finally the single common ancestor of all the genes. A tree like this, descending from a single random mating population of constant size N_e, has the following properties:

(1) The expected time back to coalescence of any pair of genes is $2N_e$ generations.

(2) The expected time to the MRCA is $4N_e$ generations for large sample size n.

(3) The expected total branch length of the tree is $4N_e\,\Sigma(1/i)$ generations where the index of summation i goes from 1 to $n-1$.

Mutations are rare and occur randomly in time and across sites on a gene. If u is the mutation rate per site per generation, then, corresponding to (1) and (2) above:

(1') The average pairwise difference between sequences is $4N_e\,u$.

(2') The expected total number of mutations in the set of sequences is $4N_e\,u\Sigma(1/i)$.

Given knowledge of the mutation rate, either of the above two expressions provides an estimate of the effective size of population, N_e.

As an illustration of property (1'), the Human Genome Project has found that a single nucleotide difference between chromosome pairs occurs on average once every 1,000 bases in the human genome, so the average pairwise difference is 10^{-3}. The mutation rate of 10^{-9} per year corresponds to a rate of 25 $\times$ 10^{-9} per generation, and substituting these figures in the expression (1') yields an estimate of human effective size of 10^4. Thus, the human species has genetic diversity equivalent to that of a species whose effective size has been constant at 10 thousand, corresponding to a census size of 30 to 40 thousand people.

Now consider a coalescent tree from a population that originated from a small number of founders and then grew rapidly to a large size. During the time when it was large, few coalescent events occurred, but before it grew the population was very small and coalescence was rapid. A gene tree from such a population might look like Figure 2, a pattern described as "star-" or "comb-" like. The total branch length of the tree is nearly proportional to the sample size n; the mean pairwise difference between samples is slightly greater than $2Tu$ where T is the time since the population growth occurred; and the top of the tree is only slightly earlier than T generations ago.

Differences among DNA sequences sampled from trees like those in Figure 1 and Figure 2 are the bases for inferences about ancient demography from DNA. First, a mutation that occurs in the tree of Figure 2 is likely to occur in one of the long terminal branches, so that it will be found only once in the sample; a mutation in the tree of Figure 1 is likely to occur near the top and hence would be represented in the sample with many copies. Hence "excess singletons and rare types" is an indicator of population expansion in the past. Second, all the pairwise differences among sequences from Figure 2 will be roughly equal, since the times separating the sequences are similar. Pairwise differences from Figure 1, on the other hand, will be erratic and differ a lot among themselves.

The first genetic marker to be studied intensively with an interest in coalescences was human mitochondrial DNA (mtDNA)—the DNA that is contained in the cell's mitochondria rather than its nucleus. It was found that the human mtDNA tree was like that of Figure 2, with the time of expansion *T* estimated to be 80,000 years ago. This pattern indicated that the human species had a focal origin, and that the genetic contribution to modern humans of most of the world population of archaic humans, like the Neanderthals of Europe, was either nonexistent or vanishingly small.

Unfortunately, subsequent studies of other genetic systems—using nuclear rather than mitochondrial DNA—have not confirmed this picture. The issue of when and how the human population grew from only a few thousand to 6 billion is the subject of lively current debate. Some nuclear genes show no evidence of population expansion, while others show mild evidence of expansion, consistent with population growth since the end of the last ice age (around 12,000 years ago). The contending hypotheses are:

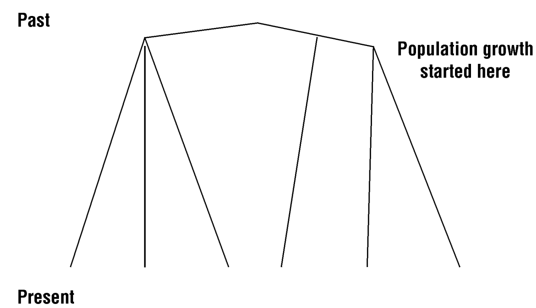
(A) There was a founding event and subsequent population expansion about 100,000 years ago, as suggested by mtDNA and some other genetic systems, but pervasive natural selection in the nuclear genome has obscured the signature of this event.

(B) A new genotype appeared before 100,000 years ago and spread throughout the species, leading to replacement of some of the genome and incorporation of genes from archaic populations at other parts of the genome. According to this hypothesis, mtDNA, the Y chromosome, and some other parts of the nuclear genome underwent replacement, but much of the nuclear genome did not.

(C) The major numerical expansion of humans has taken place since the last ice age. Many nuclear genes coalesce about 1.8 million years ago, around the time of the expansion of modern human's precursor species, *Homo erectus,* out of Africa. This corresponds to 72,000 generations at 25 years per generation. Under a constant population size model, this would imply an effective population size N_e of (72,000 ÷ 4) =18,000, which lies comfortably within the range of genetic estimates of N_e. In other words, the small human effective size reflects a focal origin 1.8 million years ago. According to this hypothesis, the evidence from human mtDNA of massive expansion over the last 100,000 years is an artifact.

FIGURE 2

Simulated Tree of Descent of a Sample of 6 Genes from a Population that Underwent Major Demographic Expansion in the Past



SOURCE: Author.

Published estimates of coalescence times of nuclear genes are generally well below 1.8 million years, but the absolute values of these estimates should not be taken seriously. They rely on knowledge of the mutation rate, which is calculated from chimpanzee-human differences and the assumed time since the two species separated. Problems with this calculation may lead to a substantial overestimation of the rate. Taking this into account, almost all of the data on coalescence times of nuclear genes are consistent with hypothesis C, but hypothesis C is inconsistent with the expansion signature in mitochondrial DNA and the evidence of expansion from some other families of markers. Scholars at the beginning of the twenty-first century found some version of hypothesis B to be the most promising.

Human Diversity in Detail

The example given above showing an estimate of human N_e of 10,000 was based on single nucleotide differences along a pair of genes. These differences are called *Single Nucleotide Polymorphisms* (SNPs), and they are one of several important classes of genetic markers. Another class is repeat polymorphisms, genes where there are repetitions of a DNA sequence. Many of these are in non-coding DNA, but they also occur in genes and affect the protein that the gene produces. Generically these are called *Variable Number of Tandem Repeats* (VNTRs). If the repeat motifs are very short—two to four bases—they are called *Short Tandem Repeats* (STRs) or microsatellites. Commonly used STRs for identification and for studies of evolution are tetranucleotide repeats with four base motifs, and dinucleotides with two. Trinucleotide repeats are less likely to be neutral since, with three base motifs, they can affect genes more easily.

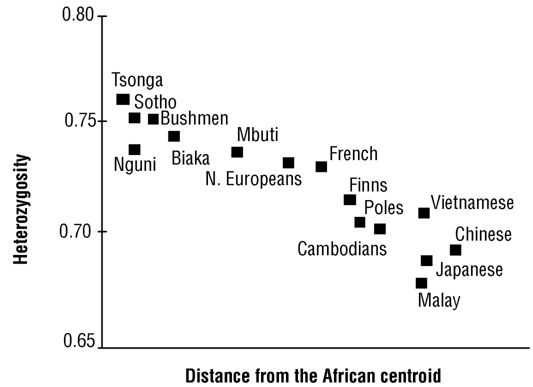
The earlier example suggested that SNP density is a natural statistic for describing genetic diversity within a population. The corresponding natural statistic for VNTR loci is the variance of repeat length in a sample of genes. Mutations change repeat length by a small amount, so that the mean squared difference between two chromosomes, as well as the probability they are the same length, should be monotonically related to the time elapsed since the common ancestor of the chromosomes, hence to the effective size of the population.

Human within-population diversity is highest in Africa and declines as one moves away from Africa. This is seen in the scatterplot in Figure 3, taken from Henry C. Harpending and Elise Eller's 1999 work. The horizontal axis of the figure is genetic distance from Africa; the vertical axis is average heterozygosity—the probability that two STR genes are the same length, averaged over 60 short repeat polymorphisms. The plot shows the relationship between how genetically different a population is from the African average and within-population genetic diversity. Populations more different from Africans are less diverse, and the relationship is nearly linear. This pattern is thought to be part of the signature of the African origin of our species and the loss of diversity associated with repeated founder effects during colonization at the edge of the expansion. While Figure 3 only includes Old World populations, other data sources show that the decline continues into the New World: American Indian populations are 15 to 25 percent less diverse than African populations. Direct studies of SNP density are likely to shed further light on this pattern as additional data become available.

Just as within-population diversity describes how different two genes from the same population are on average, between-population diversity describes how much greater is the average difference between genes from different populations relative to overall average gene differences. In other words, total diversity of a sample of populations can be partitioned into within- and between-population components in a way completely analogous to the analysis of variance in statistics.

FIGURE 3

Relationship between Genetic Distance from the African Centroid and Within-Population Genetic Diversity, for Selected Populations



Note: Genetic diversity is average heterozygosity at 60 Microsatelite marker loci.

SOURCE: Harpending and Eller (1999).

The fraction of diversity between populations is conventionally written as F_{st}. Various kinds of genetic data have been used to estimate F_{st}. For large human populations like those in Figure 3, all the estimates are in the range of 10 to 15 percent. One interpretation of this is that if the world's peoples were to mate at random, average within-population diversity would increase by this amount; another interpretation is that F_{st} measures relative within-population similarity or shared genetic material. Thus the excess shared genetic material within human subpopulations relative to the whole world is 10 to 15 percent. In a famous early discussion of this point, Richard Lewontin (1972) emphasized that 10 to 15 percent is a small amount and drew the conclusion that differences among human populations or races are insignificant. On the other hand, the excess shared genetic material within a population between grandparent and grandchild is 12.5 percent (one-eighth), and society does not regard the genetic similarity between grandparent and grandchild as trivial.

See also: *Biology, Population; Evolutionary Demography; Paleodemography; Prehistoric Populations.*

BIBLIOGRAPHY

Di Rienzo, Anna, and Allan C. Wilson. 1991. "Branching Pattern in the Evolutionary Tree for Human Mitochondrial DNA." *Proceedings of the National Academy of Sciences USA* 88: 1,597–1,601.

Harpending, Henry C., and Elise Eller. 1999. "Human Diversity and Its History." *Biodiversity* pp. 301–314.

Harpending, Henry C., and Alan Rogers. 2001. "Genetic Perspectives on Human Origins and Differentiation." *Annual Review of Genomics and Human Genetics* 1: 361–385.

Hudson, Richard R. 1990. "Gene Genealogies and the Coalescent Process." *Oxford Surveys in Evolutionary Biology* 7: 1–44.

Lewontin, Richard C. 1972. *Evolutionary Biology,* Vol. 6: *The Apportionment of Human Diversity,* ed. Theodosius H. Dobzhansky, Max K. Hecht, and William C. Steere. New York: Appleton-Century-Crofts.

Rogers, Alan R., and Lynn B. Jorde. 1995. "Genetic Evidence on the Origin of Modern Humans." *Human Biology* 67: 1–36.

Takahata, Naoyuki, Sang-Hee Lee, et al. 2001. "Testing Multiregionality of Modern Human Origins." *Molecular Biology and Evolution* 18: 172–183.

Henry C. Harpending

ARIÈS, PHILIPPE

(1914–1984)

Philippe Ariès was born in Blois, in the Loire Valley of France, to an old Bordeaux family. He studied history and geography at the Sorbonne but did not graduate. During the pre-war years, Ariès haunted the rightist-monarchist circles of the *Action Française.* In 1941 he became an instructor at the École des Cadres of La Chapelle-Saint-Serval, which had just been created near Paris by the Vichy government, and in 1943 he was appointed head of the Center of Documentation of the Research Institute on Citrus Fruits. His most important book, *Histoire des populations françaises et de leurs attitudes devant la vie,* was published in 1948 (2nd edition, 1971). It did not provoke any reaction from academic historians, but immediately attracted the attention of demographers. From 1950 to 1975, Ariès directed a series at Plon Editions and contributed regularly to the royalist *Nation française* from 1955 to 1966. His second major publication, *L'Enfant et la vie familiale sous l'Ancien Régime* (1960), translated as *Centuries of Childhood,* was a bestseller among scholarly books in the United States. He was invited to lecture in the United States, and he found financial support for his research there. Ariès's other major books, *Essai sur l'histoire de la mort en Occident* (1975) and *L'Homme devant la mort* (1977), earned him recognition at last as a prophet in his own country. He was elected Director at the École des Hautes Études en Sciences Sociales in 1978, and was called to contribute to the official anthology of the "new history." When he died in 1984, shortly after the death of his wife and lifelong collaborator, he was no longer an isolated pioneer, but one of the founders of demographic history and the unquestioned master of the history of mentalities.

Although he characterized himself as a "Sunday" historian, Ariès was by no means an occasional researcher but an authentic "everyday" scholar. Paralleling the triumphant socioeconomic history launched by the *Annales* school, he was the herald of a new cultural history, documenting the attitudes of people in their daily existence toward life, love, and death. Demography was the key that allowed him to unlock the secrets of the private domain, and the family was the privileged axis of his history of mentalities. Ariès showed that childhood, adolescence, and the indissoluble marriage were relatively recent concepts. Following Adolphe Landry (1934), he argued that the pursuit of pleasure and happiness, added to the growing rationalization of behavior, had led to the deliberate strategy of couples to separate sexuality from procreation, opening the way to birth control and to a general liberation of sexual mores. This development coincided, too, with a changing conception of death—for Ariès, the topic where the "collective unconscious" could best manifest itself. To describe how the "tamed Death" of the Middle Ages was transformed into the "forbidden Death" of the present day, Ariès and his wife made extensive and imaginative use of iconography.

Ariès did not escape some critics who reproached this "banana seller" for the lack of representativeness of his assertions, the deficiency of his quantitative measures, and his neglect of the role played by the State. But during the 1970s and 1980s, the "new history"—that is, cultural history—prevailed over the socioeconomic history of the 1950s and 1960s (even if there was, after Ariès, a risk of fragmentation of this learning). As the chronicler of everyday life in that "world we have lost," according to Peter Laslett's book, Ariès had rightly perceived many of the symptoms of future change. But he could hardly have foreseen the scope of the upheaval that the mores in Western societies were experiencing even within one or two decades of his own passing.

See also: *Culture and Population; Family: History; Historical Demography; Second Demographic Transition.*

BIBLIOGRAPHY

SELECTED WORKS BY PHILIPPE ARIÈS

Ariès, Philippe. 1960. *L'Enfant et la vie familiale sous l'Ancien Régime,* Paris: Plon. Translated as *Centuries of Childhood: A Social History of Family Life,* 1962. New York: Vintage Books.

———. 1971. *Histoire des populations françaises et de leurs attitudes devant la vie de depuis le XVIIIe siècle,* 2nd edition. Paris: SELF.

———. 1975. *Essai sur l'histoire de la mort en Occident du Moyen-Age à nos jours.* Paris: Seuil. Translated as *Western Attitudes toward Death: From the Middle Ages to the Present,* 1974. Baltimore: Johns Hopkins University Press.

———. 1977. *L'Homme devant la mort.* Paris: Seuil. Translated as *The Hour of Our Death,* 1981. New York: Knopf.

———. 1980. "Two successive motivations for the declining birth rate in the West." *Population and Development Review* 6(4): 645–650.

———. 1983. *Images de l'homme devant la mort.* Paris: Seuil. Translated as *Images of Man and Death,* 1985. Cambridge, MA: Harvard University Press.

Ariès, Philippe, ed. 1986. *Le Temps de l'histoire* (1954). Paris, Seuil.

———. 1980. *Un Historien du dimanche.* Paris: Seuil.

Ariès, Philippe, and Georges Duby, eds. 1991. *A History of Private Life.* Cambridge, MA: Belknap Press.

SELECTED WORKS ABOUT PHILIPPE ARIÈS

Gros, Guillaume. 2002. *Philippe Ariès (1914–1984). Un traditionaliste non-conformiste: de l'Action Française à l'École des Hautes Études en Sciences Sociales.* Paris: Institut d'Études Politiques.

Hutton, Patrick M. 2002. "Philippe Ariès and the Secrets of the History of Mentalities." *Historical Reflections/Reflexions historiques* 28(1): 1–19.

Landry, Adolphe. 1982 [1934]. *La révolution démographique: Études et essais sur les problèmes de la population.* Paris: Institut national d'études démographiques.

Laslett, Peter. 1984. *The World We Have Lost,* 3rd edition. New York: Scribner.

Jacqueline Hecht

ARTIFICIAL SOCIAL LIFE

Most demographic research either develops or uses some kind of theory or model: for instance, a theory of fertility or a model of the class system. Generally, such theories are stated in discursive English, although sometimes the theory is represented as an equation (for example, in regression analysis). In the 1990s researchers began to explore the possibilities of expressing theories as computer programs. The advantage is that social processes can then be simulated in the computer and in some circumstances it is even possible to carry out "experiments" on artificial social systems that would otherwise be quite impossible.

Although the simulation of social dynamics has a long history in the social sciences, the advent of much more powerful computers, more powerful computer languages, and the greater availability of data have led to increased interest in simulation as a method for developing and testing social theories.

The logic underlying the methodology of simulation is not very different from the logic underlying statistical modeling. In both cases, a model is constructed (for example, in the form of a computer program or a regression equation) through a process of abstraction from what are theorized to be the actually existing social processes. The model is then used to generate expected values that are compared with empirical data. The main difference between statistical modeling and simulation is that the simulation model can itself be "run" to produce output, while a statistical model requires a statistical analysis program to generate expected values.

Advantages of Simulation

Paradoxically, one of the main advantages of simulation is that it is hard to do. To create a useful simulation model, its theoretical presuppositions need to have been thought through with great clarity. Every relationship to be modeled has to be specified exactly and every parameter has to be given a value, for otherwise it will be impossible to run the simulation. This discipline means that it is impossible to be vague about what is being assumed. It also means that the model is potentially open to inspection by other researchers in all its detail. These benefits of clarity and precision also have disadvantages, however. Simulations of complex social processes involve the estimation of many parameters and adequate data for making the estimates can be difficult to come by.

Another benefit of simulation is that it can, in some circumstances, give insights into the "emergence" of macro level phenomena from micro level action. For example, a simulation of interacting individuals may reveal clear patterns of influence when examined on a societal scale. A simulation by Andrzej Nowak and Bibb Latané (1993), for example, shows how simple rules about the way in which one individual influences another's attitudes can yield results about attitude change at the level of a society, and a simulation by Robert Axelrod (1995) demonstrates how patterns of political domination can arise from a few rules followed by simulated nation-states.

Agent-Based Simulation

The field of social simulation has come to be dominated by an approach called agent-based simulation (alternatively called multi-agent simulation). Although other types of simulation such as those based on system dynamics models (using sets of difference equations) and microsimulation (based on the simulated aging of a survey sample to learn about its characteristics in the future) are still undertaken, most simulation research now uses agents.

Agents are computer programs (or parts of programs) that are designed to act relatively autonomously within a simulated environment. An agent can represent an individual or an organization, according to what is being modeled. Agents are generally programmed to be able to "perceive" and "react" to their situation, to pursue the goals they are given, and to interact with other agents, for example by sending them messages. Agents are generally created using an object-oriented programming language and are constructed using collections of condition–action rules. The agent examines its rules to identify those whose conditions hold true in its current situation and then executes ("fires") the actions determined by just those rules. The effect of firing the rules will normally be to alter the agent's situation, and thus in the next cycle a different set of rules will fire.

Agent-based models have been used to investigate the bases of leadership, the functions of norms, the implications of environmental change on organizations, the effects of land-use planning constraints on populations, the evolution of language, and many other topics. Examples of research can be found in the *Journal of Artificial Societies and Social Simulation.*

While most agent-based simulations have been created to model real social phenomena, it is also possible to model situations that could not exist in our world, in order to understand whether there are universal constraints on the possibility of social life (for example, can societies function if their members are entirely self-interested and rational?). These are at one end of a spectrum of simulations ranging from those of entirely imaginary societies to those that aim to reproduce specific settings in great detail.

An interesting variant on agent-based modeling is to include people in place of some or all of the computational agents. This transforms the model into a type of multiplayer computer game, which can be valuable for allowing the players to learn more about the dynamics of some social setting (for example, business students can be given a game of this type in order to learn about the effects of business strategies). Such games are known as participatory simulations.

The Potential of Simulation

Although computer simulation can be regarded as simply an another method for representing models of social processes, it encourages a theoretical perspective which emphasizes emergence, the search for simple regularities that give rise to complex phenomena, and an evolutionary view of the development of societies. This perspective has connections with complexity theory, an attempt to locate general principles applying to all systems which show autonomous behavior—including not only human societies, but also biological and physical phenomena.

See also: *Simulation Models.*

BIBLIOGRAPHY

Axelrod, Robert. 1995. "A Model of the Emergence of New Political Actors." In *Artificial Societies: The Computer Simulation of Social Life,* ed. Nigel Gilbert and Rosaria Conte. London: UCL.

Carley, Kathleen, and Michael Prietula. 1994. *Computational Organization Theory.* Hillsdale, NJ: Lawrence Erlbaum.

Epstein, Joshua M., and Robert Axtell. 1996. *Growing Artificial Societies: Social Science from the Bottom Up.* Cambridge, MA: MIT Press.

Gilbert, Nigel. 1999. "Computer Simulation in the Social Sciences." Special issue of *American Behavioral Scientist* 42.

Gilbert, Nigel, and Klaus G. Troitzsch. 1999. *Simulation for the Social Scientist.* Milton Keynes, Eng.: Open University Press.

Nowak, Andrzej, and Bibb Latané. 1993. "Simulating the Emergence of Social Order from Individual Behaviour." In *Simulating Societies: The Computer Simulation of Social Phenomena,* ed. Nigel Gilbert and Jim Doran. London: UCL Press.

INTERNET RESOURCE.

Journal of Artificial Societies and Social Simulation. <http://www.soc.surrey.ac.uk/JASSS/>.

NIGEL GILBERT

ASYLUM, RIGHT OF

The Universal Declaration of Human Rights proclaims that:

> 1. Everyone has the right to seek and to enjoy in other countries asylum from persecution. 2. This right may not be invoked in the case of prosecutions genuinely arising from non-political crimes or from acts contrary to the purposes and principles of the United Nations. (Universal Declaration of Human Rights, Article 14)

This does not establish a right to asylum, only a right to seek asylum, and if successful in doing so, to enjoy that asylum. There is no corresponding obligation on the part of states to grant asylum. As the right to asylum has never been codified, its granting is at the discretion of states. Thus, the right to decide whether someone is deserving of asylum lies with the state in which the asylum application is lodged. The 1951 Convention Relating to the Status of Refugees (Geneva Convention) and 1967 Protocol to that Convention (New York Protocol) set some limits on the sovereign right to determine who is a refugee. Two articles are of particular importance: the definition of refugee in Article 1 of the Convention, and the protection of *non-refoulement* (that is, protection against forcible return) under article 33. These articles state respectively that:

> The term "refugee" shall apply to any person who: . . . 2). . . .owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country. . .(Geneva Convention, Article 1)

And,

> No Contracting State shall expel or return ('refouler') a refugee in any manner whatsoever to the frontiers of territories where his life or freedom would be threatened on account of his race, religion, nationality, membership of a particular social group or political opinion. (Geneva Convention, Article 33)

As of February 1, 2002, 140 states were signatories to the Convention; 138 had signed the Protocol; and

135 had signed both. All European Union states are signatories to both documents. Many states in Asia have signed neither instrument. In Africa, the majority of states have not only signed the Convention and Protocol, but also a regional (Organization of African Unity) convention, extending the status of refugee to those fleeing conflicts in the region.

The states that have committed themselves to the laws and principles set out in the Convention and Protocol have divergent means of applying the tools of refugee protection. For example, some states grant refugee status only when persecution at the hands of a state or governmental actor is feared, and not in the case of persecution at the hands of a nonstate militia or other such group. For many states, conferring recognition as a refugee depends on persecution that is objectively demonstrated as targeting the individual in question. Those fleeing war, which targets whole populations, fall outside the definition as thus interpreted.

In a number of developed states, a person who is deemed not to qualify for refugee status (according to the definition cited above) but who cannot be returned to his or her country of origin (pursuant to the *non-refoulement* stipulation) may be granted a form of supplementary or complementary protection. This is the case in most of the European Union (EU) member states and in Canada, but not in the United States. This type of humanitarian status frequently has fewer rights attendant to it: There may be greater restrictions on the possibilities for family reunification, or a time limit may be applied to the length of legal residence before permit renewal. The issue of the length of time for which asylum or protection may be granted has been a contentious one in many states. Although the cessation clauses (1C) of the 1951 Convention mean that refugee status may be withdrawn if circumstances change in the country of origin, Convention status has been viewed by most states as something of permanence, at least in terms of the residence rights they confer with it.

In other situations states have sought to create explicitly temporary forms of protection. The most striking instance applied to people fleeing former Yugoslavia, including Bosnia and Kosovo, to other European states in the 1990s, who were granted temporary protection rather than refugee status. These people were deemed to be fleeing generalized violence rather than individualized persecution. But the move toward temporary forms of protective status was also driven by the administrative difficulty of dealing with a greatly increased number of asylum claims in a short period. Increasingly, time limits are being attached to the status granted to refugees. The Netherlands, for example, enacted a new Aliens Law in 2000, granting only three years residence (in yearly increments) in the first instance to persons deemed to be in need of protection.

Since the mid-1980s European states have adopted policies and practices that limit the rights of those not returned to their countries of origin, whether or not they are granted a Convention refugee status. This is partly a reaction to a real or perceived increase in xenophobia, prompted especially by concerns about asylum-seekers' access to various forms of welfare services, in money or in kind, that is available to the resident population. In part it is also because the key foreign policy support for the asylum system has changed dramatically since the end of the Cold War. The Convention definition of a refugee was written with World War II fresh in the collective memory, and the Cold War as a developing phenomenon. When the Cold War ended, political authorities in the West saw the definition as no longer fully relevant. Moreover, they started to seek partners in the newly democratic states who would take on their share of the refugee protection burden. One means of burden-shifting came with the development of the concept of a "safe third country": If asylum-seekers passed through a country in which they could have sought and enjoyed protection before reaching their desired destination, some states consider that they should be the responsibility of that country and should be returned to it. Burden-shifting trends are apparent within the EU, and between EU member states and their eastern neighbors. They are also influencing asylum policymaking in Southern Africa, Australia, and elsewhere.

As countries have tightened their asylum systems, they have seen a rise in migrant smuggling. In turning to unconventional methods of transportation and assistance in acquiring documentation, refugees become doubly vulnerable: first, as victims of persecution and second, as frequent victims of exploitation.

A further trend, emphasized by reactions to the terrorist attacks of September 11, 2001, is the linking of security and asylum issues, not only at the causal end of refugee movements, but also at the destination of the protection seeker. As states seek greater control over entry to their territories, they increasingly turn to resettlement programs of the kind seen in the U.S., Canada, Australia, and New Zealand. In these programs persons to be resettled are selected in their country of origin or a neighboring state—thereby, it is hoped, taking the initiative away from smugglers as well as permitting earlier screening for criminal background or terrorism threat. This potentially also narrows the opportunities for asylum seeking.

See also: *Ethnic Cleansing; Genocide; Immigration Policies; Refugees, Demography of.*

BIBLIOGRAPHY

Convention Relating to the Status of Refugees. 1951. 189 United Nations Treaty Series (UNTS) 137

Goodwin-Gill, Guy S. 1996. *The Refugee in International Law.* Oxford: Clarendon Press.

Gowlland-Debbas, Vera, ed. 1996. *The Problem of Refugees in the Light of Contemporary International Law Issues.* The Hague, The Netherlands: Martinus Nijhoff.

Hathaway, James C. 1991. *The Law of Refugee Status.* Toronto: Butterworths.

Nicholson, Frances, and Patrick Twomey. 1999. *Refugees Rights and Realities: Evolving International Concepts and Regimes.* Cambridge, Eng.: Cambridge University Press.

OAU Convention Governing Specific Aspects of Refugee Problems in Africa. 1969. 1001 UNTS 45.

United Kingdom Home Office. 2002. *Secure Borders, Safe Haven: Integration with Diversity in Modern Britain.* London: Crown Publishers.

Universal Declaration of Human Rights 1948. *American Journal of International Law* 1949 (Supplement) 43(3).

Vreemdelingen Wet 2000 [Asylum Act 2000]. 2000. The Hague: Staatsblad. 495 December 7, 2000.

INTERNET RESOURCES.

Protocol to the Convention Relating to the Status of Refugees. 1967. 606 UNTS 267. Available at the United Nations High Commissioner for Refugees website. <http://www.unhcr.ch>.

van Selm, Joanne. 2001. "Access to Procedures: Safe Third Countries, *Safe Countries of Origin* and Time Limits." United Nations High Commissioner for Refugees website. <http://www.unhcr.ch/cgi-bin/texis/vtx/home/>.

JOANNE VAN SELM

B

BABY BOOM, POST–WORLD WAR II

No twentieth-century demographic phenomenon in the developed countries has attracted greater attention than the "baby boom"—the sustained post–World War II fertility increases in many developed countries that produced large birth cohorts from the mid-1940s to the mid-1960s. The magnitude of the baby boom, especially in the United States, has made it a demographic event with widespread, long-lasting, and well-chronicled consequences. But demographers have focused their most serious attention on explaining why the baby boom occurred and on forecasting fertility in its aftermath. The baby boom (and the subsequent bust) is widely seen as epitomizing demographic forecasting failure. It remains demography's primary example of the unpredictability of population trends and is frequently cited as evidence that the knowledge base on human fertility is grossly deficient. However, the demographic phenomena that produced the baby boom are well known, and there is a plausible social history of the circumstances that spawned that upsurge of births.

Defining Baby Booms and Echoes

A baby boom, as a generic concept, is a large increase in the number of births relative to some previous year or average (i.e., an increase in birth cohort size). This can result from two factors: a rise in the number of potential childbearers (i.e., women aged 15 to 44, partly a function of past cohort size) and the increased average risk of having a child. When fertility increases result from large cohorts entering the childbearing years (i.e., only the first factor), demographers call this fertility increase an "echo" of a previous baby boom.

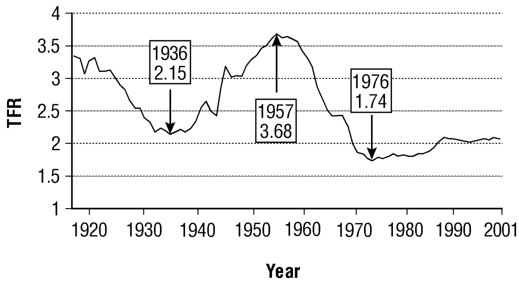
The post–World War II baby boom, however, was not driven by trends in cohort size: Indeed, the boom of the 1950s and early 1960s was produced by the small cohorts born during the 1930s. (Likewise, the American baby bust of the late 1960s and 1970s occurred in the face of the maturing baby boom.) Thus, it is clear that birth rates, not generation size, have been the key factor in the postwar upsurge of births. For this reason, researchers focus attention on changes in fertility rates as the phenomena to be explained. More specifically, there is a focus on the total fertility rate (TFR)—the number of births women would have if they experienced the age-specific fertility rates of a given period.

Fertility Increases During the Baby Boom

Figure 1 shows the U.S. TFR from 1917 to 2001. The baby boom TFR maximum is 3.68, which was reached in 1957. TFR lows preceding and following the baby boom were 2.15 and 1.74 respectively. Also note that the post–World War II baby boom lasted roughly two decades in the United States. The basic features of this TFR increase can be observed in most Western developed countries. In a 1974 study demographer Arthur Campbell analyzed data for 18 Western countries with TFRs that approximated 2 in the 1930s. TFRs for these same countries were 2.7 by the early 1950s and 3.1 by the early 1960s. All of these countries experienced subsequent sharp fertility declines. By the early 1980s all of the countries studied by Campbell had TFR values below 2.1. Table 1 presents some of Campbell's data for individual countries, updated through the 1990s; all show key features visible in the U.S. data.

FIGURE 1

Total Fertility Rate, United States, 1917–2001



SOURCE: NCHS Vital Statistics (various years).

An additional feature of the postwar baby boom was the pervasiveness of the fertility increases and declines among subgroups within countries. For instance, in the United States all major racial and educational groups participated in both the baby boom and the subsequent bust.

In contrast to its pervasiveness across geographic areas and social groups, the baby boom can be traced to a few dynamic, demographic components. TFR changes can reflect changes in the ages that women have births (i.e., the timing or tempo of childbearing) and/or changes in the number (or quantum) of children that women eventually bear. To capture the relative importance of these changes the TFR can be usefully disaggregated into age and parity components. This disaggregation allows measurement of timing (or tempo) and number (or quantum) changes.

Table 2 shows demographer Norman Ryder's classic decomposition of the U.S. baby boom and subsequent baby bust. From a low point in the mid-1930s to its peak in 1957, the TFR increased from 2.15 to 3.68. Column one shows that somewhat less than half (42%) of this birth increase can be attributed to changes in the quantum component; the remainder can be accounted for by timing shifts toward younger ages at childbearing. Further, the quantum increases are almost entirely due to increased first and second births (88%) and the timing shifts are primarily attributed to age at first birth (78%). Such decomposition shows that earlier and pervasive parenthood accounts for the majority of the baby boom increase in the TFR. Likewise, post-1957 TFR declines were driven by timing changes, in this case toward later ages of childbearing, with rising age at first birth the most important component. Post-1957 quantum changes did include important declines in third or higher order births.

Other decompositional demographic analysis provides important clues regarding whether explanations should center on cohort or period factors. The evidence is unequivocal: Postwar fertility trends in developed countries are largely accounted for by period shifts; in given calendar years, fertility rates show pervasive changes across ages. Stated differently, there is little evidence that birth year strongly conditions responses to current events.

Causes of the Baby Boom and Bust

Economist Richard Easterlin's explanation of the baby boom has spawned a large body of research. While Easterlin's theory yields valuable insights, empirical evidence requires substantial adjustments. In brief, in 1973 Easterlin identified shifts in relative income across generations as the primary cause of the baby boom. Specifically, those who were children during the 1930s were raised in uncertain times and in very modest economic circumstances. They reached adulthood in the economically prosperous postwar years and compared their economic circumstances favorably to those of their families of origin (i.e., they had high relative income). As a result, at young ages, baby boomers felt prepared to marry early and to have children early. Later, in a 1978 study, Easterlin stressed the role of relative cohort size in producing shifts in the economic well-being of successive generations. Those born and raised during the depression were members of small cohorts compared to those born during the baby boom. Small cohorts, in contrast to large ones, experienced relatively favorable conditions in educational and employment settings (had high relative income) and thus married and had children earlier. Easterlin's thesis had substantial intuitive appeal and could account for the earlier and more universal parenthood that characterized the baby boom. In addition, cohort size data accurately predicted the American fertility boom and bust. However, there is little evidence at the micro level that relative income is strongly associated with the timing of family formation or the number of children born. Since relative income is the key causal/behavioral mechanism in Easterlin's theory, this negative evidence is highly problematic. In addition, Easterlin's argument is clearly cohort-based while the empirical demo-

TABLE 1

Total Fertility Rates for Selected Low-Fertility Countries: 1930s–1995

Country	Pre-WW II (1930s)	Post-WW II (Early 1950s)	Baby Boom Peak	Baby Bust (1975)	Contemporary Levels (1985)	(1995)
Australia	2.16 *(1933)*	3.09 *(1950-52)*	3.51 *(1961)*	2.20	1.89	1.83
Austria	1.65 *(1933-34)*	2.07 *(1950-52)*	2.81 *(1963)*	1.83	1.47	1.40
Belgium	1.96 *(1933-37)*	2.37 *(1948-52)*	2.69 *(1964)*	1.74	1.51	1.55
Canada	2.69 *(1936-40)*	3.53 *(1950-52)*	3.93 *(1959)*	1.83	1.64	1.65
Denmark	2.13 *(1936)*	2.53 *(1950-52)*	2.63 *(1963)*	1.92	1.45	1.80
United Kingdom	1.83 *(1939)*	2.15 *(1950-52)*	2.88 *(1964)*	1.81	1.80	1.71
Germany (West)	2.03 *(1934)*	2.06 *(1951-53)*	2.54 *(1964)*	1.45	1.28	1.34
France	2.07 *(1934-38)*	2.85 *(1949-53)*	2.86 *(1964)*	1.93	1.82	1.70
Netherlands	2.63 *(1933-37)*	3.17 *(1948-52)*	3.19 *(1961)*	1.66	1.51	1.53
Norway	1.84 *(1932-35)*	2.6 *(1951-55)*	2.96 *(1964)*	1.98	1.68	1.87
Sweden	1.7 *(1933-37)*	2.31 *(1948-52)*	2.49 *(1964)*	1.78	1.74	1.74
Switzerland	1.75 *(1937)*	2.34 *(1950-52)*	2.66 *(1964)*	1.61	1.52	1.48
United States	2.04 *(1934-36)*	3.08 *(1949-51)*	3.76 *(1957)*	1.78	1.84	2.03

SOURCE: Campbell (1974); OECD publications.

graphic evidence indicates the dominance of period change. Thus, substantial empirical evidence challenges Easterlin's theory and the scientific soundness of generalizing his arguments.

An adequate understanding of the baby boom requires a period orientation—period explanations "emphasize society-wide shifts that appear to affect all groups at the same time, as if there were something in the air that influenced everyone's lives" (Cherlin, p. 31). This *something* is much harder to identify precisely because multiple factors are changing across periods. Sociologist Andrew Cherlin approaches the task of explaining period trends in the United States through contrasting the social history of the 1950s and 1960s to the 1970s and 1980s. For instance, the breadwinner family, traditional gender-role ideology, and a robust economy characterized the 1950s. In this environment, marriage and childbearing occurred sooner and were within the reach of many. In contrast, the 1970s brought greater participation of women in the labor force, ideologies stressing individualism and self-actualization, and economic stagnation. Individuals responded to these period conditions in ways that suggested a common understanding of their meaning and that were not influenced by cohort-specific socialization experiences. These social histories provide plausible explanations for changes in the dynamic demographic components described above and broadly characterize many Western industrialized countries in these decades. Comparative work across countries might identify the most important period factor or set of factors. However, isolating cause in a continually evolving social system poses difficult challenges; a compelling retrospective social history might be all that can be reasonably attained.

TABLE 2

Decomposition of the Change in the Total Fertility Rate in the American Baby Boom: Quantum and Tempo Components (percentage distributions)

Quantum/Tempo	Baby boom (from start to peak) (1936–1957)			Baby bust (from peak to trough) (1958–1975)		
Quantum effect	42			45		
Parity 0 & 1		37	*88*		17	*38*
Parity 2+		5	*12*		28	*62*
(Total quantum)		(42)	*(100)*		(45)	*(100)*
Tempo effect	58			55		
Age at first birth		45	*78*		31	*56*
Other timing changes		13	*22*		24	*44*
(Total tempo)		(58)	*(100)*		(55)	*(100)*
Total effect	100	(100)		100	(100)	

SOURCE: Ryder (1980).

Underemphasized in Cherlin's U.S. baby boom social history is the importance of new methods of contraception and more widely available abortion. In 1977 demographers Charles Westoff and Norman Ryder characterized the 1965 to 1975 period as a "contraceptive revolution." The import of effective fertility control interacts with changes in the timing of fertility described above. Compared to the baby boom, baby bust women had more effective fertility control, had children later, reached their desired family sizes at later ages, and thus were at lower risk of having unintended births for a fewer number of years. A substantial proportion of births during the baby boom can be classified as unwanted (i.e., women claimed that prior to the relevant pregnancy they preferred to have no more children), a proportion that declined during the baby bust. Thus, the effectiveness and availability of birth control contributed to the pace and magnitude of the baby bust.

Could There Be Another Baby Boom?

In the twenty-first century, economically advanced countries are very unlikely to experience sustained fertility at baby boom levels (i.e., TFR greater than 2.5); in fact, it is generally expected that below-replacement fertility will prevail with occasional periods of very low (TFR less than 1.5) fertility. This forecast rests on the observed secular decline in high parity births. As noted above, high parity births played a very limited role in the baby boom fertility increases of the 1950s and 1960s, and the baby bust included an acceleration of the trend away from large—three or more children—families. The prohibitive costs of large families in developed countries, and the absence of powerful and persuasive ideologies that encourage having many children, combined with effective means of fertility control make a return to large families extremely unlikely. Instead, any future baby booms will result from the same demographic mechanisms responsible for the post–World War II baby boom: earlier family formation and nearly universal parenthood. Earlier childbearing ages and pervasive two-child families could conceivably produce a future baby boom of substantial size. But nearly universal parenthood does not seem likely in contexts in which women have substantial nonfamilial opportunities. Thus for most developed countries, the more likely future includes few large families and fairly high rates of voluntary childlessness. Baby booms are likely to be modest in size and will result primarily from changes in the timing of fertility.

See also: *Cycles, Population; Fertility, Below-Replacement; Population Decline.*

BIBLIOGRAPHY

Bongaarts, John, and Rodolfo A. Bulatao, eds. 2000. *Beyond Six Billion: Forecasting the World's Population.* Washington, D.C.: National Academy Press.

Bongaarts, John, and Griffith Feeney. 1998. "On the Quantum and Tempo of Fertility." *Population and Development Review* 24: 271–291.

Campbell, Arthur A. 1974. "Beyond the Demographic Transition." *Demography* 11(4): 549–561.

Cherlin, Andrew J. 1992. *Marriage, Divorce, Remarriage,* rev. edition. Cambridge, MA: Harvard University Press.

Easterlin, Richard A. 1973. "Relative Economic Status and the American Fertility Swing." In *Family Economic Behavior,* ed. E. B. Sheldon. Philadelphia: Lippincott.

———. 1978. "What Will 1984 Be Like? Socioeconomic Implications of Recent Twists in Age Structure." *Demography* 15: 397–432.

———. 1987. *Birth and Fortune: The Impact of Numbers on Personal Welfare.* Chicago: University of Chicago Press.

Macunovich, Diane J. 2002. *Birth Quake: The Baby Boom and Its Aftershocks.* Chicago: University of Chicago Press.

Morgan, S. Philip, and Rosalind B. King. 2001. "Why Have Children in the 21st Century? Biological Predisposition, Social Coercion, Rational Choice." *European Journal of Population* 17: 3–20.

Ní Bhrolcháin, Márie. 1992. "Period Paramount? A Critique of the Cohort Approach to Fertility." *Population and Development Review* 18: 599–629.

Pampel, Fred C., and H. Elizabeth Peters. 1995. "The Easterlin Effect." *Annual Review of Sociology* 21: 163–194.

Rindfuss, Ronald R., and James A. Sweet. 1977. *Postwar Fertility Trends and Differentials in the United States.* New York: Academic Press.

Ryder, Norman B. 1980. "Components of Temporal Variations in American Fertility." In *Demographic Patterns in Developed Societies,* ed. R. W. Hiorns. London: Taylor and Francis.

Sweet, James A., and Ronald R. Rindfuss. 1983. "Those Ubiquitous Fertility Trends: United States 1945–79." *Social Biology* 30: 127–139.

United Nations. 2001. *World Population Prospects: The 2000 Revision.* New York: United Nations.

Westoff, Charles F. 1987. "Perspective on Nuptiality and Fertility." In *Below-Replacement Fertility in Industrial Societies,* ed. K. Davis, M. S. Bernstam, and R. Ricardo-Campbell. New York: The Population Council.

Westoff, Charles F., and Norman B. Ryder. 1977. *The Contraceptive Revolution.* Princeton, NJ: Princeton University Press.

S. Philip Morgan

BECKER, GARY S.

(1930–)

Gary S. Becker received his Ph.D. in economics from the University of Chicago in 1955. He taught at Columbia University from 1957 to 1970, after which he returned to the University of Chicago. He was awarded the Nobel Prize for Economics in 1992. His numerous other distinctions include the Irene B. Tauber Award from the Population Association of America in 1997, in recognition of his many contributions to demography and population studies.

Beginning with his 1957 analysis of the economics of discrimination, Becker's work builds on the assumption that rational economic choice governs all spheres of human behavior. His approach of using standard economic models to analyze demographic behavior is demonstrated in his classic 1960 paper on the economics of fertility. Becker drew an analogy between decisions about childbearing and decisions about the purchase of consumer durables. Like consumer durables, Becker argued, children are long-term investments in which decisions about both quantity and quality play an important role. Becker observed that in the case of consumer durables such as automobiles or televisions, increases in income often led to greater increases in the quality of the good rather than in the number of units purchased. According to Becker, this quantity-quality tradeoff plays an important role in explaining why increasing income does not necessarily lead to higher fertility. This analysis of the quantity-quality tradeoff in fertility was further formalized and refined in later work by Becker and other economists, such as Robert Willis.

Becker's other important insight about the economics of fertility also helps explain why there is often a negative association between income and fertility. Building on his 1965 research on the economics of time allocation, Becker emphasized the fact that children are relatively time-intensive compared to other commodities, making children relatively more expensive to high-wage couples than to low-wage couples. This recognition of the relationship between the value of time and the cost of children has had a profound influence on understanding trends in fertility in both high-income and low-income countries.

In a similar use of standard economic tools in the modeling of demographic and social processes, Becker's work on the economics of marriage in 1973 and 1974 formalized the analogy between marriage markets and other markets in which two sides combine to form matches or partnerships. His analysis of assortative mating drew on a long tradition in mathematics and economics of assignment problems. Becker concluded from these models that there would be positive assortative mating in the marriage market when traits are complementary and negative assortative mating when traits are substitutes. Becker also developed models of the economics of divorce, noting that imperfect information and changes in characteristics may eventually cause the gains of marriage to fall below what was expected at the time of marriage.

Another of Becker's important contributions to research on families was his analysis of intra family resource allocation. Beginning with his influential paper on social interactions in 1974, he developed models exploring the importance of altruism in the family. One result was what he called the Rotten Kid Theorem, which argues that even a selfish child will act to maximize overall family well-being, since this will cause the household head (assumed to be an altruist) to increase the child's consumption. This has broad and often surprising implications for government policy. For example, the Rotten Kid Theorem implies that a government program designed to increase food consumption of school children may have little effect, since household heads may simply reduce their own transfers to children to offset the government grant, effectively neutralizing the program. As with many of Becker's results, the Rotten Kid Theorem holds in its strictest form only under particular assumptions. In 1989, economist Theodore Bergstrom provided a useful analysis of the conditions under which the Rotten Kid Theorem does and does not apply. Becker's model of the family has also been criticized from a feminist perspective, for example, by Nancy Folbre in 1997.

Building on his work on quality-quantity tradeoffs, intra-family allocations, and human capital, Becker has made important contributions to research on intergenerational transmission of inequality. A series of papers coauthored with Nigel Tomes developed models exploring issues such as how assortative mating and quality-quantity tradeoffs in fertility affect the distribution of income in a society. Becker subsequently expanded this work into models exploring the role that fertility and child investments play in the long-term dynamics of economic growth.

Becker provides a convenient overview of his approach to economics in his 1993 Nobel Prize lecture. A more comprehensive summary of his contributions to the economics of fertility, marriage, and the family is provided in his book *A Treatise on the Family* (1991).

See also: *Economic-Demographic Models; Family Demography; Microeconomics of Demographic Behavior; Partner Choice.*

BIBLIOGRAPHY

SELECTED WORKS BY GARY S. BECKER.

Becker, Gary S. 1957. *The Economics of Discrimination.* Chicago: University of Chicago Press.

———. 1960. "An Economic Analysis of Fertility." In *Demographic and Economic Change in Developed Countries.* Princeton, NJ: National Bureau of Economic Research.

———. 1964. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education.* New York: Columbia University Press.

———. 1965. "A Theory of the Allocation of Time." *Economic Journal* 75(299): 493–517.

———. 1973–1974a. "A Theory of Marriage," pts I and II. *Journal of Political Economy* 81(4): 813–846; 82(2): S11–S26.

———. 1974b. "A Theory of Social Interactions." *Journal of Political Economy* 82(6): 1,063–1,093.

———. 1991. *A Treatise on the Family,* enlarged edition. Cambridge, MA: Harvard University Press.

———. 1993. "Nobel Lecture: The Economic Way of Looking at Behavior." *Journal of Political Economy* 101(3): 385–409.

Becker, Gary S., and Robert J. Barro. 1988. "A Reformulation of the Economic Theory of Fertility." *Quarterly Journal of Economics* 103(1): 1–25.

Becker, Gary S., Edward L. Glaeser, and Kevin M. Murphy. 1999. "Population and Economic Growth." *American Economic Review* 89(2): 145–149.

Becker, Gary S., Elisabeth M. Landes, and Robert T. Michael. 1977. "An Economic Analysis of Marital Instability." *Journal of Political Economy* 85(6): 1,141–1,188.

Becker, Gary S., and H. Gregg Lewis. 1973. "On the Interaction between the Quantity and Quality of Children." *Journal of Political Economy* 81(2), Part II: S279–S288.

Becker, Gary S., Kevin M. Murphy, and Robert Tamura. 1990. "Human Capital, Fertility, and Economic Growth." *Journal of Political Economy* 98(5), Part II: S12–S37.

Becker, Gary S., and Nigel Tomes. 1979, "An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility." *Journal of Political Economy* 87(6): 1,153–1,189.

SELECTED WORKS ABOUT GARY S. BECKER.

Bergstrom, Theodore. 1989. "A Fresh Look at the Rotten Kid Theorem and Other Household Mysteries." *Journal of Political Economy* 97(5): 1,138–1,159.

Folbre, Nancy. 1997. "The Future of the Elephant-Bird." *Population and Development Review* 23(3): 647–654.

Willis, Robert. 1973. "A New Approach to the Economic Theory of Fertility Behavior." *Journal of Political Economy* March–April: S14–S64.

David Lam

BERELSON, BERNARD

(1912–1979)

Bernard Berelson was an influential thinker and writer on population issues during the 1960s and 1970s, when population growth became a global concern and international assistance to family planning programs in developing countries increased substantially. Berelson's career mixed academic appointments and administrative and policy positions in international development assistance groups. He was, in Parker Mauldin's phrase, a "practical scholar" whose work contributed to social science and to the improvement of family planning programs (1979, p. 260).

Berelson was graduated from Whitman College in 1934. He received his Ph.D. from the University of Chicago in 1941 and joined the Foreign Broadcast Service of the Federal Communications Commission. He later served as research director of Columbia University's Bureau of Applied Social Research and held appointments as professor at the University of Chicago and as director of the Ford Foundation's Behavioral Science Program. Before becoming involved in the population field, Berelson produced important books on voting, graduate education, and human behavior.

Berelson joined the Population Council in 1962 as director of its communication research program. He became vice president in 1963 and president in 1968. He remained in that position until 1974, when he resigned, in part because of disagreements with John D. Rockefeller 3rd, the Council's founder and chairman of its board of trustees, about new directions in population policy and the importance of family planning for slowing population growth. Berelson continued as a senior fellow at the Council until his death in 1979.

Berelson excelled at summarizing important scientific work, pointing out missing pieces, and spelling out implications. He had a well-developed sense of what research findings would make a practical difference, and his influential syntheses shaped the knowledge-base and the direction of field programs. His contributions in this mode include "Beyond Family Planning" (1969); "The Great Debate on Population Policy: An Instructive Entertainment" (1975); "The Record of Family Planning Programs" (1976); "Paths to Fertility Reduction: The Policy Cube" (1977); and "The Condition of Fertility Decline in Developing Countries, 1965–75" (1978). Some 14 of his articles and essays were posthumously published in a volume edited by John A. Ross and W. Parker Mauldin (1988). That volume also includes Berelson's full bibliography. His writings on population reflect the conviction that population growth was "among the great problems on the world agenda," because "rapid population growth retards social and economic development." From these premises he drew the conclusion that "everything that can properly be done to lower population growth rates should be done" (Ross and Mauldin, 1988, p. 42).

Berelson encouraged collaboration between scientists and family planning providers to develop innovative service delivery programs and to evaluate them carefully. The best-known example was the Taichung experiment in Taiwan, but similar approaches were used in South Korea, Thailand, and Bangladesh to evaluate specific family planning interventions and to reassure government leaders that program interventions would be politically and socially acceptable. Similar work continues in the twenty-first century in Ghana and other places in Africa.

Berelson's impact on the population field is also evident in a number of other ways. He established the journal *Studies in Family Planning,* and in 1965 organized the first international conference on population programs and edited the report of that conference. Together with John D. Rockefeller 3rd, Berelson promoted the World Leaders Declaration on Population, which was released in 1967. He served as a member of the U.S. Commission on Population Growth and the American Future, and provided an array of useful ideas on communicating family planning messages.

See also: *Family Planning Programs; Freedman, Ronald.*

BIBLIOGRAPHY

SELECTED WORK BY BERNARD BERLESON.

Berelson, Bernard, and Gary A. Steiner. 1964. *Human Behavior: An Inventory of Scientific Findings.* New York: Harcourt, Brace and World.

SELECTED WORKS ABOUT BERNARD BERLESON.

Harr, John Ensor, and Peter J. Johnson. 1991. *The Rockefeller Conscience.* New York: Scribners.

Lincoln, Richard. 1989. "Review of *Berelson on Population.*" *Population and Development Review* 15(1): 150–153.

Mauldin, W. Parker. 1979. "Bernard Berelson: A Personal Appreciation." *Studies in Family Planning* 10(10): 259–261.

Ross, John A., and W. Parker Mauldin, eds. 1988. *Berelson on Population.* New York: Springer-Verlag.

Peter J. Donaldson

BERTILLON, JACQUES

(1851–1922)

Jacques Bertillon was a French physician and statistician, who played a key role in developing the international classification of causes of death and was a leader of France's pronatalist movement. Several members of Bertillon's family were distinguished in the field of demography. His maternal grandfather, Achille Guillard (1799–1876), coined the term *demography* (1855); his father, Louis-Adolphe (1821–1883), taught the first course in demography at the Paris Medical School (1875) and was director of the *Bureau de Statistique Municipale* in Paris—a post also held by Jacques.

Several decades of effort had been devoted to devising a classification for the causes of deaths by the time Bertillon began his research in the area. He used the work he had done on Parisian death data, and drew on the scheme proposed by William Farr (1807–1883), which had been adapted to the new bacteriological knowledge. The resulting classification system, known as the Bertillon classification, was first promulgated at the Chicago conference of the International Statistical Institute in 1893 and was accepted by the American Health Association in 1897. It became the International Classification in 1900 after approval by an international commission in Paris.

Bertillon also wrote demography manuals and a series of studies on fertility characteristics, the latter using the latest statistical techniques, such as parity-specific birth probabilities. But Bertillon is better known in France as the founder, in 1896, of the first pronatalist movement, the *Alliance nationale pour l'accroissement de la population française.* He attempted to explain why couples had small families (adducing reasons such as high taxation and small apartments), proposed new pronatalist measures such as a cash bonus for the fourth child, and conceived the notion of population aging. It was largely at his urging, through the *Conseil Supérieur de la Natalité,* that a law was passed in 1920 forbidding dissemination of birth control information and techniques.

See also: *Causes of Death; Demography, History of; Disease, Concepts and Classification of; Farr, William.*

BIBLIOGRAPHY

SELECTED WORKS BY JACQUES BERTILLON.

Bertillon, Jacques. 1883. *Étude démographique du divorce et de la séparation de corps dans les différents pays de l'Europe.* Paris: G. Masson.

———. 1895. *Cours élémentaire de statistique.* Paris: Société d'études scientifiques.

———. 1911. *La dépopulation de la France, ses conséquences, ses causes, mesures à prendre pour la combattre.* Paris: Alcan.

SELECTED WORKS ABOUT JACQUES BERTILLON.

Bourdelais, Patrice. 1993. *L'âge de la vieillesse. Histoire du vieillissement de la population.* Paris: Odile Jacob.

Dupâquier, Michel. 1983. "La famille Bertillon et la naissance d'une nouvelle science sociale: la démographie." *Annales de démographie historique* 293–311.

Dupâquier, Jacques, and Michel Dupâquier. 1985. *Histoire de la démographie.* Paris: Perrin.

Patrice Bourdelais

BIBLIOGRAPHIC AND ONLINE RESOURCES

For many years, demographers and other social scientists with population interests considered themselves fortunate to have available the annotated bibliographic journal *Population Index,* which was published from 1937 to 2000. With early computerization, *Popline* and *Medline* also provided useful easily searchable bibliographies. As high-speed Internet access became available, researchers could routinely draw on a much wider array of bibliographic resources and other research tools. The power of this technology derives from the speed at which information can be transmitted, the low costs involved for end users, the relative ease with which content can be updated or revised, the seemingly limitless amounts of information that can be carried, the superior graphic possibilities offered by electronic displays as compared to paper, and the scope for interactivity between user and information. Users have masses of information at their fingertips, albeit together with similar masses of dubious or tendentious material that libraries might have screened out. The new ways of accessing, processing, and disseminating information and data that the Internet allows are having a notable effect on the way researchers work and interact—in what is likely to be just the beginning of a long-term, technology-driven process.

Various categories of online resources are relevant to demographic research. Practically every major population training and research center and many statistical offices throughout the world have web sites giving information about their activities and often providing access to their publications. Software for various demographic procedures and computations can be downloaded, often without cost. Vast amounts of demographic data are also obtainable from remote locations. Such data may come in the form of files that can be downloaded and archived in the user's computer for further processing, or in the form of interactive databases presenting data that can be tailored to meet the user's needs. Bibliographic resources are increasingly abundant—from the online catalogs of major libraries around the world to online libraries containing the actual texts of publications, including books. Nearly all demographic journals and newsletters have an Internet presence—a web site that shows at least the table of contents, usually an abstract, and in some cases the full text of articles.

Given the volume of demographic material available, users face an increasing problem of identifying and retrieving data and information in an efficient way. There are essentially two strategies to extract information from the Internet: "searching" and "browsing." Searching works best when what is being sought can be conceptualized with a distinctive keyword. A search engine such as Google can then mine the Internet for occurrences of that keyword. (There are a large number of search engines. A survey of them and discussion of search-engine technology and use can be found at a site called Search Engine Watch, which is maintained by Internet.com.)

A critical factor in the success of any search is the formulation of the query—the key word or phrase should not be conceptually too broad or too narrow. In 2002 the keyword "population" by itself yielded some 15.9 million documents on Google—far too many to be of practical interest. Adding another keyword—say, a country name—in a Boolean search procedure might be needed to trim the total to manageable numbers.

But in many cases, users may be looking for something that cannot be easily indexed in keywords. Like a reader leafing through interesting parts of a book rather than perusing the index, the Internet user may prefer to browse relevant sites and survey what is available before narrowing the search in a particular direction. Some sites that might be used in this fashion are noted below, grouped in three categories: portals, databases, and content-rich sites.

Portals

The pioneer portal in the population field was the Demography and Population Studies section of the World Wide Web Virtual Library, maintained by the Demography Program of the Australian National University. *Popnet*, which describes itself as "the directory for global population information" is another high-quality population portal—comprehensive, well-organized, and attractively presented. It is maintained by the Population Reference Bureau, which has population information as its core mandate. *DemoNetAsia* offers another comprehensive repertory of online resources of particular interest to demographers.

In addition there are a number of more specialized portals. The Population Information Network (POPIN), maintained by the United Nations Population Division, aims to provide access to population information on the web sites of the entire United Nations system. In the area of reproductive health, Johns Hopkins University manages the Reproductive Health Gateway and the United Nations Population Fund sponsors a Population and Reproductive Health portal in the Development Gateway web site. In the area of migration, the Migration Policy Institute runs the Migration Information Source.

Databases

Both bibliographic and statistical databases should be noted. Among the bibliographic databases, *Popline,* which contains several hundred thousand records and is maintained by Johns Hopkins University, provides citations with abstracts of the worldwide literature in the field of population, with an emphasis on family planning and related health issues. *Population Index,* as mentioned, for over six decades was the primary reference tool on the world's population literature. Its database covering the years from 1986 to its demise in 2000, containing almost 50,000 records—many in subject areas not well covered by *Popline*—is available online from Princeton University's Office of Population Research and is a valuable tool for literature searches pertaining to that period.

Online statistical databases present demographic indicators and projections for individual countries or regions, as well as data in the broader field of population and development. The main demographic databases are those of the United Nations Population Division and the U.S. Bureau of the Census. Notable among the numerous databases covering aspects of population and development is the World Bank's World Development Indicators Data Query. The DemoNetAsia web site offers a list of databases and databanks (noninteractive statistical data archives in population and closely related subjects). The Internet Crossroads maintained by the University of Wisconsin and the Virtual Data Library of the University of North Carolina's Carolina Population Center cover a broader range of the social science data resources that are available online.

Content-Rich Sites

The web sites of many population research and teaching institutions are essentially electronic versions of traditional brochures, designed to present information about the institution rather than as a resource to support the work of others. The sites of the various professional associations in the population field are mainly services for their members. There are, however, notable exceptions: institutions whose web sites are rich in documents and other resources, such as software, databases, and repertories of links. These include: INED, France's Institut national d'études démographiques (National Institute of Demographic Research); the Population Research Institute of Pennsylvania State University; the Carolina Population Center of the University of North Carolina; and the Max Planck Institute for Demographic Research. An Internet application of particular interest concerns distance learning. For demography, the Distance Advancement of Population Research project at the Carolina Population Center is a pioneering effort in this area.

Most demographic journals also have web sites. Some, such as *International Family Planning Perspectives* or the Population Reference Bureau's *Population Bulletin,* make their full contents available online, but the majority either limit themselves to tables of contents and abstracts or restrict online access to subscribers. *Demographic Research,* a free, peer-reviewed journal, is published exclusively online. A comprehensive list of population periodicals available online is offered by DemoNetAsia.

A major storehouse of past population research is the contents of the main English-language population journals compiled by the JSTOR (Journal Storage) project. The full text of every issue of nine population journals (*Demography,* 1964–; *Family Planning Perspectives,* 1969–; *International Family Planning Perspectives,* 1979–; *International Migration Review,* 1966–; *Population: An English Selection,* 1989–; *Population and Development Review,* 1975–; *Population Index,* 1937–1985; *Population Studies,* 1947–; and *Studies in Family Planning,* 1963–), from first publication up to the volume several years before the current year, is available online, in searchable form. Hard copies of individual articles can be printed. (Numerous other journals in the social sciences and humanities are also included.) Access to JSTOR is typically through institutional subscription by universities or major libraries.

Conclusion

Many of the advantages of the Internet can turn into problems and sources of inefficiency. The ease with which web sites can be started and revised results in a low degree of stability; in addition, as web sites age and expand, maintenance becomes increasingly time and resource consuming and is often neglected. Quality control is frequently poor. In a number of countries, inadequate telecommunication infrastructures and sometimes explicit policies discourage users and limit the Internet presence of their institutions. As a result, Internet use for research can sometimes be frustrating.

Nevertheless, the Internet has established itself as an essential utility in workplaces and homes throughout most of the world, radically changing expectations about how easy it should be for researchers to gain access to and disseminate information and to interact with other researchers regardless of geographical distance. As its use spreads further, it will revolutionize the way demographers and others work and collaborate—very much as computers did in the 1970s and 1980s.

See also: *Journals, Population.*

BIBLIOGRAPHY

INTERNET RESOURCES.

Australian National University. Demography Program. 2002. "World Wide Web Virtual Library: Demography and Population Studies." <http://demography.anu.edu.au/VirtualLibrary>.

Demographic Research. 2002. <http://www.demographic-research.org>.

DemoNetAsia. 2002. "The DemoNetAsia Links Directory." <http://demonetasia.org/links.htm>.

———. 2002. "DemoNetAsia Links: Databases." <http://demonetasia.org/links/linksdbases.htm>.

———. 2002. "DemoNetAsia Links: Population Journals." <http://demonetasia.org/links/linksjournals.htm>.

Google. 2002. <http://www.google.com>.

Institut national d'études démographiques. 2002. <http://www.ined.fr>.

International Family Planning Perspectives. 2002. <http://www.agi-usa.org/journals/ifpp_archive.html>.

Internet.com. 2002. "Search Engine Watch." <http://www.searchenginewatch.com>.

Johns Hopkins University. 2002. "Popline." <http://www.popline.org>.

———. 2002. "Reproductive Health Gateway." <http://www.rhgateway.org>.

JSTOR (Journal Storage). 2002. <http://www.jstor.org>.

Max Planck Institute for Demographic Research. 2002. <http://www.demogr.mpg.de>.

Migration Policy Institute. 2002. "Migration Information Source." <http://www.migrationinformation.org>.

Pennsylvania State University. Population Research Institute. 2002. <http://www.pop.psu.edu>.

Population Reference Bureau. 2002. "Popnet." <http://www.popnet.org>.

Princeton University. Office of Population Research. 2002. "Population Index." <http://popindex.princeton.edu>.

United Nations. Population Division. 2002. Population Information Network (POPIN). <http://www.un.org/popin>.

———. 2002. "World Population Prospects Population Database." <http://esa.un.org/unpp>.

United Nations Population Fund. 2002. "Population and Reproductive Health." <http://developmentgateway.org/node/146526>.

U.S. Bureau of the Census. 2002. "International Data Base." <http://www.census.gov/ipc/www/idbnew.html>.

University of North Carolina. Carolina Population Center. 2002. <http://www.cpc.unc.edu>.

———. 2002. "Distance Advancement of Population Research." <http://www.cpc.unc.edu/projects/dapr/dl>.

———. 2002. "Virtual Data Library." <http://www.cpc.unc.edu/dataarch>.

University of Wisconsin. 2002. "Internet Crossroads in the Social Sciences." <http://dpls.dacc.wisc.edu/newcrossroads/index.asp>.

World Bank. 2002. "World Development Indicators Data Query." <http://www.worldbank.org/data/dataquery.html>.

ARMINDO MIRANDA

BIODEMOGRAPHY

Biodemography is an omnibus term for the numerous connections between demography and biology.

Demography has multiple points of contact with biology, as well as with mathematics, statistics, the social sciences, and policy analysis. The biology–demography interface was central to the research of two distinguished demographers, Alfred J. Lotka (1880–1949) and Raymond Pearl (1879–1940), in the early decades of the twentieth century. Lotka developed concepts and methods that are still of fundamental importance in biodemography; his two most significant books are *Elements of Physical Biology* (1925) and *Théorie Analytique des Associations Biologiques* (1934–1939). Pearl pioneered biodemographic research on several species, including flatworms, the aquatic plant *Ceratophyllum demersum, Drosophila,* and humans. He founded two major journals, the *Quarterly Journal of Biology* and *Human Biology* and helped found both the International Union for the Scientific Investigation of Population Problems (which later became the International Union for the Scientific Study of Population) and the Population Association of America.

At the beginning of the twenty-first century biodemography is reemerging as a locus of cutting edge demographic research. It is clearly accepted that fertility, mortality, morbidity, and other processes of profound interest to demographers have a basic biological component. Moreover, biology is fundamentally a population science and there is growing recognition that biological studies can benefit greatly from demographic concepts and methods. From a biologist's perspective, biodemography envelops demography because it embraces research pertaining to: any nonhuman species; populations of cells or molecules within an individual; populations of genotypes; and biological measurements related to age, health, physical functioning, and fertility. Within this vast territory, several research foci are noteworthy and are briefly described below.

Evolutionary Demography

Nothing in biology, the eminent biologist Theodosius Dobzhansky (1900–1975) asserted, makes sense except in light of evolution. It is equally valid to say that nothing in evolution can be understood except in light of demography. Evolution is driven by population dynamics governed by age schedules of fertility and survival. Lotka emphasized this. Following his groundbreaking research, models of the evolution of fertility, mortality, and other life-history patterns have been based on stable population theory. Lotka's equation

$$\int_0^{\omega} e^{-ra}\,\ell(a)m(a)da = 1$$

specifies the intrinsic growth rate, r, of a closed population, typically of females, as a function of the proportion, $\ell(a)$, of newborns surviving to age a and the age-specific probability of maternity (or fertility), $m(a)$. If a new subspecies emerges as a result of mutation, the subspecies is assumed to have an evolutionary advantage if its intrinsic growth rate is greater than that of other subspecies.

William D. Hamilton (1936–2000) used this perspective to model the evolution of senescence: In an influential article published in 1966 he argued that evolutionary pressures would inevitably result in a rising trajectory of age-specific death rates. Hamilton was a biologist who studied stable population theory and other aspects of demography at the London School of Economics. Recently the demographer Ronald D. Lee reconsidered the evolution of senescence and concluded that age-specific death rates can increase, decrease, or remain constant over age in various periods of life depending on the nature of intergenerational transfers of resources from parents to children, for example. Other demographers, including Shripad Tuljapurkar and Kenneth W. Wachter, have also explored this issue, from different perspectives.

Comparative Biodemography

Much can be learned by comparing mortality and fertility patterns across species. Relying on Gompertz's Law (developed by English actuary Benjamin Gompertz [1779–1865]), it had been thought that death rates rose exponentially at adult ages for almost all species. A dozen or so species, from yeast, worms, and insects to humans, have now been studied in sufficiently large numbers for the age trajectory of mortality at advanced ages to be reliably understood. For all these species, including humans, death rates either level off or decline at sufficiently advanced ages. Explaining this surprising deceleration of mortality is an active area of research in biodemography. One of the leaders in this field is James R. Carey, who has also done important comparative biodemographic research on the role of the elderly in nature and on the duration of life in thousands of species.

Ecodemography

Lotka was deeply interested in the dynamics of interacting species. This interest is commemorated in the Lotka-Volterra equation (the model was developed independently by Lotka in 1925, and Italian mathematician Vito Volterra in 1926), which describes cycles in the populations of predators and prey. The yet to be solved two-sex problem in demography (i.e., how to satisfactorily incorporate both males and females in models of fertility and population growth) demonstrates how difficult it is to study interacting populations. Research in this area is crucial to understanding environmental stability and population–environment interactions.

Demography of a Species

Humans are but one of millions of species of living organisms. Life tables and many of the other basic concepts and methods of demography can be applied to any species. Life tables, including age-specific maternity rates, have been estimated for hundreds of species. Research has also been done on populations of populations of a species, such as honeybee hives.

Experimental Biodemography

To test demographic hypotheses, experiments can be conducted with nonhuman populations. Pearl pioneered this powerful form of research, focusing on whether population growth followed a logistic pattern. In the 1990s demographers, working with biologists, designed and carried out experiments to test whether there is a genetically determined maximum length of life for individuals in all or most species. No sign of a maximum was found in genetically identical populations of yeast, worms, and insects, casting doubt on whether humans were subject to such a limit. More recently, various biodemographic experiments have been conducted to explore the relationship between fertility and mortality. Among genetically identical individuals in controlled environments, reproduction decreases subsequent probabilities of survival. Other experiments have been conducted to determine the impact of lethal and sub-lethal stress on the subsequent mortality of a cohort. Mortality selection (the death of the frail) and hormesis (the increased resistance of individuals who survive) increase future survival chances whereas debilitation decreases them.

Genetic Demography

Some individuals die young; others live to an advanced age. Some individuals have no children; others have many. The genetic and common environment components of these variations—in lifespans, fertility, and other demographic characteristics—

can be analyzed in humans using data on twins, siblings, cousins, and other relatives of various degree. These data are available in genealogies and in twin, household, parish, and other population registries. In nonhuman species, inbred and crossbred lines can be studied. It is not necessary to have information from DNA about specific genes: it is necessary rather to have information about the proportion of genes shared by two individuals and about shared nongenetic influences. Analysis of variance methods, correlated frailty approaches, and nested event-history models have been applied by demographers. Hans-Peter Kohler has studied how much of the variation in number of children can be attributed to genetic variation in family size preferences among potential parents, and Anatoli Yashin has analyzed genetic variation as it relates to susceptibility to various diseases and to mortality in general.

Another topic in genetic demography concerns the genetic structure and dynamics of a population. Data about population size, migration flows, and inbreeding can lead to insights into the genetic heterogeneity of a population. Information from DNA about genetic polymorphisms (i.e., mutations) can be used to determine the genetic structure of a population and to make inferences about the influence of migration and inbreeding on the population.

Molecular Demography

A central goal of molecular demography is to identify genetic polymorphisms that affect mortality, morbidity, functioning, fecundity, and other sources of demographic change. Some of this research has focused on finding genetic variants that influence longevity. This relationship can be studied by analyzing changes with age in the proportion of survivors who have some specific allele (i.e., version of a gene). If in a given cohort the allele becomes more frequent with age, that allele may be associated with lower mortality.

Some research concerns how differences in the frequency of a particular allele among populations lead to differences in mortality patterns and life expectancy. Douglas Ewbank, for example, has studied the demographic impact of variants of the *ApoE* gene in various population distributions. Other research, by Richard Udry, has focused on how hormone levels influence behavior relevant to fertility and family dynamics, and in particular the differences in behavior between males and females.

Epidemography

Demography and epidemiology intersect and overlap. Demographers frequently focus on how diseases and disabilities influence the structure and dynamics of a population, whereas epidemiologists are more typically concerned with how population patterns of a specific disease can shed light on the etiology, prevention, and cure of the disease. Many demographers, however, have acquired substantial knowledge of the biology of various diseases and disabilities and have developed models of morbidity and mortality. Some of these models relate disease and disability patterns and trends in a population to consequences for health-care systems. Kenneth G. Manton is a leading researcher in this field.

Biometric Demography

Demographers since the last half of the twentieth century have become increasingly involved with the design of surveys and the analysis of survey data, especially that pertaining to fertility or morbidity and mortality. Various kinds of physical measurements (such as height and weight), physiological measurements (for example, of blood pressure and cholesterol levels), nutritional status (as assessed by analysis of blood or urine and other methods), physical performance (for example, hand-grip strength or ability to pick a coin up from the floor), and genetic makeup (as determined by analysis of DNA) have been added to surveys, including those conducted by Kaare Christensen, Noreen Goldman, Maxine Weinstein, and Zeng Yi. These biological measurements (biomarkers) can be used as covariates in demographic analyses in much the same way that social and economic information is used.

Paleodemography

Skeletal remains are the source of information about prehistoric populations regarding sex, age at death, lifetime morbidity and nutrition, as well as, for women, number of children born. Hence, a main focus of paleodemography is determining how to extract more information from bones. This requires a sophisticated understanding of biology as well as facility with methods of using physical indicators to determine sex and to estimate age at death and other variables. A promising recent advance has been the development, by Ursula Wittwer-Backofen and Jutta Gampe, of methods to count annual rings deposited in teeth as a way of determining age at death. (Roughly similar methods can be used to estimate the age of animals in the wild, with teeth used for mammals and otoliths, ear bones, for fish). Lesions in bones and minerals in teeth and bones can shed light on health and nutritional histories. Information about human population development for the long period during which written records were scarce or nonexistent thus hinges on biological information.

See also: *Aging and Longevity, Biology of; Animal Ecology; Archaeogenetics; Biology, Population; Evolutionary Demography; Life Span; Lotka, Alfred; Paleodemography; Sociobiology.*

BIBLIOGRAPHY

Carey, James R. 1993. *Applied Demography for Biologists.* New York: Oxford University Press.

Finch, Caleb E., James W. Vaupel, and Kevin Kinsella, eds. 2001. *Cells and Surveys: Should Biological Measures Be Included in Social Science Research?* Washington, D.C.: National Academy Press.

Hamilton, William D. 1996. *Narrow Roads of Gene Land,* Vol. 1. Oxford: W. H. Freeman.

Hoppa, Robert D., and James W. Vaupel. 2002. *Paleodemography: Age Distributions from Skeletal Samples.* Cambridge, Eng.: Cambridge University Press.

Kingsland, Sharon E. 1995. *Modeling Nature.* Chicago: University of Chicago Press.

Kohler, Hans-Peter, Joseph L. Rodgers, and Kaare Christensen. 1999. "Is Fertility Behavior in Our Genes: Findings from a Danish Twin Study." *Population and Development Review* 25(2): 253–288.

Manton, Kenneth G., and Anatoli Yashin. 1999. *Mechanisms of Aging and Mortality: The Search for New Paradigms.* Odense, Denmark: Odense University Press.

Udry, J. Richard. 1994. "The Nature of Gender." *Demography* 31(4): 561–573.

Vaupel, James W., James R. Carey, Kaare Christensen, Thomas E. Johnson, Anatoli I. Yashin, Niels V. Holm, Ivan A. Iachine, Vaino Kannisto, Aziz A. Khazaeli, Pablo Liedo, Valter D. Longo, Zeng Yi, Kenneth G. Manton, and James W. Curtsinger. 1998. "Biodemographic Trajectories of Longevity." *Science* 280: 855–860.

Wachter, Kenneth W., and Caleb E. Finch, eds. 1997. *Between Zeus and the Salmon: The Biodemography of Longevity.* Washington, D.C.: National Academy Press.

JAMES W. VAUPEL

BIOGEOGRAPHY

The global spread and growth of human populations has had a profound, lasting, and often irreversible impact on the flora and fauna of continents, islands, and oceans. Humans depend on nature's living resources for food, energy, medicine, construction, recreation, and education. Even low human densities may lead to overexploitation and extinction of a plant or animal species, especially if the animals are big and have a restricted diet and distribution like the giant panda (*Ailuropoda melanoleuca*) of China. High human densities inevitably cause the displacement of nonhuman natural habitats, the simplification of ecosystems, and the proliferation of waste products that may act as pollutants of natural systems. Human-caused extinction processes have exceeded the natural extinction rates of flora and fauna for several centuries.

Human Impact on Birds

Birds provide a good example of the human impact on biodiversity. They are the best known group of animals, occur on all continents, and respond quickly to changing environmental factors. Some 12 percent (1,186 bird species) of all birds are globally threatened with extinction; among these, habitat loss, fragmentation, and degradation constitute the major survival threat for 1,008 bird species. Exploitation and the impact of invasive species are the second- and third-most important risk factors.

In prehistoric times, human dispersal across the globe was followed by rapid and major extinction waves of vertebrate animals on several continents as well as on many Pacific islands; scores of flightless island bird species vanished within a few hundred years after the arrival of the Polynesian settlers.

Human Populations and Ecosystems

The domestication of plants and animals was a revolutionary event in human history that stimulated human population growth and changed the face of the earth. The need for cropland and pastures has not abated and massive deforestation, the transformation of natural prairies, and the draining of wetlands continue worldwide. In Europe, only 15.6 percent of the land remains undisturbed as of 2003; equivalent values for North America are 56.3 and for Africa 48.9 percent. Only 22 percent of the earth's original forest remains in large natural blocks.

Habitat Destruction and Alien Species Introduction in the United States

Habitat destruction and degradation have emerged as the most pervasive threat to U.S. biodiversity, endangering 85 percent of imperiled and federally listed species. The historic range and population of the California condor (*Gymnogyps californianus*) collapsed along the Pacific coast of North America when Europeans settled there and began to convert California's Central Valley into rangeland and later into cotton, alfalfa, and rice fields.

Urbanization causes a sometimes drastic reduction in native species. The birds of Honolulu are almost completely non-native, introduced birds from Asia, Europe, and Central America. Other metropolitan regions in India, China, South America, and Africa contain species sets that have adapted and benefited from high human densities. Many weed, pest, and disease species thrive in dense human conglomerations; indeed, some disease organisms can only maintain themselves in urban landscapes. Some predict that this species set will constitute the global flora and fauna of the twenty-first century.

The introduction of alien species has become the second-most important risk factor for threatened U.S. biota. Competition with or predation by alien species affects some 49 percent of the imperiled species. Some of the alien species originate from deliberate introductions (many game fish species) while others are escaped pets or have inadvertently been transported on trucks, planes, and ships into the country. Some lakes and rivers in the United States have more alien than native fish species. Additional survival problems in U.S. waterways arise from chemical and thermal pollution. After flowering plants (1,031 species critically imperiled), native aquatic life is most at risk: freshwater fishes (300), stone flies (260), freshwater mussels (202), and crayfishes (165 species).

The American West still contains large blocks of wildlands that have never been modified; a unique patchwork of urban, rural, and protected open space constitutes the modern bio-landscape. Southern California is a "hotspot" of global biogeographic significance with an unusually high number of endemic species restricted to this region. The development pressure on the remaining open space lands is intense, transportation links have fragmented wildlife habitats, and pollution threatens entire ecosystems. A similar situation exists in Florida where heavy human immigration and rapid urbanization processes threaten the survival of the Everglades and other irreplaceable ecosystems.

Threats to Biodiversity in the Tropics

Many of the biologically richest and most threatened landscapes are in the tropics. After Australia, the four countries richest in endemic higher vertebrates (mammals, birds, reptiles, and amphibians) found nowhere else are Mexico (761), Brazil (725), Indonesia (673), and the Philippines (473 species). These countries face difficult problems in their rural environments due to burgeoning human populations. The management and conservation of their increasingly fragmented forest landscapes constitutes a major national and international challenge. A remarkable conservation endeavor concerns the fate of the remaining five tiger (*Panthera tigris*) subspecies stretching from India to Northeast Siberia; three subspecies are already extinct (Caspian, Bali, and Javan tiger). A powerful coalition of conservation groups with worldwide support has slowed the habitat loss in tiger habitats and hopes to safeguard the remaining wild tiger populations in reserves that often lie adjacent to densely populated agricultural areas.

Threats to the Oceans

In the oceans of the world, fish resources have been overexploited in the Atlantic and Northern Pacific. Large whales were nearly exterminated before a worldwide ban on whaling was agreed upon by most whaling nations. The exceptional richness of coral reef ecosystems in the Pacific and Southeast Asia is also at risk due to high demand for tropical fishes and corals in Europe, North America, and East Asia. The reefs are poisoned and plundered by impoverished fishermen, a classic repetition of the overexploitation of living resources that culminated in the extinction of some 484 animal species since 1600.

Habitat Destruction: Past and Future

In hindsight, the case histories of extinct animals show the human folly of reckless habitat destruction, hunting, and trapping as well as the absence of sustainable use and resource management. The benefits of nature's riches and the unique species diversity of each continent are at greater risk in the early twenty-first century than ever before in human history. Both the developed and the developing countries face challenging land-use decisions for their human and non-human inhabitants.

See also: *Carrying Capacity; Geography, Population; Sustainable Development.*

BIBLIOGRAPHY

BirdLife International. 2000. *Threatened Birds of the World.* Barcelona and Cambridge, Eng.: Lynx Edicions and BirdLife International.

Cox, George W. 1999. *Alien Species in North America and Hawaii: Impacts on Natural Ecosystems.* Washington, D.C.: Island Press.

Flannery, Tim, and Peter Schouten. 2001. *A Gap in Nature: Discovering the World's Extinct Animals.* New York: Atlantic Monthly Press.

Groombridge, Brian, ed. 1992. *Global Biodiversity: Status of the Earth's Living Resources.* London: Chapman and Hall.

Heywood, Vernon H., ed. 1995. *Global Biodiversity Assessment.* New York: Cambridge University Press.

Quinn, John R. 1994. *Wildlife Survivors: The Flora and Fauna of Tomorrow.* Blue Ridge Summit, PA: TAB Books/McGraw-Hill.

Seidensticker, John, Sarah Christie, and Peter Jackson, eds. 1999. *Riding the Tiger: Tiger Conservation in Human-Dominated Landscapes.* Cambridge, Eng.: Cambridge University Press.

Steadman, David W. 1995. "Prehistoric Extinctions of Pacific Island Birds: Biodiversity Meets Zooarchaeology." *Science* 267: 1,123–1,131.

Stein, Bruce A., Lynn S. Kutner, and Jonathan S. Adams. 2000. *Precious Heritage: The Status of Biodiversity in the United States.* New York: Oxford University Press.

HARTMUT S. WALTER

BIOLOGY, POPULATION

Population biology is the study of the ecological and evolutionary aspects of the "distribution and abundance of animals"(Andrewartha and Birch 1954). The ecological aspect focuses on living organisms as individuals, groups, species, and interacting assemblages of species. The evolutionary aspect focuses on genetic and environmental changes that shape observed characteristics—the phenotypes—of organisms past and present. Like demography, population biology is a discipline with fuzzy boundaries that shade into specialized subjects: ecology *per se,* not directly concerned with evolution; population genetics, focused on genetic change and variation, and evolution; epidemiology, concerned with host–parasite associations; paleobiology, focused on the historical record; behavioral ecology; physiological ecology; and many others. This entry is a selective account of population biology at the start of the twenty-first century.

From Individual to Population

A basic unit of analysis in population biology is the individual, with a focus on the individual as *ontogeny*—a process of development and change from birth to death. Demographers and ecologists often use the terms life cycle or life history for this process. The transitions that occur during development can be complex in different species, involving distinct developmental stages that can differ in terms of actual habitat (e.g., water, land, or air), growth and form, feeding, and reproduction. A staggering variety of life cycles is observed in nature, to the delight of natural historians since before Charles Darwin, but this variety challenges scientific analysis. As just one example of the scale of variation, population biologists deal with species whose characteristic life spans range from an hour (or less, for bacterial division) to centuries (long-lived trees such as redwoods).

The study of life cycles in population biology focuses on the qualitative and quantitative analysis of life cycle transitions—their sequencing, rates, interaction, proximate determinants, and evolutionary determinants. An organizing principle here, enunciated by the statistician Ronald Fisher (1890–1962) in the 1930s and implicit even in the work of Darwin, is the allocation of resources—in the course of life, individuals gather resources such as energy and materials that are allocated among processes such as metabolism, growth of reproductive and other body parts, foraging, repair of internal systems, mating, and reproduction. It is commonly accepted that life cycles in nature are adapted to the environments in which they are found—it would be surprising if they were not—and hence that resources must be allocated over the life cycle in an optimal way. The claim of optimality in population biology is loosely supported by the notion that Darwinian natural selection results in life cycles that have a high *fitness* in their environmental context relative to other possible life cycles. It is difficult to say how fitness is to be measured in a given context, or how an optimum is defined, but in practice optimality conditions can be defined by the context and nature of life cycles. Foraging birds or large predators, for example, are likely to be efficient in terms of how they use their time or focus their effort. Many population biologists employ such criteria, plus the tools of optimality theory, to gain useful insight into life cycles.

The environment in which organisms live is critically important, as it is in all demographic studies. A major component of the environment is *biotic:* the set of other individuals with which any given individual interacts. In the simplest case, the density of other individuals in space and time and how this density affects life cycle transitions is of primary importance. Thus, death rates can be regulated by density-dependent interactions between individuals of the same species (such as competition or cannibalism), or interactions between individuals of different species (a familiar example is predation; less familiar may be symbiosis, a mutually beneficial relationship exemplified by rhizobia bacteria that live in structures called nodules on the roots of plants and fix atmospheric nitrogen for the plants in return for energy and a habitat). In a finer-grained view, interactions can depend on the characteristics and behavior of the individuals involved. Competition for food, for example, may depend on body size; success in attracting a mate can depend on phenotypes such as plumage or antler size; and so on. The *abiotic* environment also plays a major role by setting resource levels, environmental conditions (such as light or moisture or temperature), and the predictability or unpredictability of such factors.

The analysis of interactions between individuals requires aggregation from individuals to populations, a process affected by scale in space and time. The simplest case is an isolated population of a single species, such as a bacterial culture in a laboratory Petri dish. Spatially localized populations in nature are often studied as isolated populations if migration is not significant. More generally, populations have patchy distributions over space, and a population may really be an aggregation over many spatial patches connected by migration. Depending on the species, a population may occupy some spatial locations only some of the time, as with migrating birds or butterflies that trace a roughly regular spatial migration route in the course of a year. In other cases, local patches can be ephemeral, supporting a small population of a species for a small part of an occasional year. Spatial distributions may be weakly or strongly determined by underlying physical and biological features in space and time.

For a population of a single species, the key questions concern dynamics: How and why do population numbers and composition change over time and space; what is the short-run and long-run variability in population; what is the viability (i.e., ability to persist at reasonable numbers) of a population? These questions are also central to the sciences of conservation biology and population management. Conservation biologists are typically interested in viability, in the likelihood of extinction, and in spatial distributions; exploited populations (e.g., for fishing, hunting, recreation) are, in a surprising number of cases, actively managed for abundance and persistence.

From Populations to Ecosystems

As noted, interactions between individuals of different species can be important in the life cycles of individuals and in the dynamics of populations. Some interactions between pairs of species are studied using common concepts and methods. Examples include interactions between predator and prey, host and parasite, or species competing for similar resources. Interactions play a central role in population biology, underlying pattern and process in ways that were first highlighted by the British ecologist Charles Elton (1900–1991) and the American ecologist G. Evelyn Hutchinson (1903–1991); current paradigms in the field build on the work of the American ecologists Robert MacArthur and Edward O. Wilson, among others.

Predator–prey interactions are often analyzed in terms of the response of predator behavior to changes in the distribution and abundance of prey—a general theory for this functional response of the predator has been developed and successfully applied in several cases.

Host–parasite interactions are more complex because parasites come in many varieties, from parasitic organisms that spend part or all of their life cycle within one or more hosts, to insect parasitoids that spend their adult lives outside a host but need to find, and lay their eggs inside or on, a host. There are useful general methods for analyzing different classes of host–parasite interaction. A significant part of the science of host–parasite interactions originated in the study of human malaria, with the work of the great British epidemiologist Ronald Ross (1857–1932), and from subsequent epidemiological work on human and non-human disease. Since about 1980 population biologists and epidemiologists have paid increasing attention to the transmission and control of viral infections ranging from influenza to HIV.

Competitive interactions vary depending on what competition exists (for space, food, mates, and so on) and the type of competitive interaction (which may involve quite distinct abilities, e.g., efficiency at finding a resource, or ability to displace other individuals from a resource). Here too, a number of general principles of analysis have been developed and tested. Individual behavior clearly plays a key role in interactions, and behavioral ecology is the study of behaviors and their evolution.

Moving up in scale from pair-wise interactions, there are communities of species that interact in many different ways over some spatial region. The complexity of communities depends on their diversity (measured in terms of the numbers and relative abundance of different species), their trophic structure (if all species in the community are arranged into a who-eats-whom pyramid there is a hierarchy of levels; the subset of species at each level is called a trophic level), and the network of interactions between each species and the rest. Communities range from a few dozen bacterial species in a square foot of soil to assemblages of hundreds of species in a large national preserve or park. Still further up in scale, there are ecosystems that may contain numerous communities that interact weakly with each other, from complete islands to areas of subcontinental scale. As spatial scale changes, so does the time scale over which communities display significant change. For communities and ecosystems, ecologists are concerned with their dynamics, viability, resilience (ability to withstand perturbations such as changing environmental conditions or invasion by new species), biodiversity, and biogeography. A subject of increasing interest is the dynamic interaction between humans and ecosystems.

Evolutionary Ecology

In population biology, evolution can make causality run from individual characteristics to interactions (e.g., the outcome of competition is determined by the characteristics of competing individuals), or from interactions to characteristics (e.g., characteristics such as plumage displays can evolve in response to their impact on relative mating success). Time scale is important in determining which effects are studied: In the conventional paradigm, evolutionary changes are usually much slower than ecological changes. Even so, the evolutionary changes people can observe and document are those that take place over a period shorter than the human life span. The classic example is the change in the moth *Biston betularia* from mostly light to mostly dark individuals in the half-century beginning in about 1848 as the industrial revolution increasingly polluted Britain. Many population biologists are concerned with historical evolutionary processes that generated the behaviors, interactions, and life cycles observable in the present; others, with how evolution is changing the patterns observed in the early twenty-first century.

Much of evolutionary ecology generalizes Darwin's insights: Elton did so in 1930, with an emphasis on the evolution of individual characteristics in ecological contexts. But many new insights have emerged in studying phenomena that Darwin did not consider or found too challenging. The study of social evolution—how collective behavior evolves—was given a solid basis by the British evolutionary biologist William Hamilton (1936–2000) in 1964, by the introduction of the concept of inclusive fitness, which extends fitness to include the effects of an individual's behavior on the fitness of kin. Work on social traits in behavioral ecology and evolution has also provided insights in subjects such as anthropology and human ecology. Evolutionary questions that remain topics of active research include aspects of the evolution of sex and sex ratios, the evolution of senescence (the British biologist J. B. S. Haldane (1892–1964) and the British immunologist Peter Medawar (1915–1987) were pioneers in this area), and the evolution of larger-scale patterns in ecology.

Population Genetics

Evolutionary ecologists tend to think largely in terms of natural selection as the main force for adaptation and evolution. Population genetics takes a more careful look at the evolutionary process. The American population biologist Richard Lewontin (born 1929) emphasized that evolution is a multi-level affair: An individual's genes make up its genotype; genotype plus environment interact to determine the individual's phenotype. The crux is the presence of heritable genetic variation between individuals—variation is modified by differential selection on phenotypes, by random events (especially *drift,* the unavoidable randomness in choosing a finite sample from a finite population), and by the introduction of naturally occurring random mutations into genotypes. Evolution is the consequence of a dynamic process of change in the genetic variation within populations under the forces of selection, drift, and mutation. Many basic features of evolution were worked out by Fisher, Haldane, and the American population geneticist Sewall Wright (1889–1988) in the 1930s and 1940s.

In subsequent decades population geneticists have brought increasing experimental power to bear on the measurement and characterization of genetic and phenotypic variability within populations, from the early studies of the American population geneticist Theodosius Dobzhansky (1900–1975) on chromosome structures in fruit flies (the genus *Drosophila*) to current studies of genetic sequences and gene microarrays. A striking overall finding is that there is a huge amount of genetic variability within populations, and a key question in population genetics is why so much variability exists. In broad terms, there are two answers. One, originating with Dobzhansky, holds that selection is responsible for much of the variation; the other, originating with the Japanese population geneticist Motoo Kimura (born 1925), holds that much variation is simply neutral, a consequence of mutation followed by random drift, and has little selective significance. It is known that each answer applies in some domain of nature, but precise formulation and testing of these and more sophisticated hypotheses remains an important subject for research.

Since about the 1980s, population geneticists have increasingly turned to the analysis of phylogeny, the historical relationships among lineages of organisms or their parts (including their genes). Given a sample of genes from different humans in the year 2000, for example, one can ask whether these genes exist as the result of evolution from a single ancestral population, and estimate the time it took for the current genetic variation to materialize. Phylogenetics also provides powerful insights into the evolutionary *trees* that have resulted in variation between species as found at the beginning of the twenty-first century.

To someone concerned with human demography, population genetics is key to understanding how genetics and evolution have shaped aspects of human traits and behavior. Population genetics has been strikingly effective in the analysis of genetic variants that have major effect on health (such as the *Apo E* locus, implicated in Alzheimer's disease and atherosclerosis). Biodemographers look to population genetics as a way of identifying segments of the genome that have major effects on quantitative traits such as components of mortality. Demographers are becoming interested in the genetic contribution to traits as diverse as fertility and health, partly stimulated by the availability of modern technologies for extracting genetic information from small samples of human cells collected in surveys. However, it is far from obvious that genetic analyses can sensibly inform an understanding of complex traits that have major social and cultural components. As demographers' earlier experience with eugenics demonstrates, there are sound historical reasons to be cautious and precise in such work.

See also: *Aging and Longevity, Biology of; Animal Ecology; Biodemography; Darwin, Charles; Lotka, Alfred; Sociobiology.*

BIBLIOGRAPHY

Andrewartha, Herbert G., and Louis C. Birch. 1954. *The Distribution and Abundance of Animals.* Chicago: University of Chicago Press.

Crow, James F. 1986. *Basic Concepts in Population, Quantitative, and Evolutionary Genetics.* New York: W. H. Freeman.

Elton, Charles S. 2001. *Animal Ecology* (1927), with new introductory material by Mathew A. Leibold and J. Timothy Wootton. Chicago: University of Chicago Press.

Fisher, Ronald Aylmer. 1958. *The Genetical Theory of Natural Selection,* rev. 2nd edition. New York: Dover Publications.

Futuyma, Douglas J. 1998. *Evolutionary Biology,* 3rd edition. Sunderland, MA: Sinauer Associates.

Hutchinson, G. Evelyn. 1965. *The Ecological Theater and the Evolutionary Play.* New Haven, CT: Yale University Press.

Krebs, John R., and Nicholas B. Davies, ed. 1997. *Behavioural Ecology: An Evolutionary Approach.* Cambridge, MA: Blackwell Science.

Lewontin, Richard C. 1974. *The Genetic Basis of Evolutionary Change.* New York: Columbia University Press.

Maynard Smith, John. 1998. *Evolutionary Genetics,* 2nd edition. New York: Oxford University Press.

Ricklefs, Robert E., and Gary L. Miller. 2000. *Ecology,* 4th edition. New York: W. H. Freeman.

Shripad D. Tuljapurkar

BIRTH CONTROL, HISTORY OF

Evidence of attempts at contraception and induced abortion are found in many societies. Many preliterate societies used a variety of herbal remedies in attempts to suppress fertility or to induce menstruation. Literary evidence of contraception is found in the work of Egyptian, Classical, and Arabic writers, such as the Greek physicians Disocorides and Soranus (first–second centuries C.E.), the Roman historian Pliny the Elder (died 79 C.E.), and the Arabian physician and philosopher Avicenna (died 1037 C.E.). Archaeological evidence of induced abortion has been found in a Romano-Gallic site in the Netherlands where the skeleton of a young a woman was discovered with a bone stylet, which was used to induce abortion, in the pelvis.

In classical times, the principal export of the Mediterranean port of Cyrene was a plant called silphion. Related plants demonstrate oxytocic properties, and sylphion seems to have been such an effective abortifacient that it was harvested to extinction. The oldest pictorial representation of a mechanical abortion is in a bas relief illustrating massage abortion in the great temples of Angkor Wat in Cambodia (1150 C.E.). The image depicts devils in masks pounding the abdomens of women who appear to be about 20 weeks pregnant. An identical procedure continues to be widely used in contemporary Southeast Asia.

The Judeo-Christian Tradition

Induced abortion is mentioned once in the Bible (Exod. 21:22), which categorizes it as a crime, but explicitly not as murder. *Coitus interruptus* is mentioned once in a passage in Genesis (38: 9). The story of Onan, "who spilled it [his seed] on the ground" is well known. Talmudic commentators are divided as whether God slew Onan because he practiced withdrawal, or because he disobeyed his father's command to make Tamar, his dead brother's wife, pregnant.

The New Testament makes no comment on any aspect of fertility regulation, but Saint Paul, in his letters, places women in an inferior position to men. The early fathers of the Church became increasingly conservative in their interpretation of human sexuality. Saint Augustine (died 430) had the same mistress for many years, with whom he had one child, and he may have practiced *coitus interruptus.* He taught that original sin had been passed down the generations in the semen, much like some precursor to the HIV virus, and therefore the unbaptized were condemned to eternal damnation. He argued that nocturnal erections were evidence of human sin because they were not under the control of the human will. Given such interpretations, Saint Augustine was led to conclude that the only justification for sexual intercourse was to perpetuate the human race. In his words, "that which is done for lust must be done in such a way that it is not for lust's sake" (*Contra Julianum,* 5, 9). Other western theologians constructed even more contrived restraints on human sexuality. By the later Middle Ages, intercourse was forbidden on Sundays, Fridays (the day when Christ died), feast days (which were numerous), and throughout the 40 days of Lent. In effect, intercourse was forbidden for approximately half the year. Women were told that if they had a congenitally abnormal baby it was because they had sex during menstruation or during some forbidden time.

Augustine condemned all types of artificial conception, including periodic abstinence. But in the late-nineteenth century, contrived exceptions began to be constructed to permit use of the rhythm method (abstinence limited to what was believed to be the fertile period of the woman's menstrual cycle). In 1920 the Lambeth Conference of Anglican Bishops moved to a cautious recognition of licitness of all artificial contraception. The Second Vatican Council (1962–1965), which marked a watershed in Catholic teaching in a variety of domains, was expected to move the Catholic Church in the same direction. Most people expected that the approval of contraception would be widened, at least to include the then newly available oral contraceptives. Pope Paul VI, who became pope in 1963, set up a commission to review the topic, which eventually included five women. The majority of the commission voted to revise the church teaching of birth control. However, Paul VI rejected these recommendations and published the encyclical *Humanae vitae* in 1968. It condemned any contraception, defined as "action, which is either before, at the moment of, or after sexual intercourse, that is specifically intended to prevent procreation—whether as an end or a means." It was a linear continuation of Augustine's teachings.

Only fragments of written information exist to illuminate the pain these teachings brought to countless women and their families over the centuries. An Inquisitor condemning Albigensian heretics to the stake (circa 1320) in Montaillou, France, interrogated one woman who had had a sexual relationship with a priest. "What shall I do if I become pregnant by you? I shall be ashamed and lost," she said. "I have a certain herb" responded her lover, "the one the cowherds hang over a cauldron of milk in which they have put some rennet to stop the milk curdling" (Le Roy Ladurie). Between 1647 and 1719, in Colyton (in Devon, England), the mean age of marriage for women rose to 29.6 years. In one parish in Somerset only one in 200 pregnancies was to women under age 17. Ecclesiastical court records show that while many women went to the altar pregnant, premarital sex was limited to a very short interval before marriage. Women who did bear a bastard child could be publicly whipped on market day—with extra stripes if they did not breastfeed their baby. In 1671, a French aristocrat, Madame de Sévigné wrote to her daughter, "I beg you, my love, do not trust to two beds; it is a subject of temptation. Have someone sleep in your room."

The Nineteenth Century

With industrialization, urbanization, and some fall in infant mortality, the pressure to control family size grew. The first articulated efforts to disseminate knowledge about family planning technologies date from the early-nineteenth century. They began with English Free Thinkers such as Francis Place (1771–1854) and John Stuart Mill (1806–1873). Place had 15 children and he understood the sufferings of factory workers and servants in the big cities. He wrote what contemporaries called the *Diabolical Handbills* describing the use of a sponge inserted vaginally. In 1832, the American physician Charles Knowlton (1800–1850) published anonymously *The Fruits of Philosophy,* which described post-coital douching. Several publishers were prosecuted under obscenity laws in the United States and Britain for republishing Knowlton's work.

In 1871, Charles Bradlaugh (1833–1891), a Free Thinker who had been elected to the British Parliament, and Annie Besant (1847–1933), a writer who had rejected the conventions of marriage and joined the Secular movement, deliberately challenged the law by republishing *The Fruits of Philosophy.* Their trial was widely reported in daily papers and sales of the book rose from 1,000 a year to 100,000 in three months. Bradlaugh and Besant were acquitted on a technicality. A substantial and continued decline in the British birth rate began at that time, most likely driven by increasing use of withdrawal and rising abortion rates, along with the commercial availability—albeit under the counter—of condoms and spermicides. Historical demography suggests that withdrawal, along with delayed marriage, was being used to limit family size in Elizabethan England and *coitus interruptus* almost certainly played a major part in the decline in family size in France that began in the eighteenth century. Even in the mid-twentieth century *coitus interruptus* remained one of the most common methods of contraception in Europe.

In nineteenth-century England, abortion up to the time of quickening was legal. But in 1861, the Offenses Against Persons Act not only made abortion at any time during pregnancy a crime, but even the intention to commit an abortion became a felony. During the same period, every state in the United States passed a law against abortion, although women struggled to terminate unintended pregnancies. In 1871, Ely van de Warkle described abortion practices in Boston, Massachusetts. To test their safety, he purchased the many herbal remedies that were available at that time and either ate them, or gave them to his dog. "The luxury of an abortion," he wrote in the *Journal of the Boston Obstetrical Society*, "is now within the reach of the serving girl."

In America, a dry goods salesman named Anthony Comstock began a one-man crusade against obscenity. Amongst other things, the law he successfully lobbied Congress to pass in 1873 defined all types of contraception as pornographic. Comstock also persuaded his wife to visit a well-known New York abortionist who called herself Madame Restell. She begged her for an abortion, which Restell promised to provide. Comstock then had Restell arrested. She cut her throat the night before her trial was to begin. Comstock described this as a "bloody end to a bloody business."

Class differences in both attitudes to and practice of birth control persisted through the nineteenth century. By 1900, in England, clergymen and doctors were having families that were only one quarter the size of those of miners and dock laborers. Yet it was the professional classes that were most opposed to making family planning available to the working classes.

Twentieth Century

It is difficult to reconstruct the sexual conservatism of late-nineteenth century Europe and North America. Marie Stopes (1880–1958) was one of the first women with a Ph.D. in Britain. The daughter of a middle class Edinburgh family, she married a fellow botanist called Ruggles Gates. He proved to be impotent and it is a measure of the ignorance of the time that it seems to have taken some while for his wife to discover that something was missing from her marriage. As a divorced virgin in 1918, she penned a book called *Married Love.* In flowery and convoluted language, and without mention of any of the anatomy of the genitalia, she argued that woman had a right to enjoy sexual pleasure in marriage. This novel view helped make the book widely read—both in Britain and in many other countries.

World War I generated a lively debate between those interested in family planning and a body of militaristic lobbyists who argued that contraception was unacceptable because it interfered with the birth of the next generation of soldiers. In 1920, Russia under the leadership of Lenin became the first country to legalize abortion. Several Scandinavian countries passed tortuous and complicated abortion legislation between the 1930s and the late-1950s. In 1966, Britain struck down Queen Victoria's 1861 Offenses against Persons Act forbidding abortion. This example led to important changes in some of the countries of the British Commonwealth (including India, Singapore, and Zambia). Over the next 30 years, every European country, except Malta and Ireland, had passed legislation making safe abortion widely available. In Italy, the decision was the result of a nationwide referendum in 1974.

The spread of contraception and safe abortion between 1960 and 1990 facilitated—some would say, caused—the marked fall in the total fertility rate that took place in Western countries. Low fertility had been achieved in parts of Europe between World War I and World War II, when abortion—although illegal—became relatively widely available in some places. For example, knowledgeable sources estimated one abortion for every live birth in Hamburg in the 1930s. In Vienna the abortion rate was thought to be 20 for every 1,000 women and the very low total fertility rate of 1.2 was thought to be one-third the result of abortion and two-thirds the result of contraception—probably, mainly *coitus interruptus.* A generalized pattern of low fertility in the West was widely predicted in the 1930s by demographers, anticipating declining populations by the second part of the twentieth century. This was not to be: To demographers' surprise, the postwar decades first brought a baby boom that was followed by rapid decline of fertility to well below replacement levels in many European countries.

In the 1950s and 1960s, the lowest birth rates in the world were in Eastern Europe, again based on widespread use of withdrawal backed up by abortion. In the twenty-first century the total fertility rate of most Western countries is below 2. A similar rapid decline in fertility that has occurred in most other parts of the world also owes much to the improved availability and range of contraceptive choices and access to safe abortion; examples include South Korea, Taiwan, Thailand and Sri Lanka.

Historically, the twentieth century not only saw increasing access to reproductive choices, but also witnessed important reversals of this trend. It is notable that many twentieth-century dictators took steps to restrict reproductive choices. One of the first moves that the Nazis made when Hitler came to power was to close down what had been a promising beginning to family planning services in Germany and Austria. It was in Nazi dominated Vichy France in 1942 that the last execution of an abortionist took place. Stalin in Russia and Nicolae Ceausescu in Romania both reversed previously liberal abortion laws.

The first family planning clinic to be established was in the Netherlands in the 1880s. Birth control leader Margaret Sanger (1883–1966) opened a clinic in Brooklyn, New York in 1917. Immediately, large numbers of women attended, but ten days later the police, enforcing the Comstock laws, closed it down. In Britain, Stopes opened her first family planning clinic in 1921. In the United States, precedents were developed that held that if physicians prescribed contraceptives "for the cure and prevention of disease" then their use was deemed to fall outside the Comstock laws. (*Congressional Globe* 1873: 1436). In 1937, this precedent was reinforced in the case of *United States v. One Package of Japanese Pessaries,* 13 F. Supp. 334 (E.D.N.Y. 1936). These developments brought short-term relief to those trying to provide contraceptive services, but it also contributed to the undue medicalization of contraceptive practice, particularly as at that time the only clinical methods were vaginal barriers. The last of the U.S. Comstock laws were not struck down until the Supreme Court ruling of 1965 in *Griswold v. Connecticut,* 381 U.S. 479 (1965).

In 1966, the British abortion law was reformed to take into account the "woman's total environment" (The Abortion Act, 1967). Framing abortion as a medical problem helped dull political opposition, but the fine print of medical regulation in England delayed for decades the introduction of safe abortion that would require only day care. When Commonwealth countries such as India and Zambia adopted a version of the British Abortion Law, medical restrictions meant that the law had little or no effect on the frequency of unsafe abortions.

Griswold was based on the right to privacy and this also became the foundation of the unexpected decision of the U.S. Supreme Court in 1972 in *Roe v. Wade,* 410 U.S. 113 (1973), to strike down the anti-abortion laws that remained across America. *Roe v. Wade* also framed abortion as a right to privacy and an issue of religious toleration rather than a medical issue. "We need not resolve the difficult question of when life begins," wrote the justices, "when those trained in the respective disciplines of medicine, philosophy and theology are unable to arrive at any conclusion."

Fertility Regulation Methods

All the methods of contraception now in use, except for systemically active oral contraceptives, implants, and injections, were available and documented by the end of the nineteenth century. Condoms made from sheep caeca, which date back to the seventeenth century, have been discovered by archaeologists. Famed diarist James Boswell describes using a condom with a prostitute in London in 1763. Condoms became widely available with the invention of vulcanization of rubber by Charles Goodyear and Thomas Hancock in 1844. The cervical cap was described in the early nineteenth century in Germany and the diaphragm was available by the turn of the twentieth century. The manufacturing and distribution of contraceptives was poorly regulated until well into the second half of the twentieth century. Sales were illegal in the United States, France, and several other European countries. In Britain sales were "under the counter." Intrauterine Devices (IUDs) began to be used in the late-nineteenth century. In the 1920s Ernst Grafenberg, a German gynecologist, did extensive work on IUDs, but after fleeing Nazi persecution he found that political freedom in America did not entail the freedom to continue his research. IUDs went through a renaissance of interest in the 1960s, when flexible plastic devices, such as the Lippes Loop, replaced the metal rings used previously. In 1971, Hugh Davis launched the Dalkon Shield. He claimed very low pregnancy rates without revealing that he counseled the clinical trialists also to use spermicides with the device. Deaths occurred due to rapidly spreading septicemia in pregnant women with a Dalkon Shield in situ. The legal cases that followed bankrupted the A. H. Robbins Company that had marketed the device, and led to a great reluctance to use any type of IUD in the United States. In Finland, obstetric and gynecological specialist Tapani Lukkenian devised the first hormone-releasing IUDs; in Chile, obstetric and gynecological specialist Jaime Zipper devised the first copper-releasing IUDs.

James Young Simpson, Queen Victoria's gynecologist, describes what twenty-first century society would call manual vacuum aspiration, a method of abortion, but the method was lost. The current method of manual vacuum aspiration, used for abortions up to the tenth week of pregnancy, was described by Harvey Karman in 1972.

In the 1920s, reproductive physiologist Ludwig Hablandt described the physiological basis of oral contraception. But the method made no progress, partly because of the lack of a cheap source of steroid and also because contraceptive research was not academically acceptable. The U.S. National Institutes of Health was forbidden by congressional mandate to support contraceptive research and, until the 1960s, the Vatican blocked any assistance from the World Health Organization in family planning. When Gregory Pincus, John Rock, and M.C. Chang, working in the Worcester Institute outside Boston, finally developed the Pill in the 1950s, contraception was still illegal in Massachusetts. For this reason, the initial large-scale trials were conducted in Puerto Rico. In 1963, American obstetrician and gynecologist John Rock, a devout Catholic, wrote *The Time Has Come: A Catholic Doctor's Proposal to End the Battle over Birth Control.* Rock argued that hormonal contraceptives should be licit because they imitated the natural processes whereby pregnancy and lactation inhibited ovulation. He died an embittered member of his Church. In 1966, obstetrician and gynecologist Elismar Coutino in Brazil demonstrated that an injectable form of progesterone, administered every three months, was a highly effective contraceptive.

One of the few genuine advances in birth control technology in the late-twentieth century was the discovery by reproductive physiologist Étienne-Émile Baulieu in France of the anti-progestigen Mifepristone (RU-486), an abortifacient effective if used during the first 50 days of pregnancy. Although Mifepristone is widely available in Europe, the controversy surrounding its development and use delayed its introduction in the United States.

Conclusion

The history of birth control is one of controversy, of slow progress in technology and scientific analysis, of legal restraints, and of medical conservatism. It is a tale of two steps forward and one step backward.

The twenty-first century has opened with a serious demographic divide. The Western nations and the emerging economies of Latin America and Asia have total fertility rates of 2.5 or less, while much of sub-Saharan Africa, Pakistan, and parts of northern India have total fertility rates of 5 or more. The legal and social attitudes toward family planning and abortion in the remaining high fertility countries has similarities to the situation in Europe and North America in the early twentieth century, in that contraception is not readily accessible to much of the population and abortion is illegal (or legal but difficult to get, as in India). Interestingly, countries furthest removed from the western cultural influence have had the most rapid fertility transitions; one was communist China in the 1970s and 1980s, and the other the Islamic Republic of Iran in the 1980s and 1990s. Undoubtedly, there were sad cases of coercion in China, although a plausible case can be made that if a national program had been started a decade earlier, a purely voluntary decline might have occurred as in South Korea and Taiwan. Iran shows that making family planning choices available leads to rapid fertility decline, even in a conservative religious theocracy.

Much of the proximate cause of the demographic divide within the contemporary world can be traced back to the uneven rate in which fertility regulation technologies have spread around the world. While the British Empire introduced significant public health measures, such as vaccination, clean water, and sewage treatment to many parts of the world, it opposed family planning. Birth control organizations began in the 1930s in India, as did an awareness of rapid population growth, but the country had to wait until independence before it could put in place any birth control policies. Many high fertility nations still have anti-abortion legislation that has existed since colonial times.

See also: *Contraception, Modern Methods of; Family Planning Programs; Induced Abortion: History; Infanticide; Reproductive Rights; Sanger, Margaret.*

BIBLIOGRAPHY

Himes, Norman E. 1963 [1936]. *Medical History of Contraception*. New York: Gamut Press.

Le Roy Ladurie, Emmanuel. 1979. *Montaillou: The Promised Land of Error*. New York: Vintage Books.

Mohr, James C. 1978. *Abortion in America: The Origins and Evolution of National Policy, 1800–1900.* New York: Oxford University Press.

Noonan, John T. 1967. *Contraception. A History of Its Treatment by the Catholic Theologians and Canonists.* Cambridge, MA: Harvard University Press.

Potts, Malcolm, and Thomas Tsang. 1995. "History of Contraception." In *Gynecology and Obstetrics,* pp. 1–23. Philadelphia: Lippincott-Raven.

Ranke-Heinemann, Uta. 1990. *Eunuchs for Heaven: The Catholic Church and Sexuality.* London: Andre Deutsch.

Wrigley, Edward Anthony. 1966. "Family Limitation in Preindustrial England." *Economic History Review* 29: 82.

David Malcolm Potts

BIRTH RATE

See *Fertility Measurement*

BLACK DEATH

In any textbook on infectious diseases the chapter on plague will describe three pandemics of bubonic plague.

The Three Pandemics

The first pandemic—the plague of Justinian—originated in Egypt, erupted in Constantinople in 541 C.E., spread to Ireland by 544, but did not touch England until 120 years later. The second pandemic originated in India, China, or the steppes of Russia. It touched the shores of Western Europe (Messina) in the autumn of 1347, then spread across the continent, striking places as remote as Greenland. The disease recurred periodically through the eighteenth century and possibly into the nineteenth century. Despite claims in some textbooks, the plague of Marseilles in 1720–1721 was not this pandemic's European finale. In 1743 an estimated 48,000 people perished from the plague in Messina, and in 1770–1771, over 100,000 people died in Moscow. The third pandemic began in the mid-nineteenth century, spread slowly through the Chinese province of Yunnan, and did not reach Hong Kong until 1894. From there, steamship commerce aided its transmission across much of the world. However, except for India and a few other subtropical regions, its spread was confined largely to the docks of Sydney, Lisbon, Hamburg, Glasgow, and San Francisco. Instead of millions of deaths as Europeans feared, the death counts in temperate zones rarely surpassed 100.

Were the Three Plagues the Same?

The reason for claiming an identity among these three waves of epidemic rests on the supposedly unmistakable signs of bubonic plague. For the first wave of plague no quantitative records such as burials or last wills and testaments survive, and few narrative sources describe even the signs or symptoms. Paul the Deacon's *Historia Langobardorum*, written around 790 and describing plague in rural northern Italy in the 560s, is the most explicit. It points to "swellings of the glands . . . in the manner of a nut or a date" in the groin "and in other rather delicate places followed by an unbearable fever." The Emperor Justinian was afflicted with a boil in the groin and survived. Abbess Aethelthryth in 680 was less lucky; she died from a large boil under her jaw—a strange site for modern plague.

Differences between Medieval and Modern Plague

Few other examples of individual cases of plague can be gleaned from these sources, but the epidemiological clues point to a disease that was not characteristic of the plague whose agent (*Yersinia pestis*) was discovered in 1894.

The "first pandemic" spread rapidly and caused high mortality, especially among those, such as monks and nuns, who lived under the same roof, suggesting a highly contagious person-to-person airborne disease. In 664 the plague took only 91 days to travel 385 kilometers (239 miles) as the crow flies from Dover to Lastingham, England. By contrast, as the microbiologist Robert Koch commented in 1900, modern bubonic plague is a rat disease in which humans occasionally participate. Because the rat does not travel far, the bubonic plague of the twentieth century moved overland at a rate of about 12 to 15 kilometers (7 to 9 miles) a year. Thus, modern plague, even with the advantage of railways and automobiles, would need 25 years to cover the distance traveled in 3 months by the early medieval plague. Further, no literary or archaeological evidence shows the existence of rats in Anglo-Saxon England and no source mentions any signs or symptoms of this plague in England or Ireland. Despite this lack of evidence, some historians remain convinced that this disease was the bubonic plague discovered at the end of the nineteenth century.

The narrative sources for the "second pandemic" set off by the Black Death of 1347–1352 explode in number and variety. In addition to hundreds of chronicles from abbeys, city-states, and principalities across Europe, the plague tract, written for the most part by university-trained doctors, became one of the earliest forms of "popular literature" by the early fifteenth century. Further, the survival of thousands of last wills and testaments, necrologies, burial records, manorial rolls, and lists of ecclesiastical vacancies allows quantitative analyses of this plague, including its cycles of mortality, its seasonality, and the characteristics of its victims: age, sex, occupation, class, and locality. In addition to these rich sources, citywide burials and "Bills of Mortality" spread from Tuscany to north of the Alps in the late fifteenth century and as early as the 1420s (in Florence) began to indicate causes of death. Yet despite this wealth of information, no evidence links these late medireview and early modern European plagues to any disease carried by rodents and from which rodents were the first to die.

The epidemiological evidence raises further suspicions. First, like the early medieval plague, the second pandemic was a fast mover, spreading in a day as far as modern plague travels in a year. Doctors and chroniclers marveled at the Black Death's lightning-fast transmission and contagion—a word frequently used by doctors and chroniclers, who claimed that the plague spread by breath, touch, and even sight. For later strikes they distinguished plague from other diseases by this epidemiological feature as much as by the bubo. To reconcile the differences between the late medieval and modern plagues, historians and scientists say that the Black Death's speed and contagion relied on its pneumonic form and claim that as with modern plague, once it became airborne, it became "highly contagious" and free from rodents.

However, these claims are mistaken, as Wu Tien Teh discovered with the Manchurian plagues of 1911 and 1922. First, this disease was primarily an infliction of a rodent, *tarabagan*, whose pelt became a highly-prized commodity in the early twentieth century. Secondly, even in tightly packed train cars Wu observed that the infected rarely passed the disease to fellow passengers. As a consequence the worst-known epidemic of pneumonic plague, that of Manchuria in 1911, infected and killed less than 0.3 percent of the population exposed to the disease as opposed to fatality rates that were as high as 40 percent from the Black Death.

Thirdly, the seasonality of the late medieval plagues does not resemble that of modern plague. Modern plague can be sustained only within a narrow temperature band (50 to 78°F) accompanied by high levels of relative humidity because of its dependence on fleas as its vector. By contrast, bouts of late medieval plague could occur at almost any time of year, including January, in places as inhospitable to modern plague as Norway. Further, in the warmer Mediterranean areas the Black Death and its recurrent strikes peaked consistently at the warmest and driest times of the year (June and July), the least likely time for modern plague to peak in light of the rat flea's fertility cycle in those areas.

Fourthly, modern plague has never attained the mortalities seen with major instances of the Black Death or even with those of many of its minor assaults. In the summer months of 1348 Florence may have lost as much as three-quarters of its population. From manorial records, villages in Cambridgeshire and around St.-Flour (Auvergne) lost 76 percent of their populations, and according to chroniclers, places such as Trapani on the western coast of Sicily were totally abandoned. Further, although later strikes of plague in the seventeenth century were not as widespread as the first wave of the Black Death, they could be equally devastating, as they were for Genoa and Naples in 1656–1657, when two-thirds of those populations were destroyed. By contrast, modern plague has never approximated such levels of human carnage—not even in India, where over 95 percent of the modern plague's casualties have occurred. The highest mortality for any city in any plague year was in Bombay City in 1903, when less than 3 percent of its population perished from plague.

Fifthly, the cycles and trends of the second and third pandemics have been entirely different. Because humans have no natural immunity to *Yersinia pestis* and cannot acquire immunity, plague cases and mortality in India increased for a decade or more and then jumped randomly from year to year before declining in the 1920s as a result of rats (not humans) acquiring immunity to the pathogen. Similar patterns occurred in Brazil, Thailand, Vietnam, and other subtropical regions later in the century, even after the introduction of DDT, antibiotics, and modern sanitary measures.

Moreover, the age structure of the victims of modern plague did not change over the twentieth century. As with the first strike on virgin-soil populations, those in the prime of life, between ages 20 and 40, are the plague's principal victims. By contrast, the Black Death over its first 100 years shows a remarkable adaptation between its pathogen and human hosts. By the fourth strike in the 1380s the disease was claiming as little as one-twentieth the toll taken in 1348, and as chroniclers across Europe describe and the rare burial records in Siena confirm, it had become largely a childhood disease.

Misleading Similarities

Why have historians and scientists been so certain that the two pandemics were the same? They point to Boccaccio and occasionally to a handful of chroniclers, insisting that their descriptions of swellings point to the unmistakable signs of *Yersinia pestis.* But first, as health workers in Asia are taught in the early twenty-first century, swellings in the lymph nodes are not unique to plague, hence cultures of the infected regions must be taken. Second, Boccaccio as well as other chroniclers and physicians, from Michele da Piazza in Messina (1347) to doctors of the plague of London (1665), went beyond the bubo to describe various sizes and colors of pustules, rashes, and carbuncles that covered the victims' bodies. Some, such as Geoffrey le Baker in England and Giovanni Morelli in Florence, pointed to these as the more deadly signs, far worse than buboes as large as hens' eggs in the lymph nodes. Moreover, buboes of the late medieval plagues were not confined to the lymph nodes but are described on shins, arms, the face, and under the breasts. By contrast, from over 3,000 clinical reports of plague from hospitals around Bombay City in 1896–1897, only 5 percent of the victims who developed the plague boils had more than one, and in not a single case did those or smaller spots spread over the victims' bodies. Moreover, with modern bubonic plague, from 60 to 75 percent of the plague boils form in the groin because fleas generally bite on or below the shins. However, not a single medieval source points to the groin as the buboes' principal site. Instead, from miracle cures found in saints' lives and doctors' reports, the late medieval boils' usual location was the neck, behind the ears, or on the throat.

Results of the Black Death

Historians have seen the Black Death as responsible for the insurrections of the late fourteenth century, the end of serfdom and feudalism, the rise of vernacular languages, the Reformation, and even modernity at large. Whether the plague can explain such broad and often time-lagged changes is open to debate. Often the immediate and longer-term consequences of the Black Death differed or were the opposite of one another, and its effects varied. For instance, immediately after the Black Death places such as Florence vigorously recouped many of their losses through quick rises in fertility and by drawing migrants from the hinterlands. Curiously this demographic pattern changed in the fifteenth century. Fertility fell perhaps because the disease, although now less lethal, killed greater proportions of those who could replenish population numbers—the young—and cities in northern and central Italy attracted fewer migrants from the countryside. In part this decline stemmed from improved conditions created for peasants by the population losses and the resultant rising demand for agricultural labor.

However, the economic and social consequences of the Black Death and depopulation were not the same across Europe, as worsening conditions for rural labor in Eastern Europe attest. Neither were the Black Death and its successive strikes as "universal" as contemporaries claimed. Plague may not have touched places such as Douai in Flanders until 1400, and population losses in Hainault, Holland, northern Germany, parts of Poland, and Finland were notably lower than they were in many other cities and regions across Europe. Historians have yet to analyze these diverging demographic histories forged by the late medieval plagues or analyze the effects they may have had on economic development and social transitions in the early modern period.

The psychological and cultural consequences of the plague were not uniform over time. In 1348 the clergy, merchants, and physicians evoked God's wrath, looked to the stars, and imagined bizarre happenings in distant lands to explain the Black Death. Except for frenzied acts of expiation—flagellant movements and the burning of Jews—Europeans saw no efficacy in human intervention and looked on doctors' cures as only quickening the pace of death.

However, as early as the second strike of plague in the 1360s, the explanations and immediate reactions to the plague's mass mortalities took an aboutface. Instead of referring to floods of frogs, worms that killed by their stench, and black snows that melted mountains, chroniclers and doctors explained the outbreak of new plagues by turning to the human sphere: wars, poverty, and overcrowding. Physicians recommended remedies and procedures they believed had cured them and their patients, and armed with the repeated experiences of plague, they claimed to have surpassed the ancients in the art of healing. No doubt, such success had less to do with their medicine than with their immune systems. Change from utter despondency over the first plague to a new culture of hope and hubris by the end of the fourteenth century rested on the particular character of the Black Death and its recurring bouts—the swiftness with which late medieval Europeans and the new bacillus (whatever it might have been) adapted to each other.

See also: *AIDS; Epidemics; Historical Demography; World Population Growth.*

BIBLIOGRAPHY

Benedict, Carol. 1996. *Bubonic Plague in Nineteenth Century China.* Stanford, CA: Stanford University Press.

Biraben, Jean-Noël. 1975–1976. *Les Hommes et la Peste en France et dans les Pays Européens et Méditerranéens,* 2 vols. Paris: Mouton.

Blockmans, W. P. 1980. "The Social and Economic Effects of Plague in the Low Countries 1349–1500." *Revue Belge de Philologie et d'Histoire* 58: 833–863.

Burnet, Sir Marfarlane. 1962. *Natural History of Infectious Disease,* 3rd edition. Cambridge, Eng.: Cambridge University Press.

Carmichael, Ann G. 1986. *Plague and the Poor in Renaissance Florence.* Cambridge, Eng.: Cambridge University Press.

Catanach, I. J. 1988. "Plague and the Tensions of Empire: India 1896–1918." In *Imperial Medicine and Indigenous Societies,* ed. David Arnold. Manchester, Eng.: Manchester University Press.

Cipolla, Carlo. 1979. *I Pidocchi e il Granduca: Crisi Economica e Problemi Sanitari nella Firenze del '600.* Bologna: Il Mulino.

Cohn, Samuel K. 1992. *The Cult of Remembrance and the Black Death: Six Renaissance Cities in Central Italy.* Baltimore: Johns Hopkins University Press; revised edition: 1997.

———. 1999. *Creating the Florentine State: Peasants and Rebellion, 1348–1434.* Cambridge, Eng.: Cambridge University Press.

———. 2002. *The Black Death Transformed: Disease and Culture in Early Renaissance Europe.* London: Arnold and Oxford University Press.

Cole, Stewart T., and Carmen Buchrieser. 2001. "Baterial Genomics: A Plague o' Both Your Hosts." *Nature* 413: 467–470.

Cook, Gordon, ed. 1996. *Manson's Tropical Diseases,* 20th edition. London: W.B. Saunders.

Dubois, Henri. 1988. "La Dépression: XVIe et XVe Siècles." In *Histoire de la Population Française,* Vol. I, ed. Jacques Dupâquier. Paris: Presses Universitaires de France.

Hatcher, John. 1977. *Plague, Population and the English Economy 1348–1530.* London: Macmillan.

Maddicott, J. R. 1997. "Plague in Seventh-Century England." *Past and Present* 156: 7–54.

Pollitzer, Robert. 1954. *Plague.* Geneva: World Health Organization.

Twigg, Graham. 1984. *The Black Death: A Biological Reappraisal.* New York: Schocken Books.

White, Norman F. 1918. "Twenty Years of Plague in India with Special Reference to the Outbreak of 1917–18." *Indian Journal of Medical Research* VI: 190–236.

SAMUEL COHN, JR.

BLAKE, JUDITH

(1926–1993)

Judith Blake was born in New York City and spent most of the first three decades of her life there. She received her B.S. degree *magna cum laude* from Columbia University in 1951 and her Ph.D. in Sociology, also from Columbia, in 1961. Her first exposure to social demography came through a course co-taught by demographers Hope Eldridge and Kingsley Davis (1908–1997), whom she later married.

Blake moved to Berkeley, California, in 1955 and initially held a series of lectureships, first in the School of Nursing at the University of California, San Francisco, and later in Sociology and then Speech at the University of California, Berkeley. Having completed her dissertation, in 1962 she was appointed Acting Assistant Professor of Demography in the School of Public Health at Berkeley. She quickly advanced to the rank of Professor and along the way established the Graduate Group in Demography (1965), soon to become the Department of Demography (1967), with herself as Chair.

The Department of Demography could not withstand the tumultuous anti-war protest years at Berkeley, and, under a new Chancellor, the department was disbanded in the early 1970s. Nevertheless, Blake, together with her two faculty colleagues in the department (demographers Samuel Preston and Nathan Keyfitz) and Kingsley Davis in the Sociology Department, managed to train an impressively large number of prominent demographers in a relatively short period of time. Following the closing of the department, Blake moved for a short while to the university's School of Public Policy. Then, in 1976, she became the first holder of the Fred N. Bixby Chair in Population Policy at the University of California, Los Angeles (UCLA), with joint appointments in Public Health and Sociology. Blake was the first woman at UCLA to be appointed to an endowed chair.

From the beginning, Blake was intensely interested in the determinants and consequences of fertility-related attitudes and behaviors. Her dissertation, which was published as *Family Structure in Jamaica: The Social Context of Reproduction* in 1961, explored why Jamaica's birth rate was so much lower than Puerto Rico's. One of her most original and influential articles, "Social Structure and Fertility: An Analytic Framework," co-authored with Davis in 1956, identified a set of intermediate variables through which any social factors affecting fertility must operate. This line of research endures in contemporary work on the proximate determinants of fertility.

Blake's research on American fertility was wide ranging. In a 1968 article, she criticized economists for equating children with consumer durables and for ignoring important components of the opportunity cost of childrearing and other non-economic determinants of fertility differentials. She showed that, in their fertility attitudes and practices, American lay Catholics and non-Catholics were actually quite similar and that the Vatican's influence over the use of contraception was minimal. In her influential book *Family Size and Achievement* (1989), Blake demonstrated that single children were not disadvantaged in terms of their sociability and that children with few or no siblings experienced higher levels of material well-being and cognitive development. She showed that earlier studies of attitudes toward abortion were simplistic, and she accurately predicted (to her dismay) the emergence of a backlash against abortion in the United States. She drew forceful attention to the pronatalism inherent in U.S. laws and institutions, including the emerging women's movement, and argued, at a time when U.S. fertility was still near its postwar peak and well above replacement level, that a reduction in fertility could be accomplished by a lifting of these incentives rather than by an introduction of disincentives.

Whether in her teaching, her performance at professional meetings, or in her published work, Judith Blake was invariably intellectually challenging and often provocative. She did not shy away from controversy, and she was a fearless and penetrating critic both of her own work and that of others. Her scientific contributions to social demography were recognized with her election as President of the Population Association of America in 1981, and, at the time of her death, she served as editor of the *Annual Review of Sociology*.

See also: *Davis, Kingsley; Fertility, Proximate Determinants of; Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY JUDITH BLAKE.

Blake, Judith. 1961. *Family Structure in Jamaica: The Social Context of Reproduction.* New York: Free Press.

———. 1968. "Are Babies Consumer Durables? A Critique of the Economic Theory of Reproductive Motivation." *Population Studies* 22: 5–25.

———. 1972. "Coercive Pronatalism and American Population Policy." In *Aspects of Population Growth Policy: U.S. Commission on Population Growth and the American Future,* 6: 85–108, ed. Robert Parke Jr. and Charles F. Westoff. Washington, D.C.: Government Printing Office.

———. 1989. *Family Size and Achievement.* Berkeley: University of California Press.

———. 1994 (1972). "Fertility Control and the Problem of Voluntarism." *Population and Development Review* 20: 167–177.

Davis, Kingsley, and Judith Blake. 1956. "Social Structure and Fertility: An Analytic Framework." *Economic Development and Cultural Change* 4: 211–235.

SELECTED WORKS ABOUT JUDITH BLAKE.

Bourque, Linda B., Judith Blake, Jennifer Frost, Thomas Espenshade, Ronald Lee, Valerie Oppenheimer, and Jean van der Tak. 1995. "A Biographical Essay on Judith Blake's Professional Career and Scholarship." *Annual Review of Sociology* 21: 449–477.

THOMAS J. ESPENSHADE

BOSERUP, ESTER

(1910–1999)

Ester Boserup was a Danish economist and internationally renowned writer on population and agrarian development. She graduated from the University of Copenhagen in 1935 and began her career in the Danish civil service, dealing with practical problems related to trade policy and regulatory issues. In 1947 Boserup moved to Geneva, having taken a position with the newly established United Nations Commission for Europe. The move marked the beginning of several decades of work in various international posts, assignments, and consultancies in the field of development economics, entailing long stays in India and Africa and extensive participation in international meetings, conferences, and committees. Living in Brissago, Switzerland, she remained professionally active until the early 1990s and was a productive scholar until her death at the age of 89.

Boserup rose to international prominence as an eminent social scientist and an influential intellectual figure with the publication, in 1965, of her book *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure.* In India, she and her husband, the economist Mogens Boserup, had been part of the research team working on the massive study *Asian Drama: An Inquiry into the Poverty of Nations,* under Swedish economist Gunnar Myrdal. As a result of this experience, she became increasingly convinced that the then generally accepted theory of zero marginal productivity and agrarian surplus population in densely-populated developing countries was an unrealistic theoretical construction. She resigned from the Myrdal study and started work on her book on the conditions of agricultural growth, drawing in addition on studies she conducted in Africa. The book challenged the dominant Malthusian paradigm (accepted by the majority of classical economists) on the relationship between population growth and technical progress by arguing that population pressure can lead to agricultural intensification and to the adoption of improved methods of production. Looking back at her career at the end of her life, in a slim autobiographical volume published in 1999, Boserup gave a pithy summary of her 1965 message: "my conclusion was the opposite of the general opinion at that time, when it was believed that the carrying capacity of the globe was nearly exhausted and that the ongoing demographic transition in developing countries would result in soaring food prices and mass starvation" (p. 21). Two other important (and widely translated) books followed; they addressed the two major topics to which she had devoted most of her research and writings in the 1970s and 1980s: *Woman's Role in Economic Development* (1970) and *Population and Technological Change: A Study of Long-Term Trends* (1981). A selection of Boserup's major essays, *Economic and Demographic Relationships in Development,* appeared in 1990. In a review of that volume in *Population and Development Review* (December 1990, p. 775), the agricultural economist Vernon Ruttan commented: "Ester Boserup's writings have had a major impact over the last quarter century on the evolution of thought in anthropology, demography, economics, and sociology about the interrelationships among economic, demographic, and technical change."

BIBLIOGRAPHY

SELECTED WORKS BY ESTER BOSERUP.

Boserup, Ester. 1965. *The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure.* Chicago: Aldine.

———. 1970. *Woman's Role in Economic Development.* London: Allen and Unwin.

———. 1981. *Population and Technological Change: A Study of Long-Term Trends.* Chicago: University of Chicago Press.

———. 1985. "Economic and Demographic Interrelationships in Sub-Saharan Africa." *Population and Development Review* 11(3): 383–397.

———. 1987. "Population and Technology in Preindustrial Europe." *Population and Development Review* 13(4): 691–701.

———. 1990. *Economic and Demographic Relationships in Development.* Baltimore: Johns Hopkins University Press.

———. 1999. *My Professional Life and Publications 1929–1998.* Copenhagen, Denmark: Museum Tusculanum Press.

PAUL DEMENY

BOTERO, GIOVANNI

(1543–1617)

Giovanni Botero was an Italian statesman, political writer, and upholder of the principles of the counter-reformation of the Catholic Church. Botero was a major figure in the early history of the social sciences and was recognized as the originator of modern population theory, in some important respects anticipating English economist T. R. Malthus. He was a member of the Jesuit order and held various diplomatic posts in France and Spain, and later in Rome. His ten-volume work *Della Ragion di Stato* (The Reason of State) (1589) is comparable in interest, if not in length, to Italian political philosopher Niccolò Machiavelli's *The Prince* (1513). Botero's book, like that of his more famous predecessor, is written for the prince who intends to conserve with prudence the domain he won by force. However, Botero's prince must be virtuous, religious, and faithful to the Catholic Church, "the eternal seat of power," and in this he opposed the lay vision of Machiavelli's prince. A later work, *Relazioni Universali* (1593–1596), describes the state of Christianity throughout the world.

In the field of demography, Botero is mainly of interest for the three-volume work *Cause della grandezza e magnificenza delle città* (The Greatness of Cities) (1588). In this work, the subject of population, seen as the wealth of a city or nation, is at the center of a quantitative depiction of human society. Botero had a quantitative vision of overpopulation, anticipating theories that became established much later. He contended that the civil development of populations did not lie in the possession of more riches, but above all in the numerical increase and productive activities of the people themselves. Botero attributed the increase of populations to the *generative virtue* of man and the *nutritional virtue* of the city. When the latter is insufficient, he argued, the solution lies in the creation of colonies, as practiced by the ancient Romans: the export of population as a relief valve for demographic excess. (This idea had already been introduced by Machiavelli in the *Discorsi sopra la prima deca di Tito Livio,* which suggested that when the demographic mass exceeds the productivity of the earth, famine, disease, or floods will take place.) In effect, Botero produced a first doctrinal draft of a theory of population, more than 200 years before Malthus. Despite the distance in time and, in some respects, in philosophy, the similarity between the thinking of the late-eighteenth-century Protestant clergyman Malthus and the late-sixteenth-century writing of the Jesuit Botero goes beyond the basic framework of their analytic approach. For example, Botero's views on the types and *modus operandi* of what came to be known as "positive checks" and "preventive checks" to population growth are a remarkable anticipation of Malthus's familiar treatment, even if the latter is set out in a more rigorous and modern fashion. Like Malthus (who did not know about the work of his Italian predecessor), Botero also sought to ground his reasoning in observable demographic facts, even though that effort was largely frustrated by his lack of access to reliable statistics and by his misconceptions about the demography of both the ancient and the contemporary world.

See also: *Demography: History of; Malthus, Thomas Robert.*

BIBLIOGRAPHY

SELECTED WORKS BY GIOVANNI BOTERO.

Botero, Giovanni. 1583. *De Regia Sapienza.* Milano: Pacifico Ponti.

———. 1591–1596. *Delle Relazioni Universali.* Rome: Giorgio Ferrari.

———. 1956 (1588). *The Greatness of Cities,* trans. Robert Peterson. New Haven: Yale University Press; originally published as *Delle Cause della Grandezza e Magnificenza delle Città.* Rome: Giovanni Martinelli.

———. 1956 (1589–1596). *The Reason of State,* 10 vols., trans. P. J. and D. P. Waley; originally published as *Della Ragion di Stato,* Venice: I

Gioliti; Ferrara: Vittorio Baldini Stampator Ducale; 1596. Torino: Gio. Dominico Tarino.

Italo Scardovi

BRASS, WILLIAM

(1921–1999)

The Scottish demographer and statistician William Brass is best known for his imaginative, elegant, and innovative contributions to methods for demographic estimation. Although always insistent on methodological rigor, Brass was, as he used to say, "a practical man" for whom the ultimate justification of a method was that it helped answer an important question and solve a problem.

After graduating from Edinburgh University in 1947 with a degree in mathematics and natural philosophy, Brass joined the East African Statistical Department as a statistician. While working there he developed a lifelong interest in sub-Saharan Africa and the problems of demographic estimation based on deficient or defective data. In 1955 he joined Aberdeen University to work on the application of mathematical models to medical statistics but maintained his interest in demographic estimation.

A year's leave of absence at Princeton University's Office of Population Research in 1961–1962 to work on the demography of tropical Africa proved to be a turning point in his career. During that period Brass developed several of his signature demographic estimation methods, notably methods for estimating child mortality from women's reports of their children ever born and their children who had died, for evaluating reported fertility rates by comparison with measures of lifetime fertility, and for the use of the logit transformation to fit life tables to fragmentary data. Those methods were applied systematically to the survey data from Africa then available.

In 1965 Brass moved to the London School of Hygiene and Tropical Medicine, first as a reader and then as a professor of the new field of medical demography. He continued to develop new methods as data availability and quality improved, including methods for estimating adult mortality from data on the survival of parents, the evaluation of data on deaths by age through comparisons with age distributions of the living, the relational Gompertz fertility model, methods to evaluate birth history data, and ways to use truncated data on parity progression for women of reproductive age to study fertility change. He applied those methods, among others, in an authoritative analysis of fertility trends in Kenya that was published as part of a series of reports on the population dynamics of sub-Saharan Africa produced by the U.S. National Academy of Sciences.

Many of the methods originally developed by Brass have been developed further by others. A full bibliography of Brass's writings is included in the commemorative volume *Brass Tacks* (2001).

See also: *Demography, History of; Estimation Methods, Demographic.*

BIBLIOGRAPHY

SELECTED WORKS BY WILLIAM BRASS.

Brass, William. 1975. *Methods for Estimating Fertility and Mortality from Limited and Defective Data.* Chapel Hill: University of North Carolina Press.

———. 1981. "The Use of the Gompertz Relational Model to Estimate Fertility." *International Population Conference, Manila,* 3: 345–362.

Brass, William, John Blacker, and Basia Zaba, eds. 2001. *Brass Tacks: Essays in Medical Demography: A Tribute to the Memory of Professor William Brass.* London: Athlone Press.

Brass, William, and Ansley J. Coale. 1968. "Methods of Analysis and Estimation." In *The Demography of Tropical Africa,* W. Brass, A. J. Coale, P. Demeny, D. F. Heisel, F. Lorimer, A. Romaniuk, and E. van de Walle. Princeton NJ: Princeton University Press.

Brass, William, and Kenneth Hill. 1973. "Estimating Mortality from Orphanhood." *International Population Conference, Liège,* 3: 111–123.

Brass, William, and Carole Jolly, eds. 1993. *The Population Dynamics of Kenya.* Washington, D.C.: National Academy Press.

Brass, William, and Fatima Juarez. 1983. "Censored Cohort Parity Progression Ratios from Birth Histories." *Asian and Pacific Census Forum* 10: 5–13.

Brass, William, and Hoda Rashad. 1992. "Evaluation of the Reliability of Data in Maternity Histories." In *The Analysis of Maternity Histories,* ed. Allan Hill and William Brass. Liège, Belgium: Ordina Editions.

KENNETH H. HILL

BUSINESS DEMOGRAPHY

Business demography entails the application of demographic concepts, data, and techniques to the practical concerns of business decision makers. This loosely organized field includes but is not limited to site selection, sales forecasting, financial planning, market assessment, consumer profiles, target marketing, litigation support, and labor force analysis. Specific applications have evolved over time, reflecting changes in data sources, computer technology, statistical techniques, and the business environment. This entry surveys the major features of this eclectic and rapidly changing field, focusing on the United States.

Evolution of the Field

Businesses have based decisions on demographic data and techniques since the late nineteenth century. The emergence of business demography as a distinct field, however, is quite recent. The release of 1970 census data in machine-readable form gave rise to an electronic data industry that grew from a handful of companies to at least 70 competitors by the mid-1980s. Although the number of data vendors has declined since that time, many new firms focusing on marketing, survey research, trend analysis, mapping, and software development have been established. As the field matured, it became routine for businesses to base decisions on the advice of consultants and employees skilled in collecting, analyzing, and interpreting demographic data.

Responding to these developments, the Population Association of America formed a Committee on Business Demography in 1982, which, together with the Committee on State and Local Demography, launched the publication of the newsletter *Applied Demography* in 1985. During that formative period two commercially oriented magazines (*American Demographics* and *Business Geographics*) were launched, reporting on demographic trends, data availability, technological advances, and business applications. Business demography thus coalesced into a visible and well-established area of endeavor, although the field remains loosely defined and organized.

The Practitioners

Business demographers fall into three distinct groups. The first group consists of analysts employed by private companies whose work pertains specifically to those companies and their business activities (e.g., market analyses, customer profiles, site selection). The second group consists of analysts with firms that create demographic databases (e.g., population estimates, consumer spending, lifestyle clusters), develop proprietary software applications, and perform customized research (e.g., estimates and projections of the population residing within five miles of a supermarket). These firms serve both government agencies and business enterprises. The third group consists of individual consultants who undertake specific projects for individual clients. For some of these practitioners, consulting is a full-time activity; for most, it is a part-time pursuit outside their regular work activities.

Not all practitioners have formal training in demography. Indeed, the diversity in training, educational background, and current occupation reflects the eclectic nature of business demography as a field. Many practitioners have backgrounds in economics, geography, marketing, statistics, survey research, real estate, or other disciplines. Even those with formal demographic training have acquired many job skills principally through work experience rather than academic training. Few academic programs extend their demographic focus to the field of business, and few business schools offer training in demographic applications.

The Tools

The tools of business demography parallel those that demographers use generally: data from a variety of sources, computer hardware and software, and basic demographic concepts, measures, and techniques. Those tools are set apart by the purposes for which they are used. Business demography is intended to clarify and inform business decisions rather than to advance knowledge. The tools of demography are described elsewhere in this encyclopedia; here the focus is on their business applications.

Data sources include publicly available censuses, surveys, and administrative records (e.g., building permits, registered voters, Medicare enrollees); proprietary surveys (e.g., of new or repeat purchasers); and firm-specific records (e.g., customer files, business transactions). The availability and reliability of such data vary considerably across levels of geography and among countries. Typically, the smaller the area is, the more difficult it is to obtain useful data. Because business decisions often pertain to local markets, there is a premium on assembling reliable data for small areas.

Exponential increases in computing power and data storage capacity have greatly expanded the possibilities for organizing, integrating, and analyzing data. Computer networks enable analysts to share information and transfer data globally over the Internet. Powerful software packages have largely automated statistical analysis and reporting functions. Advances in geocoding and the displaying of spatial information through geographic information systems (GIS) have been especially influential, as many analyses call for data that are grouped into customer service areas, market analysis zones, and other uniquely defined geographic areas. The ability to use these computing tools effectively is crucial for many business demographers.

The concepts and measures of business demography focus primarily on dimensions relevant to commerce and enterprise: population composition (e.g., age, sex, race, income), consumer units (e.g., individuals, families, households), demographic events (e.g., births, deaths, marriage, migration), and the distribution of demographic characteristics and events across geographic areas (e.g., counties, census tracts, postal code areas). Business demographers have extended these measures by using consumer data. For example, geodemographic segmentation systems classify neighborhoods with similar demographic characteristics and consumer preferences into lifestyle clusters. Owing to business demography's emphasis on decision making, techniques that update recent census data and project future values play a particularly important role.

Demographers introduce fresh perspectives to the business world because they can envision business problems differently than business people ordinarily do (for example, distinguishing among age, period, and cohort effects that reshape a market). They inform and advise, broaden perspectives, and serve as catalysts for organizational change. By exposing business people to new perspectives, demographers can elevate management thinking from an operational to a strategic level.

Examples

The business concerns that demographers address are many and varied. Accurate sales forecasts depend on foreseeing changes in population size and composition. Human resource planning requires data on the characteristics of the labor force and the personnel needs of the business enterprise. Site analyses require information on local populations within reach of a particular geographic location. Financial planning requires information on how demographic changes affect cash flows and return on investment. Many projects require population estimates and projections, often with detailed characteristics (e.g., age or income). The following illustrations suggest the range of business applications.

Marketing and retailing. Demographic information and analysis have become essential to identifying, locating, and understanding the diverse consumer groups that form markets for goods and services. For example, newspaper publishers and editors recognize that they must adapt to the powerful demographic and societal changes that are transforming reading habits and readers' interests. Many readers live alone, are divorced or remarried, or are cohabiting. Among married couples, fewer have children at home but more anticipate future eldercare obligations. Accompanying these diverse lifestyles are new interests and obligations. Demographers can identify the changing demographics of newspaper readers, helping publishers cater to collections of small audiences with certain shared interests who constitute an increasingly segmented readership. Demographers also can devise and calibrate specialized tools for segmenting customers.

Human resource planning. The demographics of a corporate work force have important long-term implications for benefits, productivity, and profitability. General Motors, for example, spends more than $3 billion annually on health care for its current and former employees and their dependents. Since health-care expenditures vary greatly by age, information on likely future changes in the age structure is critical. Hallie Kintner and David Swanson (1997) analyzed the expected longevity of General Motors employees, developed a series of projections by age and sex, and made recommendations to the company's senior management that helped the company control health-care costs.

Site selection and evaluation. Geographic proximity to consumer markets is important because most retail transactions are made at specific locations. Productive retail sites generally are situated in the middle of dense consumer populations or are readily accessible to the potential users of a firm's goods and services. Local availability of an appropriately skilled labor force also is critical for many businesses. Evaluating a proposed site or weighing the comparative merits of several competing sites is another way demographers support business decision making.

Tracking emerging markets. As markets have globalized, businesses have increasingly focused on international markets, including the emergence of consumers within the massive populations of developing countries such as India and China. A defining characteristic of emerging economies is rapid economic growth, along with the ripening market potential that accompanies such growth. Anticipating future growth of consumer markets poses distinctive problems that are amenable to demographic analysis. With only a minimum of data, demographic accounting models can capture the upward economic mobility of newly prosperous consumers.

Conclusions

Business demography is a problem-driven field with an emphasis on using rather than advancing knowledge. Its practitioners address problems and inform decision making within a specific business context. Its tools and perspectives are drawn from demography generally but are applied to the practical needs of the business community. It is an eclectic and continually evolving field that is responsive to the opportunities that expanding data sources, statistical techniques, demographic methods, and information technology offer. Although its focus has been primarily on small areas, new applications and trends toward globalization are pushing it increasingly into broader areas with national and international implications. Future opportunities in business demography promise to be diverse.

See also: *Small-Area Analysis; State and Local Government Demography.*

BIBLIOGRAPHY

Kintner, Hallie J., and David A. Swanson. 1997. "Estimating Vital Rates from Corporate Databases: How Long Will GM's Salaried Retirees Live?" In *Demographics: A Casebook for Business and Government,* ed. Hallie J. Kintner, Thomas W. Merrick, Peter A. Morrison, and Paul R. Voss. Santa Monica, CA: RAND.

Lauderdale, Diane S., and Bert Kestenbaum. 2000. "Asian American Ethnic Identification by Surname." *Population Research and Policy Review* 19: 283–300.

Mitchell, Susan. 1995. "Birds of a Feather." *American Demographics* 17(2): 40–48.

Morrison, Peter A., and Allan F. Abrahamse. 1996. "Applying Demographic Analysis to Store Site Selection." *Population Research and Policy Review* 15: 479–489.

Morrison, Peter A., Morlie H. Levin, and Paul M. Seever. 1996. "Tracking Growth of Emerging Consumer Markets Worldwide: Where Demographic Analysis Fits In." Paper presented at the Sixth International Conference on Applied and Business Demography, Bowling Green, OH.

Pol, Louis G., and Richard K. Thomas. 1997. *Demography for Business Decision Making.* Westport, CT: Quorum Books.

Russell, Cheryl. 1984. "The Business of Demographics." *Population Bulletin* 39(3). Washington, D.C.: Population Reference Bureau.

Siegel, Jacob S. 2002. *Applied Demography: Applications to Business, Government, Law and Public Policy.* San Diego, CA: Academic Press.

Voss, Paul R. 1997. "Targeting Wealthy Ex-Wisconsinites in Florida: A Case Study in Applied Demography." In *Demographics: A Casebook for Business and Government,* ed. Hallie J. Kintner, Thomas W. Merrick, Peter A. Morrison, and Paul R. Voss. Santa Monica, CA: RAND.

Weiss, Michael J. 1988. *The Clustering of America.* New York: Harper & Row.

Stanley K. Smith
Peter A. Morrison

C

CALDWELL, JOHN C.

(1928–)

John C. Caldwell began an academic career later than most professional demographers, having spent nearly a decade as a secondary school teacher before starting his Ph.D. studies at the Australian National University (ANU). Since his first academic appointment (at the University of Ghana) in 1962, his research output—much of it in collaboration with his wife, Pat Caldwell—has been prolific, amply compensating for the late start. His early years as a demographer were spent at the Population Council, where he worked in various regions of Africa. Since 1970, his base has been at the ANU, where he is a professor of demography, heading the Department of Demography until 1988 and then serving as associate director of ANU's National Centre for Epidemiology and Population Health. He has engaged in extended periods of fieldwork in Africa and South Asia and has organized numerous multi-country research projects. He has served as the president of the International Union for the Scientific Study of Population (1994–1997).

Caldwell's most notable contributions to population studies have been in the fields of fertility transition and health transition. His works are cited almost *de rigeur* by those in these fields. His wealth flows theory, first set out in a 1976 article, traced the onset of fertility transition to changes in the direction of intergenerational transfers within the family. Although criticized for its lack of testability, it captured the imagination of many researchers—from the fields of anthropology and economics as well as demography—and stimulated greater attention to field-based micro-demographic research. The theory illustrates Caldwell's willingness to theorize provocatively based on less than complete evidence, and thereby inspiring numerous research studies by others intent on testing his propositions.

Caldwell has done much to revive interest in population theory and give it a greater role in promoting research. He has also made original contributions in many areas of demographic theory. These include the focus on family relationships and family economics for explaining demographic change; the identification of education as a major factor in the survival of individuals and their children; and the significance of the position of women in determining demographic change. Since the late 1980s, he has made a major contribution to the study of the AIDS epidemic in developing countries, notably in Africa, in its social and behavioral context, and to health transition research more generally, through his editorship of the journal *Health Transition Review.*

In addition to his contributions to theory, Caldwell has also had an important impact on the methodology of population studies. The emphasis he has placed on anthropological-type field research in demography has been adopted by many other demographers, and has fostered a more symbiotic relationship between anthropologists and demographers in studying matters related to demographic change.

See also: *Anthropological Demography; Demography, History of; Health Transition; Intergenerational Transfers; Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY JOHN C. CALDWELL.

Caldwell, John C. 1982. *Theory of Fertility Decline.* London: Academic Press.

———. 1986. "Routes to Low Mortality in Poor Countries." *Population and Development Review* 12(2): 171–220.

———. 2001. "The Globalization of Fertility Behavior." In *Global Fertility Transition,* Supplement to *Population and Development Review* 27: 93–115.

Caldwell, John C., and Pat Caldwell. 1986. *Limiting Population Growth, and the Ford Foundation Contribution.* London: Frances Pinter.

———. 1996. "The African AIDS epidemic." *Scientific American* 174(3): 40–46.

Caldwell, John C., P. H. Reddy, and Pat Caldwell. 1988. *The Causes of Demographic Change: Experimental Research in South India.* Madison: University of Wisconsin Press.

SELECTED WORKS ABOUT JOHN C. CALDWELL.

Schultz, T. Paul. 1983. "John C. Caldwell, Theory of Fertility Decline." *Population and Development Review* 9(1): 161–168.

Willis, Robert J. 1982. "The Direction of Intergenerational Transfers and Demographic Transition: The Caldwell Hypothesis Re-examined." *Population and Development Review* 8(Supp.) (82): 207–234.

Gavin W. Jones

CANCER

Cancer is the common name for a group of 100 or more chronic, progressive diseases, all characterized by abnormal and continuous multiplication of cells in a particular tissue or organ without reference to the needs of the body. This commonly gives rise to a solid mass or tumor composed of such cells (e.g., in the lung, breast, or brain), but it can also affect almost any tissue or organ, including the blood-forming cells of the bone marrow (leukemias), the immune defense system (lymphomas), and the soft tissues, such as muscles, cartilage, or blood vessels (sarcomas). Invasion of the organ or tissue of origin by a malignant tumor—called a neoplasm, or new growth—can itself be fatal, but cancer mortality arises mainly from the tendency of most cancers to metastasize elsewhere in the body and to disable or destroy vital organs such as the brain, lung, liver, or bone marrow.

Cancer afflicts all animals as well as humans. The ultimate cause of all cancers is failed control of the growth, reproduction, or senescence (aging) of cells. This is due in turn to inherited and/or acquired damage to cellular DNA, giving rise to a malignant clone comprising all the descendant cells of the original cancerous cell. Inherited susceptibility can greatly increase the risk of developing cancer, but it appears to account for only a small proportion of all cancers, and congenital malignancy is extremely rare. Cumulative genetic damage acquired over the course of life accounts for the occurrence of most cancers. Knowledge in this domain is likely to increase rapidly with further progress in cancer genetics following the completion of the Human Genome Project.

Among the known environmental causes of cancer, use of tobacco (smoking, chewing, sucking, or inhaling) is the most important and most widely recognized. Tobacco use probably accounted for up to a third of all cancers in 2000, and a higher proportion of all cancer deaths, since it is a cause of some of the most fatal cancers—lung, larynx, pharynx, esophagus, and pancreas. Other causes include:

- Exposure to certain chemicals and other substances. For example, benzene exposure is a cause of leukemias, and exposure to asbestos produces mesothelioma of the lung lining and abdomen.
- Ionizing radiation. X-rays and γ-radiation cause solid tumors as well as leukemias.
- Solar or artificial ultraviolet radiation. Exposure produces skin cancers including melanoma.
- Obesity. Obesity increases the risk of breast and colon cancers.
- Infection by certain bacteria. For example, *Helicobacter pylori* is a cause of stomach cancer.

- Infection by certain viruses. Certain human papilloma viruses (HPV) cause cervical cancer; some hepatitis viruses cause liver cancer; human immunodeficiency virus (HIV) causes Kaposi sarcoma and other cancers.
- Infection by certain parasites. For example, some liver flukes can cause biliary tract cancers, and schistosomes are a cause of bladder cancer.

Many cancers can be prevented by avoidance of exposure to the underlying cause or risk factor. Thus, 90 percent of lung cancers that are directly attributable to tobacco use would not occur in the absence of exposure; almost all mesotheliomas would be avoided if asbestos exposure were eliminated. Vaccination against hepatitis B can prevent associated liver cancers, and vaccination against HPV will almost certainly prevent cervical cancers. Mass population screening, in which selected groups of the entire population are systematically invited for regular diagnostic tests, has been shown to reduce mortality from some cancers by detecting tumors at an early stage before they are clinically detectable or give rise to symptoms, and when treatment is more effective for most cancers. The cancers most widely screened for are breast cancer in women aged 50 to 69 (using mammography), and cervical cancer in women of reproductive age and up to age 60 (using a cervical smear or direct visualization). Screening for bowel cancer by detection of occult blood in the stool is also likely to reduce mortality. Mortality from cancers that do occur would be greatly reduced if all patients were diagnosed earlier, investigated thoroughly, and treated appropriately.

Around the turn of the twenty-first century, the International Agency for Research on Cancer (part of the World Health Organization) estimated that about 10 million people worldwide developed cancer every year, and that 6.9 million cancer deaths occurred in 2000, or 12.4 percent of the global death toll. Estimates of global mortality from the most common cancers are shown in Table 1. The economic cost of cancer is huge: over $100 billion dollars a year in medical expenditure and lost productivity in the U.S. alone in 2000. The human cost is incalculable.

The total number of cancers arising in a population depends on the size of the population, its age and sex structure, and the age- and sex-specific risks of developing cancer. All three components differ between countries and populations, and over time. Population growth and aging both lead to an increase in the annual number of new cancers. About half of all cancers in 2000 arose in developed countries, with just a quarter of the world's population, but the proportion of cancers arising in developing countries is set to rise substantially as the relatively young populations in those countries increase and become older. About half of all cancers occur over the age of 65 years. Primary prevention to reduce the risk of developing cancer at any given age is, and will remain, the most effective long-term strategy for cancer control.

TABLE 1

Estimates of Worldwide Cancer Mortality (Thousands of Deaths per Year), by Sex, 2000: Selected Cancers and All Cancers Combined

Cancer	Males	Females	Total	Percent of total
Trachea/bronchus/ lung	895	318	1213	17.5
Stomach	464	280	744	10.7
Liver	433	193	626	9.0
Colon/Rectum	303	276	579	8.4
Breast	0	458	459	6.6
Esophagus	274	139	413	6.0
Mouth and oropharynx	242	98	340	4.9
Lymphomas, multiple myeloma	173	118	291	4.2
Cervix uteri	—	288	288	4.2
Leukemia	145	119	265	3.8
Prostate	258	—	258	3.7
All cancers	3918	3011	6930	100.0

SOURCE: World Health Organization (2001). *World Health Report*, Statistical Annex Table 2 (pp. 144–9).

See also: *Diseases, Chronic and Degenerative; Tobacco-Related Mortality.*

BIBLIOGRAPHY

Coleman, Michel, Jacques Estève, Philippe Damiecki, Annie Arslan, and Hélène Renard. 1993. *Trends in Cancer Incidence and Mortality* (IARC Scientific Publications No. 121). Lyon: International Agency for Research on Cancer.

Miller, Anthony, Jocelyn Chamberlain, Nick Day, Matti Hakama, and Philip Prorok. 1990. "Report on a Workshop of the UICC Project on Evaluation of Screening for Cancer." *International Journal of Cancer* 46: 761–69.

Peckham, Michael, Herbert Pinedo, and Umberto Veronesi, eds. 1995. *Oxford Textbook of Oncology*. Oxford, Eng.: Oxford Medical Publications.

Peto, Julian. 2001. "Cancer Epidemiology in the Last Century and the Next Decade." *Nature* 411: 390–395.

Tomatis, Lorenzo, A. Aitio, Nick Day, Elisabeth Heseltine, John Kaldor, Anthony Miller, et al., eds. 1990. *Cancer: Causes, Occurrence and Control* (IARC Scientific Publications No. 100). Lyon: International Agency for Research on Cancer.

World Health Organization. 2001. *The World Health Report 2001*. Geneva: World Health Organization.

MICHEL P. COLEMAN

CANNAN, EDWIN

(1861–1935)

Edwin Cannan was an English economist whose many publications included some material on population, almost all of which is still considered important. Cannan spent his entire working life at the London School of Economics, joining the teaching staff of that school at its foundation in 1895, becoming a professor of political economy in 1907, and retiring in 1926.

Cannan is credited with developing the notion of an optimum population. He rejected the Malthusian argument that there is an inherent tendency toward overpopulation. In his first book, *Elementary Political Economy* (1888), Cannan wrote: "[P]roductiveness of industry is sometimes promoted by an increase of population, and sometimes by a decrease" (p. 22). He believed that in a specific area of land a definable amount of labor is required for the maximum productiveness that is possible. He subsequently elaborated those ideas, especially in *Wealth* (1914, 3rd ed. 1928), and used the expression *optimum population.* The optimum may rise or fall with changes in knowledge or capital, but in practical and moral terms any resulting policy (which in principle should recognize the interests of future generations) can only specify a direction of movement at any particular time.

The *Economic Journal* for December 1895 included Cannan's "The Probability of a Cessation of the Growth of Population in England and Wales during the Next Century." That article presented the first cohort-component population projection, in which each age group is dealt with separately, and births, deaths, and migration are taken into account separately. His projection assumed the same number of births each ten years as had occurred in the period 1881–1890 (and thus a declining rate of childbearing) and the same proportionate losses at each age as a result of mortality and emigration combined as was observed between the 1881 and 1891 censuses.

Cannan correctly predicted, against contemporary opinion, the continuation of the decline in the birthrate in Britain that had begun recently. This was a remarkable achievement. As John Hajnal commented in a paper presented at the 1954 World Population Conference, Cannan "could publish 36 years later, in 1931, a paper which said in effect 'I told you so'" (p. 46). Even though, as Hajnal noted, "the accuracy of his forecast was not outstanding. . .[and] by 1911, i.e., only 15 years after the forecast was made, the population enumerated at the census exceeded the prediction by 7 per cent and by 1916 the population had increased beyond his estimate of the maximum it would ever reach. . . . Cannan's forecast, though inaccurate, predicted an unexpected development by acute analysis"(pp. 46–47, 48).

Cannan later became aware that the birthrate had declined in other Western countries and in *Economic Scares* (1933), perhaps 40 or 50 years before this became empirically incontrovertible, declared that "the cause of it—birth control—will doubtless in time affect the rest of the world" (p. 92). He foresaw also, though, that for many years non-Western countries would experience considerable and even enhanced population growth "owing to decrease of huge infant mortality."

See also: *Demography, History of; Optimum Population; Projections and Forecasts, Population.*

BIBLIOGRAPHY

SELECTED WORKS BY EDWIN CANNAN.

Cannan, Edwin. 1888. *Elementary Political Economy.* London: H. Frowde.

———. 1895. "The Probability of a Cessation of the Growth of Population in England and Wales during the Next Century." *Economic Journal* 5: 505–515.

———. 1914. *Wealth.* London: P. S. King.

———. 1933. *Economic Scares.* London: P. S. King.

———. 1997. *Collected Works,* 8 vols., ed. Alan Ebenstein. London: Routledge/Thoemmes Press.

SELECTED WORKS ABOUT EDWARD CANNAN.

De Gans, Henk A. 1999. *Population Forecasting 1895–1945.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

Hajnal, John. 1955. "The Prospect for Population Forecasts." *Proceedings of the World Population Conference* 3: 43–53.

Robbins, Lionel. 1927. "The Optimum Theory of Population." In *London Essays in Economics: In Honour of Edwin Cannan,* ed. Theodor E. Gregory and Hugh Dalton. London: Routledge.

C. M. Langford

CANTILLON, RICHARD

(1697–1734)

Born in Ireland, Richard Cantillon made a fortune as a banker through clever speculation in England and on the continent, before being murdered by a disgruntled servant. His only surviving work, entitled *Essay on the Nature of Commerce in General,* may have been written either in English or in French, but only the French version, published in 1755, has survived. The work has been called the first systematic treatise on economics.

Cantillon's view that all value originates in the land influenced the Physiocrats, and his theory of money is deemed especially important. His views of population involve an early discussion of what would later be called the Western European pattern of marriage. Society is divided into three classes: the proprietors who draw their wealth from ownership of the land; the entrepreneurs (Cantillon originated the term's use in economics) who include farmers, traders, craftsmen, and others who live from the uncertain profit of their activities; and hired laborers.

The tastes, fashions, and modes of living of the proprietors determine the use of the land, and hence the number of people in the state; the private property system is the ultimate regulator of population size. If the proprietors choose to use the land or the rent they receive from it for purposes other than the "Maintenance of Man" (such as for the purchase of luxury goods), numbers will diminish. "Men multiply like Mice in a barn if they have unlimited Means of Subsistence," he wrote (Cantillon, 2001, p. 37). Cantillon contended that the size of population is not limited by mortality (as Adam Smith believed), but by marriage, since men of the lower classes fear the prospect of insufficient means to support a family, and men of higher means do not want to lose status. "Most men desire nothing better than to marry if they are set in a position to keep their Families in the same style as they are content to live themselves" (2001, p. 35). That style, in Europe, implied a relatively high level of living.

Cantillon presents China as an alternative demographic model without private property and with universal and early marriage. This results in a large population living at a low material standard, recurrent famines despite a highly productive agriculture, and the practice of infanticide as a check on numbers. In the late eighteenth century political economist T. R. Malthus would echo these ideas, although there is no evidence that he had read Cantillon's *Essay.*

See also: *Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY RICHARD CANTILLON.

Cantillon, Richard. 1952 (1755). *Essai sur la nature du commerce en général,* texte de l'édition originale de 1755, avec des études et commentaires par Alfred Sauvy [et al.]. Paris: Institut national d'études démographiques.

———. 2001. *Essay on the Nature of Commerce in General.* Contains background materials, including the 1881 essay by the economist W. Stanley Jevons. New Brunswick, NJ: Transaction Publishers.

SELECTED WORKS ABOUT RICHARD CANTILLON.

Spengler, Joseph J. 1954. "Richard Cantillon: First of the Moderns." *Journal of Political Economy* 62: 281–295, 406–424.

ETIENNE VAN DE WALLE

CARDIOVASCULAR DISEASE

In industrialized countries cardiovascular disease is the leading cause of death. In the United States in 1998, the death rate from heart disease per 100,000 population was 268.2; such deaths numbered 725,000, comprising 31 percent of all deaths. The great majority of coronary heart disease (CHD) occurs among older individuals. In the United States, in 1998, the proportion of CHD deaths occurring to persons 65 years and older was 84 percent—90 percent among women and 77 percent among men. Table 1 shows the steep increase of CHD death rates by age in the United States. Yet coronary heart disease and other cardiovascular diseases such as stroke and peripheral vascular disease are not diseases of aging. There are many populations of older individuals in which the incidence of heart attacks is very low.

TABLE 1

Death Rates per 100,000 Population from Heart Disease by Age and Sex, United States, 1998

Age	Males	Females
35–44	42	16
45–54	149	52
55–64	405	173
65–74	996	524
75–84	2,382	1,587
85 and older	6,354	5,898

SOURCE: U. S. Bureau of the Census (2001).

Atherosclerosis is the basic pathology that causes heart attacks. The atherosclerotic disease begins early in life and progresses over time. This evolving atherosclerotic disease represents the "silent" or incubation period to the clinical disease, heart attack. The onset of the heart attack can occur rapidly and in about 20 percent of the cases is associated with sudden death. The amount of specific saturated fatty acids, cholesterol, and polyunsaturated fatty acids in the diet, as well as specific genetic susceptibility factors, determine the blood levels of low-density lipoprotein (LDL) cholesterol and the number of LDL particles in the blood that together predict, to a considerable degree, the extent of atherosclerosis.

Consequences of Urbanization and Industrialization

With urbanization and industrialization, and with increasing longevity, populations usually experience a transition from a high prevalence of infectious diseases and nutritional deficiencies to higher caloric intake; decreased physical activity, especially related to work; and higher intakes of both saturated fat and cholesterol in the diet. The rise in the incidence of coronary heart attacks in such populations may not occur until many years after the changes in diet and lifestyle and the rise in LDL cholesterol. The evidence of a rising epidemic of CHD will most likely first be noted among young and middle-aged individuals, signaled by a rise in the LDL cholesterol level. Unfortunately, by the time this occurs, there is extensive atherosclerosis in the population and a likelihood of subsequent higher rates of heart attack.

In developing countries, the rising incidence of CHD initially affects the better educated. There is a major increase in the use of health resources for treating cardiovascular disease in these populations, with a potential drain on resources and technology in other areas of the health system.

These same populations also typically experience an increase in caloric intake and a decrease in work-related energy expenditure. There is an increase in high-fat, calorically dense foods, often resulting in obesity, as well as an increase in processed foods whose salt (sodium chloride) content is undesirably high. These factors lead to elevated blood pressure and hypertension. This pattern is now occurring in Africa, especially in west Africa, as well as in populations of African origin in Caribbean countries.

Obesity, Diabetes, and Other Risk Factors

In many industrialized countries such as the United States, Britain, and Canada, there has been a substantial increase in obesity and diabetes. The risk of diabetes is associated with weight gain and obesity, as well as with specific genetic conditions, i.e., host susceptibility. Populations of southeastern Asian origin, including American Indians and aboriginal populations in Canada, have especially high rates of diabetes—along with the complications of diabetes. The latter include CHD and small-vessel complications of diabetes such as blindness, neurological changes, and kidney failure, and such complications can necessitate amputations. The substantial increases in body weight are due to both an increase in the total caloric intake and a decrease in work-related physical activity without a sufficient compensating increase in leisure-time physical activity.

There are other important lifestyle factors that increase the risk of heart attack among individuals with severe underlying atherosclerosis. These factors act by causing a thrombus or clot in a blood vessel or by changing the characteristics of the atherosclerotic disease.

The increase in cigarette smoking in many countries, in addition to causing major epidemics of smoking-related cancers, leads to increased risk of CHD in populations where dietary changes have increased the prevalence of atherosclerotic disease. Interestingly, in populations where diet has not changed and LDL cholesterol levels have not risen, a high prevalence of cigarette smoking is not associated with a substantial increase of CHD, although it does increase the risk of cancer. This pattern has been found in China and Japan. Unfortunately, in many developing-country populations, the increasing prevalence of cigarette smoking parallels the rise in LDL cholesterol and obesity, creating the potential for severe epidemics of CHD. At the same time, the decline in CHD mortality in many industrialized countries since the 1970s was partly attributable to decreases in cigarette smoking and blood LDL cholesterol levels, along with improved treatment of hypertension.

In all industrialized societies, the number and percent of the population over the age of 65 is increasing. In these older populations, treatment of cardiovascular disease is the leading determinant of health-care costs.

In summary, the extent of cardiovascular disease in a population can be gauged very easily by measurement of a few risk factors, mainly the levels of LDL cholesterol, blood pressure, obesity, cigarette smoking, extent of diabetes, and the age distribution of the population. Cardiovascular diseases are preventable. In the prevention effort the focus, however, needs to be on the prevention of the evolving silent disease, atherosclerosis. Treatment of individuals who have developed clinical CHD and stroke requires a huge commitment of technical and medical resources.

See also: *Disease, Burden of; Diseases, Chronic and Degenerative; Mortality Decline; Tobacco-Related Mortality.*

BIBLIOGRAPHY

Pearson, T. A., D. T. Jamison, and H. Trejo-Gutierrez. 1993. "Cardiovascular Disease." In *Disease Control Priorities in Developing Countries,* ed. D. T. Jamison. New York: Oxford University Press.

Yusuf, Salim, Srinath Reddy, Stephanie Ounpuu, and Sonia Anand. 2001. "Global Burden of Cardiovascular Diseases. Part I: General Considerations, the Epidemiologic Transition, Risk Factors, and Impact of Urbanization." *Circulation* 104: 2,746–2,753.

———. 2001. "Global Burden of Cardiovascular Diseases. Part II: Variations in Cardiovascular Disease by Specific Ethnic Groups and Geographic Regions and Prevention Strategies." *Circulation* 104: 2,855–2,864.

Lewis H. Kuller

CARRYING CAPACITY

Carrying capacity is the maximum population size that a species can maintain indefinitely in a given area—that is, without diminishing the capacity of the area to sustain the same population size in the future. Carrying capacity is thus a function of both the resource requirements of the organism and the size and resource richness of the area. The carrying capacity of an area with constant size and richness would be expected to change only as fast as organisms evolve different resource requirements.

Measuring Carrying Capacity

The concept is simple, but it is notoriously difficult to measure. The identity and dynamics of resources critical to a species, and the complex of other factors that regulate its population size, are typically poorly known. Moreover, as usage of the term has spread beyond its original context—to do with sustainable stocking levels of domestic livestock on rangeland—into disciplines such as ecology, carrying capacity has taken on subtle but substantive differences in meaning. For instance, in theoretical population ecology, carrying capacity is defined by the parameter K (the equilibrium density of a species) within the logistic equation of population growth. These variations in meaning make it difficult to apply the term consistently across disciplines. Despite these limitations, most authors consider at least the broad concept (as defined above) to be an important heuristic tool.

Carrying Capacity and Human Beings

Applied to human beings, the carrying capacity concept is further complicated by the unique role that culture, broadly interpreted, plays in our species. Three culturally linked factors stand out as critical: individual differences in types and quantities of resources consumed; rapid evolution in patterns of resource consumption; and technological and other cultural change. To take the case of energy consumption, which can be considered a proxy for overall resource use, in 1990 an average person in a developed nation used about 7.1 kilowatts of energy per year, while the average person in the developing world used just 0.9 kilowatts per year. (These averages of course mask large variation at the individual level.) Moreover, economic, social, and technological development bring vast changes in patterns of energy consumption: Global energy consumption has increased more than 20 fold since 1850, and there have been dramatic changes in the composition of energy sources and technologies.

Carrying capacity for human beings is thus highly variable across space and time, depending on levels and styles of living and their supporting technologies and social systems. Ten thousand years ago, at the dawn of agriculture, the world's human population was somewhere between 2 and 20 million, perhaps an indication of global carrying capacity under those conditions. The cultural (including technological) advances associated with the development of agriculture allowed human populations to expand far beyond the levels possible under the resource demands of a hunter-gatherer lifestyle. A few populations have retained that preagrarian pattern of resource use.

Biophysical and Social Carrying Capacity

Biologists distinguish between *biophysical* carrying capacity—the maximum population size that could be sustained biophysically under given technological capabilities—and *social* carrying capacity—the maximum that could be sustained under a specified social system and its associated pattern of resource consumption.

At any level of technological development, social carrying capacities are necessarily lower than biophysical carrying capacity, because the latter implies a factory-farm lifestyle that would be both universally undesirable and also unobtainable because of inefficiencies inherent in social systems. For example, what is considered to be food by a society is largely culturally determined. A population that eats large quantities of grain-fed meat requires four to five times more grain than a population sustained by a solely vegetarian diet. A vegetarian diet is more efficient from a caloric point of view than a meat-oriented one, but is not widely acceptable in many societies. Further inefficiencies, from a biophysical standpoint, result from unequal resource distribution—at local, national, and international scales. The higher the level of inequality, the smaller the population that can be sustained. Many other aspects of culture play significant roles in determining carrying capacity, ranging from patterns of investment in education and social development to frequency and severity of warfare.

Sustainability

A sustainable condition, process, or activity is one that can be maintained without interruption, weakening, or loss of valued qualities. Sustainability is thus a necessary and sufficient condition for a population to be at or below carrying capacity. The wide appeal of sustainability as a societal condition or goal reflects the moral conviction that the current generation should pass on its inheritance of natural wealth—not unchanged but undiminished in potential—to support future generations.

Are the collective activities of today's human population sustainable? The answer is clearly no. Many essential activities, notably food and energy production, are maintained only through the exhaustion and dispersion of a one-time inheritance of natural capital. Maintenance of the world's present human population, and accommodation of its anticipated growth, requires safeguarding the critical resources and services that are provided by this natural capital. A partial list of these includes: generation and renewal of fertile agricultural soil; provision of fresh water, energy, construction materials, and minerals; purification of air and water; mitigation of flood and drought; waste treatment and nutrient cycling; seed dispersal; generation and maintenance of biodiversity; protection from ultraviolet radiation; stabilization and moderation of climate; and crop pollination. In many parts of the world, the natural capital stocks providing this stream of goods and services are being severely degraded and depleted.

The Ecological Footprint

Ecological footprint analysis is a heuristic tool that turns the carrying capacity issue around, asking what productive land area would be required to sustain a given population's activities. It is calculated that the productive land of about two and a half more planet Earths would be required to support a global population of 6 billion people at a consumption level comparable to that of the present-day inhabitants of Vancouver, Canada, the home base of the originator of the concept.

See also: *Ecological Perspectives on Population; Land Use; Limits to Growth; Sustainable Development; Water and Population.*

BIBLIOGRAPHY

Daily, Gretchen C., and Paul R. Ehrlich. 1992. "Population, Sustainability, and Carrying Capacity." *BioScience* 42: 761–771.

Daily, Gretchen C., Tore Söderqvist, Sara Aniyar, Kenneth Arrow, Partha Dasgupta, Paul R. Ehrlich, Carl Folke, AnnMarie Jansson, Bengt-Owe Jansson, Nils Kautsky, Simon Levin, Jane Lubchenco, Karl-Göran Mäler, David Simpson, David Starrett, David Tilman, and Brian Walker. 2000. "The Value of Nature and the Nature of Value." *Science* 289: 395–396.

Dhondt, André A. 1988. "Carrying Capacity: A Confusing Concept." *Acta œcologica* 9: 337–346.

Hardin, Garrett. 1986. "Cultural Carrying Capacity: A Biological Approach to Human Problems." *BioScience* 36: 599–606.

Holdren, John P. 1991. "Population and the Energy Problem." *Population and Environment* 12: 231–255.

Rees, William, and Mathis Wackernagel. 1994. "Ecological Footprints and Appropriated Carrying Capacity: Measuring the Natural Capital Requirements of the Human Economy." In *Investing in Natural Capital,* eds. AnnMarie Jansson, Monica Hammer, Carl Folke, and Robert Costanza. Washington, D.C.: Island Press.

Jai Ranganathan
Gretchen C. Daily

CASTE

The word *caste* probably comes from the Portuguese word *casta,* meaning "species" or "breed" in relation to botany and animal husbandry. It was first applied by the Portuguese to describe the predominant organizing principle of Indian society. The word subsumes two kinds of categorization. One categorization is religious, represented by the word *varna,* which means "color" in Sanskrit. According to the varna principle, Hindus are divided into four caste groups, together with a fifth group, the untouchables, that exists outside the caste system. The other categorization is by what is called *jati,* the endogamous, (that is, in-marrying) birth grouping that determines a person's social position and duties and primary nonfamilial allegiances. There are thousands of jatis, often with highly contested (and changing) rankings by varna—and even within a particular varna.

The origins of caste are debated but probably include a mixture of scriptural injunctions, ancient ideas about racial exclusivity, long-term occupational heredity, and colonial categorizations and impositions that converted local endogamous units into pan-Indian groupings.

Caste-like categorizations also exist in some other societies, although without the fine grades of classification found in India. The best-known example outside South Asia is that of the Burakumin ("village people"—social outcasts, known also by the more pejorative term *Eta*) in Japan, a group of about 2.5 million that has faced persistent barriers to social, economic, and marital integration into mainstream Japanese society based on their ancestry.

Institutionalization of Caste

So tenacious is the hold of caste (and the concepts of social ranking and exclusivity associated with it) that it is a continuing feature of the Indian diaspora even in the developed countries of the West—witness, for example, the caste details specified in the marriage advertisements in Indian publications in the United States. Caste categories are often applied also to non-Hindus of the Indian subcontinent. Sociologists have recorded the caste-consciousness of Muslim and Christian communities in India, the caste referring to that of the Hindu ancestors of these groups before they converted to Islam or Christianity. Such caste-consciousness restricts social intercourse and deters marriages across these ancestral caste lines.

This institutionalization of the social hierarchy implicit in caste rankings in Hinduism is politically important because of the commitment of the post-independence Indian government to a casteless society and to affirmative action to improve the situation of the lowest castes. Pan-Indian and regional caste loyalties have been exploited by both the upper and lower castes to press economic and political demands, increasing intercaste rivalries. In the process, the lower castes have become better able to organize and resist the authority of the upper castes.

Demographic Implications

There are also more direct demographic implications of caste endogamy and caste hierarchy. The widespread acceptance of caste rankings has meant that groups lower down in the hierarchy try to raise their status by adopting the practices of the higher castes—a phenomenon the sociologist M. N. Srinivas termed *Sanskritization.* Sanskritization is not modernization, though the latter usually accompanies the former. Instead, Sanskritization often entails copying the most traditional, oppressive, and insular habits of the upper castes and giving up of many of the social and, especially, gender equalities and freedoms that characterized the lower castes. In many respects caste is little different from class, and in most societies, as observers such as Mary Wollstonecraft, the eighteenth-century English feminist and writer, and others have pointed out, the upper classes have not been known for greater gender sensitivity.

Caste is an important marker of demographic outcomes. India's censuses and official surveys no longer collect information on caste as such (all censuses from 1872 to 1941 included some question on caste), but they do separate out the Scheduled Castes (SCs) and Scheduled Tribes (STs). The Scheduled Castes are the former untouchables, and the Scheduled Tribes are the non-Hindu tribal groups that have remained outside the Indian cultural mainstream. The numerous jatis that make up these two groups have been listed for the purposes of affirmative action. Many of the affirmative policies also apply to what are called the "Other Backward Castes" (OBCs), a mixture of the lowest castes in the fourfold varna system and those untouchable groups that have converted to other religions. Together, SCs (about 19% of the population), STs (about 9%), and OBCs (about 32%) account for some 60 percent of the total population of India (a share that was probably fairly stable over the twentieth century). It is difficult to be sure, because these categories are more fluid than they appear.

In spite of affirmative action policies, socioeconomic differences by caste continue to be large. Even using the three broad caste-group categories, there are significant differences in fertility, mortality, and health that are not explained by differences in standard socioeconomic factors such as income and education. For example, the 1998–1999 Indian National Family Health Survey (NFHS) found infant mortality rates (per 1,000 births) of 83 for the SCs, 84 for the STs, 76 for the OBCs, and 62 for the other (upper) castes. The corresponding levels of under-five mortality were 119, 127, 103, and 83. The disadvantage of the SC and ST groups is obvious. Fertility differences are less stark: The total fertility rate in 1998–1999 was 3.15 for the SCs, 3.06 for the STs, 2.83 for the OBCs, and 2.66 for the other castes. For fertility, the regional contrasts in India are much larger.

Caste in India also continues to be a determinant of demographic behavior because it is strongly associated with socioeconomic class, and socioeconomic differentials in fertility and mortality are still marked at this stage of the demographic transition. For instance, literacy levels among ever-married female respondents in the NFHS were 27 percent for the SCs, 21 percent for the STs, 39 percent for the

OBCs, and 56 percent for the other castes; corresponding figures for regular exposure to the mass media were 52 percent, 38 percent, 59 percent, and 69 percent. As can be seen in all these indicators, the Scheduled Tribes are the most disadvantaged groups, significantly worse off than even the untouchables. Not only are these tribal groups at the lowest levels of socioeconomic development, they are also the least organized for any kind of concerted political action.

For historical (often to do with the emergence of charismatic leaders), demographic (often to do with their relative numbers), political (often to do with mass mobilization), and cultural (often to do with the position of women) reasons, caste plays more or less salient roles and the relative power of the lower castes differs in different parts of the country. The future of caste as an organizing principle of society is also difficult to predict. With education, urbanization, and all the forces associated with modernization, it could become less relevant in all but the most intimate areas of social relations (that is, marriage) and a less obvious marker of demographic behavior. However, it is also plausible that the upheavals of modernization will mean more caste-based conflict and unrest before this happy homogenization of socioeconomic aspirations and achievements comes about.

See also: *Social Institutions; Social Mobility.*

BIBLIOGRAPHY

Bailey, Frederick George. 1960. *Tribe, Caste, and Nation: A Study of Political Activity and Political Change in Highland Orissa.* Bombay, India: Oxford University Press.

Bayly, Susan. 1999. *Caste, Society and Politics in India from the Eighteenth Century to the Modern Age.* Cambridge, Eng.: Cambridge University Press.

Beteille, Andre. 1969. *Castes, Old and New: Essays in Social Structure and Social Stratification.* Bombay, India: Asia Publishing House.

Dangle, Arjun, ed. 1992. *Poisoned Bread: Translations from Modern Marathi Dalit Literature.* Hyderabad, India: Orient Longman.

Das, Veena. 1977. *Structure and Cognition: Aspects of Hindu Caste and Ritual.* Delhi, India: Oxford University Press.

Dirks, Nicholas B. 2001. *Castes of Mind: Colonialism and the Making of Modern India.* Princeton, NJ: Princeton University Press.

Dumont, Louis. 1970. *Homo Hierarchicus: An Essay on the Caste System.* Chicago: University of Chicago Press.

International Institute for Population Studies. 2000. *India: National Family Health Survey II, 1998–1999.* Mumbai, India: International Institute for Population Studies.

Moon, Vasant. 2001. *Growing Up Untouchable in India: A Dalit Autobiography.* Oxford: Rowman and Littlefield.

Srinivas, M. N. 1962. *Caste in Modern India, and Other Essays.* New York: Asia Publishing House.

Alaka Malwade Basu

CAUSES OF DEATH

Information on cause of death is essential for understanding trends and inequalities in mortality. Compiling this information requires a consistent scheme for classifying causes of death and an appropriate system for registration and record-keeping. Both were developed during the nineteenth century and had become systematic in all industrialized countries at the beginning of the twentieth century. In these countries medical certification of the cause of death is routine. This is not the case, however, in most developing countries. "Verbal autopsies"—information about the symptoms and conditions which accompanied the death obtained by questioning close relatives of the deceased—can contribute some knowledge of causes of death, especially for children, but they cannot produce reliable statistics of mortality by cause.

Classification of Causes of Death

After lengthy debate, the first international classification of diseases and causes of death, largely devised by Jacques Bertillon (1851–1922), was adopted in 1893. There have been ten subsequent revisions, none of them radically changing the original structure although producing severe disruptions in time series on causes of death. The *International Statistical*

Classification of Diseases and Related Health Problems—Tenth Revision (*ICD-10*), was adopted by the World Health Organization (WHO) in 1989.

Ten of the *ICD-10*'s 21 chapters refer to a specific bodily system, such as Chapter VI, "Diseases of the nervous system," and Chapter X, "Diseases of the respiratory system." Some other chapters refer to etiological processes, like Chapter I, "Certain infectious and parasitic diseases," and Chapter II, "Neoplasms." Still others are linked to a particular period of life, like Chapter XVI, "Certain conditions originating in the prenatal period," and Chapter XV, "Pregnancy, childbirth and the puerperium."

Such a structure makes it difficult to identify homogeneous pathological processes. Trends in distinct pathologies can depend on common factors and may be influenced through appropriate intervention. To identify these processes, several authors have suggested alternative classifications, drawing on the concept of avoidable mortality. Causes of death can be divided into "avoidable" and "unavoidable." While this may be helpful in designing health policies at a particular time, it is of little value in analyzing trends as medical progress continually shifts diseases into the avoidable category.

Ideally, a useful classification should make it possible to distinguish between different etiologies. Marc d'Espine promoted this idea in the nineteenth century, in the debates surrounding the first version of the *International Classification.* At a time when the nature of the diseases was so little known, such an exercise would have been wholly utopian. With twenty-first-century medical science, an etiological classification could be designed—and in fact has been partially attempted, using French data. In this exercise trends in mortality from different processes (such as infectious, tumoral, or degenerative processes) could be followed more precisely. The exercise was especially useful in tracking infectious disease mortality. Although many infectious diseases are covered in *ICD-10*'s first chapter, "Certain infectious and parasitic diseases," others are scattered through the remaining chapters. For instance, influenza falls in Chapter X, "Diseases of the respiratory system," and appendicitis in Chapter XI, "Diseases of the digestive system." Reclassifying diseases according to etiological criteria as infectious processes permits a better estimate of the weight of infection in total mortality.

Identifying Causes of Death

A death is the result of successive pathological processes that may have appeared or developed because of other preexisting conditions. Most studies on causes of death refer to only one cause. To insure some coherence in identifying this "underlying" cause, WHO recommends a model two-part medical death certificate and rather strict rules for coding. In Part I of the death certificate, the physician reports all the conditions that are directly responsible for the death in the reverse order they appeared. The first line contains the "direct" cause that immediately produced the death, and the last line the "initial" cause that induced the processes which finally led to the death. In Part II, the physician reports all other "contributory" causes that are not directly responsible for the death but which may have contributed to it. Coding rules help the physician to choose from among all these conditions the one which is considered to be the "underlying" cause of death. In most cases, this is the disease reported on the last line of Part I. However, in some specific cases the order of the pathological processes may be reconsidered by the authorities in charge of coding and another condition, reported elsewhere in the certificate, may be chosen as underlying cause of death.

The identification of only one cause of death considerably reduces the amount of information reported in the death certificate. This loss of information becomes increasingly serious under conditions of very low mortality. With very low mortality, most deaths occur at old ages to persons who may be suffering from several chronic diseases, making it difficult to choose the main cause of death. Hence efforts are being made to find ways of taking into account all the information reported in the death certificate, through multiple-cause analysis. Two approaches can be used. In the first, all mentions of a disease are noted, whatever the place they occupy in the death certificate. This approach highlights the part played in mortality by conditions like diabetes or alcoholism, which are seldom reported as the underlying cause of death but often contribute to deteriorating health. In the second approach, the most frequent associations of causes are examined, so as to identify sequences of pathological processes that are more lethal than others. Multiple-cause analysis is an important challenge for future studies of mortality and morbidity.

Problems of Comparability in Time and Space

Although nearly all countries producing regular statistics of deaths by cause use the current *ICD* and WHO's classification rules, comparability among countries is limited because of substantial differences in medical practice and coding habits. One such problem is in use of the category "ill-defined causes." Some countries where diagnoses tend to be imprecise assign many deaths to this category. For instance, for the year 1996, almost 12 percent of deaths in Portugal were classified into Chapter XVIII, "Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified," compared to 4.5 percent in Russia, and less than 0.1 percent in Hungary. Consequently, before making international comparisons of specified causes of death, the deaths attributed to ill-defined causes must be redistributed into specified causes. If the probability for a death being recorded as having an ill-defined cause is independent of the actual cause of death, it is possible to proportionally redistribute deaths from ill-defined causes into all the specified categories. More sophisticated methods of redistribution can also be used. Beyond the general problem of ill-defined causes, international comparisons are affected by systematic differences in diagnostic practice. A case in point concerns myocardial infarction and other ischemic heart diseases: some countries, such as France, prefer the first diagnosis; others, such as the United Kingdom, prefer the second. To compare the level of mortality from ischemic heart diseases, it is better to combine the two pathologies (myocardial infarction and other ischemic heart diseases). In the same way, in theory *ICD-10* allows one to distinguish between cancer of the cervix and other cancers of the uterus. In practice the distinction is not made on the same criteria from one country to another and a comparison of deaths classified as "cancer of the cervix uteri" would lead to erroneous conclusions. In general, in any investigation that uses a detailed cause of death, it is necessary to consider at the same time all other causes that may be confused with it.

Problems of comparability are still more serious when dealing with time trends. As with cross-national comparisons, a prior redistribution of deaths from ill-defined causes is necessary. Such categorization of deaths generally decreased as diagnostic precision improved. For instance, in France, use of the category fell from 30 percent in 1925 to 6 percent in 1996. More problematic for comparisons over time are the breaks introduced in the time series by the successive revisions of the *ICD.* As medical knowledge expands, the contents of the *ICD* are revised: new disease designations are added, and others are removed. The number of items in the *ICD* has risen from 203 in the first classification of 1893 to more than 10,000 in *ICD-10.* To observe long-term trends, it is necessary to reclassify deaths using a constant medical definition of the cause. This would be relatively straightforward if registration authorities produced a double classification of deaths under the old and new classifications whenever a revision came into effect, but that is seldom done. Thus, reconstruction of long-term cause-of-death series for any country usually requires long and meticulous work to insure medical and statistical coherence. The few countries for which this has been done include France, the Netherlands, and some countries of the former Soviet Union.

Main Trends in Causes of Death

Until the 1960s in industrialized countries, the principal contribution to rising life expectancy was the reduction of mortality from infectious diseases and the subsequent decrease in infant mortality. Following this fundamental change in the pattern of causes of death, the pace of increasing life expectancy slowed under the double effect of the emergence of man-made diseases (diseases due to tobacco and alcohol, and traffic accidents) and the growing weight of chronic diseases (cardiovascular diseases, cancer). From the 1970s, life expectancies continued increasing because of successes in controlling man-made diseases and in reduction of mortality from cardiovascular diseases, especially among the elderly. However, this resumption of progress was not general. Countries of Eastern Europe (including the former Soviet Union) lagged in the control of the chronic diseases and their life expectancy, especially for males, stagnated or even decreased.

The situation in developing countries shows even greater contrasts. Some countries, such as China, South Korea, Mexico, and Tunisia, have followed the same path as the developed world and, thanks to a rapid decrease in mortality from infectious diseases, have reached high levels of life expectancy. In contrast, countries of sub-Saharan Africa have largely failed to control infectious diseases. The emergence of AIDS and the reemergence of diseases like malaria contribute to the poor health status of these populations.

See also: *Bertillon, Jacques; Disease, Burden of; Disease, Concepts and Classification of; Epidemiological Transition; Farr, William; Mortality, Age Patterns of; Mortality Decline.*

BIBLIOGRAPHY

Bourgeois-Pichat, Jean. 1952. "Essai sur la mortalité biologique de l'homme." *Population* 7(3): 381–394.

Holland, W. W., dir. 1993. *European Community Atlas of Avoidable Death,* 2nd edition, volume 2. Oxford, Eng.: Oxford University Press.

Ledermann, Sully. 1955. "La répartition des décès de cause indéterminée." *Revue de l'Institut international de statistique* 23(1): 3.

Meslé, France. 1996. "Les causes médicales de décès." In *Démographie: analyse et synthèse. Causes et conséquences des évolutions démographiques.* Paris: CEPED/DSD.

———. 1999. "Classifying Causes of Death According to an Aetiological Axis." *Population Studies* 53(1): 97–105.

———. 1996. "Reconstructing Long-Term Series of Causes of Death." *Historical Methods* 29(2): 72–87.

Meslé, France, and Jacques Vallin. 1984. "The Problem of Studying Mortality Patterns By Cause over a Long Period of Time: An Example from France, 1925 to 1978." In *Methodologies for Collection and Analysis of Mortality Data,* ed. Jacques Vallin, John Pollard, and Larry Heligman. Liège: IUSSP, Ordina Éditions.

Omran, Abdel R. 1971. "The Epidemiologic Transition: A Theory of the Epidemiology of Population Change." *Milbank Memorial Fund Quarterly* 49(4): 509–538.

World Health Organization. 1992. *International Statistical Classification of Diseases and Related Health Problems,* 10th revision, volume 1. Geneva: World Health Organization.

Wolleswinkel-van den Bosch, Judith. 1998. *The Epidemiological Transition in the Netherlands.* Rotterdam: Erasmus University.

INTERNET RESOURCES.

Vallin, Jacques and France Meslé. 1998. "Les causes de décès en France depuis 1925." *Institut national d'études démographiques.* <http://matisse.ined.fr/~tania/causfra/data/>.

World Health Organization. 2001. <http://www.who.int/whosis>.

France Meslé

CENSUS

A population census, which usually is just called a census, is a count of the population of a country on a fixed date. National governments conduct censuses to determine population sizes, growth rates, and characteristics (such as sex, age, marital status, and ethnic background) for the country as a whole and for particular regions or localities. Generally governments collect this information by sending a questionnaire in the mail or dispatching an interviewer to every household or residential address in the country. The questionnaire asks the head of the household or a responsible adult living in the household (the respondent) to list all the people who live at the address on a particular date and answer a series of questions about each of them. Over a period of months or years the government census office aggregates and tabulates the answers and reports the results to the public.

Censuses are very expensive and elaborate administrative operations and thus are conducted relatively infrequently, generally at five- or ten-year intervals. Between censuses governments estimate the size and characteristics of the population by extrapolating past trends or drawing on other data sources. Periodic sample surveys are one such source. In the United States, the Current Population Survey of around 50,000 households is conducted monthly. The Census Bureau is planning a new rolling sample survey called the American Community Survey to provide the same level of local area detail available in a decennial census by cumulating and averaging sample estimates over a five-year period.

History

Censuses have been conducted since ancient times. Early censuses were conducted sporadically and generally were used to measure the tax or military capacity of an area. Examples include Roman and Chinese censuses, the Domesday Book, occasional city surveys such as the Florentine *Catasto,* and records of medieval manors. Unlike modern censuses, they tended to count only adult men, men liable for military service, or tithables (people liable to pay taxes) along with landholdings. The results were used for administrative purposes and were not extensively tabulated or regarded as public records. Nevertheless, historical demographers have derived estimates of total populations from them.

Census taking in the modern sense requires the conception of a uniform, countable unit of analysis. Hence, census taking had to await the development of the state and the emergence of the concept of the commensurate household. The latter occurred in the medieval European west: In the ancient world rich households with large slave labor forces could not be considered "commensurate" with the hovels of the poor. In modern censuses the household or family serves as the unit of analysis or the locus for counting the members within it.

The modern periodic census of all persons is an invention of the early modern period in Europe. One of its purposes was to monitor the progress of overseas colonies. Thus, repeated counts were taken of the colonial American population in the seventeenth and eighteenth centuries, starting in the 1620s in Virginia. In Canada, French efforts to count the population began in 1665–1666 in what is now Quebec, and censuses were conducted at irregular intervals after Canada became a British colony in 1763. Sweden began to conduct censuses in the mid-eighteenth century by tallying the records in its vital registration. England and Wales instituted a regular census on a ten-year cycle in 1801. By the early nineteenth century census taking had begun to be a regular function of government in Western Europe and North America, and in the twentieth century it spread throughout the world.

Functions and Techniques

Censuses serve a variety of purposes in different countries. At a minimum a census provides a measure of the size of the population of a country, which can be compared with the population in the past and the populations of other countries and used to make estimates of the likely population in the future. Governments use census information in almost all aspects of public policy, such as determining how many children an educational system must serve, determining where to put new roads, and providing the denominators of other measures (e.g., per capita income, crime rates, and birth rates and death rates). Private businesses use census data for market analysis in deciding where to locate new businesses or where to advertise particular products. Government agencies and private researchers use the census to provide the "sampling frame" for other types of survey research.

In the United States the census is taken during the tenth year of each decade. The resulting population count provides the data for reapportioning seats among the states in the House of Representatives and the Electoral College and for redrawing district boundaries for seats in the House, in state legislatures, and in local legislative districts. In Canada and many European countries a full census is taken during the first year of every decade. Canada also takes an abridged census during the sixth year of the decade. Canadian population data are used to apportion seats among the provinces in the House of Commons and to draw electoral districts.

Most countries create a permanent national statistical agency to take the census, such as the United States Bureau of the Census or Statistics Canada. This agency usually undertakes a public review process to determine the questions that will be asked. Most censuses ask for basic demographic information such as the age, sex, educational background, occupation, and marital status of an individual. Race, ethnic or national origin, and religious affiliation are important questions in some countries. Other questions often include a person's place of birth, relationship to the household head, individual or family income, type of house, citizenship, movement in the last five years, and language spoken at home. Questions that are routine in one nation may be controversial in another. In the United States questions on religious affiliation are not asked in the census because they are seen as an infringement of the First Amendment right to freedom of religion. Other nations, such as India, do collect this kind of information. Questions on the number of children born to a woman were quite controversial in China in the early twenty-first century because of their connection with the government's one-child policy. A question on income was considered controversial in the United States in 1940, when it was first asked; it is no longer considered problematic.

Questions also change in response to public debate about the state of society. For example, Americans wanted to know which households had radios in 1930 and introduced questions on housing quality in 1940. Canada asks census questions on unpaid work done in the home.

Census taking can be divided into several phases. In the first phase the census agency divides the country into geographic divisions, makes maps and address lists, and prepares instructions for the local census takers. To conduct the count, large numbers of temporary workers may be hired or other government employees, such as schoolteachers, may be called on. The census agency prepares, prints, and mails the questionnaires to households or has them delivered by enumerators.

In the second phase a responsible adult or household head in every household, family, or equivalent entity is asked to fill out the form or respond to the enumerator and supply the required information about each member of the household. (In the current U.S. practice a brief set of questions on a "short form" is asked of all people, usually including name, age, sex, race and ethnicity, and relationship to the household head. A sample of households is asked to complete a more complicated "long" form, which can have many detailed questions on work status, income, housing, educational background, citizenship, and recent moves.)

In the third phase the census agency enters the data into a computer and tabulates the responses for the nation, states or provinces, and cities, towns, and other local jurisdictions. The agency also cross-tabulates the answers, for example, reporting not only the number of people in a local area but the number of people in five-year age cohorts, for each sex, and for local areas. The agency publishes only the tabulated results of the count and keeps the individual responses confidential. In the United States the individual census forms are stored in the National Archives and eventually opened to the public. People then may use them to research the history of their families or construct genealogies.

The choice of census technique for a particular country is the result of its social and political traditions and technological capacities. The U.S. Census is highly automated and is conducted primarily by mail. Canada sends enumerators to deliver the census form to each household, to be completed and returned by the household head. Other nations use more labor-intensive techniques for collecting and tabulating the data, sometimes requiring people to stay home to await the census taker on census day.

The U.S. Census

The U.S. Census was mandated in the 1787 Constitution. This census was the first count in the world designed to provide population figures for apportioning the seats in the national legislature. Direct taxes levied on the states were also to be apportioned on the basis of population. At that time almost 20 percent of the American population consisted of enslaved African Americans. The framers debated whether slaves were "persons" or "property" and thus whether states should receive representation for their slave populations. The framers developed what came to be called the Three-Fifths Compromise, which discounted the size of the slave population as the equivalent of 60 percent of the free population when determining the apportionment of the House. (The abolition of slavery also abolished the compromise, but the tradition of counting the different racial groups in the population continued.)

In the first census, taken in 1790, assistant U.S. marshals were instructed to travel the country and ask six questions at each household: the name of the family head and for each household the number of free white males age 16 and over; the number of free white males under 16, the number of white females, the number of other free people (the free colored), and the number of slaves. The marshals recorded and totaled the figures for the local jurisdiction and sent them to the U.S. marshal for the state, who totaled the figures for the state and sent them to the President. The census counted 3.9 million people.

In later years the census became more elaborate, with more questions asked and more data published. In 1850 Congress mandated a census schedule (form) with a line of questions for each person, including name. A temporary Census Office, as it was then called, was set up in Washington to compile the responses and publish the results. By 1880, when the American population topped 50 million, the census was still compiled by hand, using a primitive tally system. In 1890 the Census Office introduced machine tabulation of the responses, and each person's answers were converted to codes punched into Hollerith cards, a precursor to the IBM punch card. The cards then were run through counting machines. This was the beginning of modern data processing and led to further innovations in tabulating large amounts of data. In the 1940s the Census Bureau commissioned the construction of the first nondefense computer, UNIVAC, to tabulate the 1950 census. In the late 1950s the Census Bureau developed an electronic scanning system called FOSDIC (Film Optical Scanning Device for Input to Computers) to transfer the answers on the census form to a computer.

In 1940 the United States began to collect some census information from a sample of the population and thereafter slowly shifted the detailed questions on the census to the long form sent to only about 15 to 25 percent of households. In 1970 the census became primarily a mail enumeration as the Census Bureau developed automated address files for the country. In the year 2000 over 90 percent of the roughly 110 million residential addresses in the United States received the census form by mail. If the Census Bureau does not receive a response, it sends an enumerator to determine whether the address is correct and to get the information from the household at the address.

Availability of Census Data

Until the 1980s statistical agencies published census results in large volumes of numeric tables, sometimes hundreds of those volumes. Since that time census results have become available electronically on disc, magnetic tape, and CD-ROM or the Internet. Retrospective print compilations of census data are available in libraries, and some have begun to be converted to an electronic format and posted on the World Wide Web. For example, basic population tabulations from American censuses from 1790 to 1960 are available from data compiled by the Interuniversity Consortium for Political and Social Research (ICPSR).

Availability of the original census forms varies by country. With the exception of the forms from the 1890 census, the original schedules for the U.S. censuses survive. If a country's forms are available, historical public use samples of population censuses may exist in electronic form. These samples have been compiled online, including the Integrated Public Use Microdata Series (IPUMS) for American data and planned international compilations that can be viewed on the Internet.

Issues

Censuses can become embroiled in political or social controversy simply by reporting information relevant to ongoing issues in a society. Complaints about the census generally involve concerns about the accuracy of the count, the propriety of particular questions, and the uses to which the data are put.

Censuses require public understanding, support, and cooperation to be successful. Concerns about government interference in private life can prevent people from cooperating with what is an essentially voluntary counting process. People may be wary of giving information to a government agency or may regard particular census questions as invasions of privacy.

When public trust is lacking, people may fail to cooperate. Individuals in illegal housing units, those who are resident in the country illegally, and those who do not wish to reveal their economic or social situation to a government agency are reluctant to respond to a census. In a more serious challenge, some people claim that censuses should not be conducted at all on the grounds that the results will not be held in confidence. In the Netherlands the legacy of the Nazi era, during which census records were used to identify Jews for deportation, was one of the major justifications for ending census taking in 1971.

Some political challenges to the census claim that the census does not count the population well enough. All censuses contain errors of various kinds. People and addresses are missed, and people may misunderstand or fail to answer some questions. Census officials have developed elaborate procedures to catch and correct errors as the data are collected and to impute missing answers from the answers to other questions. Nevertheless, some errors inevitably remain.

Various methods are used to measure the accuracy of censuses. Census results may be compared with population information from other sources, such as the records of births, deaths, and marriages in vital statistics. Commonly, a second, sample count (a postenumeration survey, or PES) is collected shortly after the complete census. Its results are matched against those of the census, allowing estimates to be made of the number of those missed and those who have been counted twice or are in the wrong geographic location. Some nations, such as Canada and Australia, adjust their census results for omissions and other errors.

In the United States, city dwellers, the poor, and minorities tend to be undercounted in the census relative to the rest of the population. Officials representing such undercounted jurisdictions claim that these jurisdictions have suffered loss of political representation and government funding as a result of incorrect data. Litigation seeking to compel adjustment of census results has been unsuccessful in the United States. The question of adjustment has also emerged as a political controversy in Congress: Republicans generally have opposed adjusting for the undercount, and Democrats have supported it. In 2001 the U.S. Census Bureau certified the unadjusted results of the 2000 census as the official results on the grounds that it could not guarantee that the adjusted census results were more accurate than the unadjusted count.

See also: *Databases, Demographic; Data Collection, Ethical Issues in; Demographic Surveys, History and Methodology of; Demography, History of; Population Registers.*

BIBLIOGRAPHY

Anderson, Margo. 1988. *The American Census: A Social History.* New Haven, CT: Yale University Press.

Anderson, Margo, and Stephen E. Fienberg. 2001. *Who Counts? The Politics of Census Taking in Contemporary America.* New York: Russell Sage Foundation.

Cassedy, James. 1969. *Demography in Early America: The Beginnings of the Statistical Mind.* Cambridge, MA: Harvard University Press.

Choldin, Harvey. 1994. *Looking for the Last Percent: The Controversy over Census Undercounts.* New Brunswick, NJ: Rutgers University Press.

Curtis, Bruce. 2001. *The Politics of Population: State Formation, Statistics, and the Census of Canada, 1840–1875.* Toronto: University of Toronto Press.

Eckler, A. Ross. 1972. *The Bureau of the Census.* New York: Praeger.

Glass, David. 1973. *Numbering the People.* Farnborough: Saxon House.

Herlihy, David. 1985. *Medieval Households.* Cambridge, MA: Harvard University Press.

Seltzer, William. 1998. "Population Statistics, the Holocaust, and the Nuremberg Trials." *Population and Development Review* 24: 511–552.

Wells, Robert. 1975. *The Population of the British Colonies in America before 1776: A Survey of Census Data.* Princeton, NJ: Princeton University Press.

Worton, David A. 1997. *The Dominion Bureau of Statistics: A History of Canada's Central Statistics Office and Its Antecedents: 1841–1972.* Kingston, Ontario: McGill-Queens University Press.

INTERNET RESOURCES.

Integrated Public Use Microdata Series (IPUMS). 2002. <http://www.ipums.org>.

Interuniversity Consortium for Political and Social Research (ICPSR). 2002. <http://www.icpar.umich.edu>.

Statistics Canada. 2002. <http://www.statcan.ca>.

U.S. Department of Commerce, U.S. Census Bureau. 2002. <http://www.census.gov>.

U. S. Historical Census Data Browser. 2002. <http://fisher.lib.virginia.edu/census/>.

MARGO ANDERSON

CENTRAL PLACE THEORY

Central place theory is a conceptual statement about the relative locations, numbers, and economic functions of the different-sized urban places in a region. Within a framework of several assumptions concerning the character of the region (for example, that it is a uniform physical plain, evenly settled and over which movement is possible in all directions) and the rational economic behavior of both the region's farm population as consumers and of the producers of goods and services in the urban centers, the theory allows for predictions to be made about the hierarchical ordering of the urban places and the spatial patterning of their market areas within the region. The most widely reported of these results is the urban pattern that has the regular hexagonal market areas of the more numerous smaller urban places nested within those of the fewer larger centers, as is shown in Figure 1.

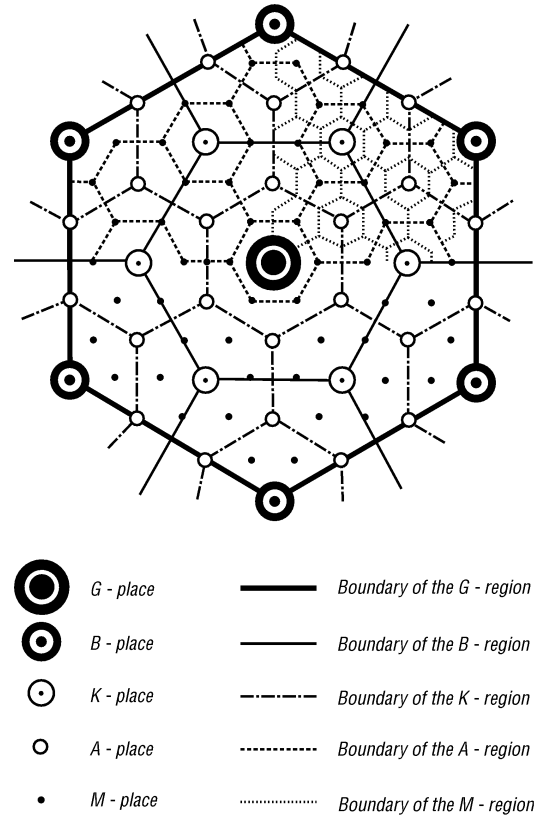
The term "central place" was coined by the geographer Mark Jefferson in 1931 to refer to the fact that, "cities do not grow up of themselves; countrysides set them up to do tasks that must be performed in central places." Jefferson's reference to the functional complementarity that exists between urban places and the surrounding rural regions was not a new idea; indeed, it had been the subject of numerous empirical studies by European geographers and American rural sociologists earlier in the same century. The later emphasis upon theorizing about these urban–rural relations flowed mainly from the work of two German scholars, Walter Christaller (1893–1969) and August Lösch (1906–1945).

In 1933 Christaller, a geographer, published his dissertation on the central places of southern Germany, in which he inductively derived laws about the "size, number and distribution of central places." It was he who first proposed the hypothetical pattern shown in Figure 1. In his schema, each center within a hierarchy of urban places offers a set of economic goods and services for the surrounding farm population. The range of these goods and services—the average distance that people from the rural area will travel to obtain them—defines the extent of the center's tributary or market area. The smaller the settlement, the fewer the functions offered and the smaller its market area. Larger places offer everything that the smaller places do along with some higher order functions. For example, in the smallest hamlet there may be only a gas station and a general store, while in the slightly larger village these same functions may be supplemented by a post office and a bank. The ideal market area of each place would be circular and overlap with those of neighboring places of the same size. The hexagonal set of market areas eliminates these overlapping zones of competition and allows for the market areas of the smaller centers to be nested within those of the larger ones.

The system shown in Figure 1, with six centers located at the vertices of the hexagonal market area of the next larger urban place, conformed to what Christaller called the "marketing principle," and he elaborated upon the variations of this pattern that would result from distortions of the transportation network and the nature of the administrative districts within the region. A more formal generalization of such a system is found in the work of Lösch, an economist. His book, *The Economics of Location,* published in German in 1939, presented a deductive schema for the emergence of systems of urban places and market areas within what he called an "economic landscape." In his formulation, the spatial arrangement of urban places and their market areas shown in Figure 1 is but one of a number of possible results.

FIGURE 1

A System of Central Places



SOURCE: Christaller, W. 1933. *Die Zentralen Orte in Süddeutschland*, tran. C. W. Baskin, 1966, p. 73.

English translations of these works of Christaller and Lösch first appeared in the 1950s. Geographers, especially in North America, quickly seized upon them as they were seeking to move their discipline in the direction of more quantitative and theoretical work. Those social scientists engaged in the development of the newly emergent field of "regional science" also took an interest. Central place theory subsequently fostered many lines of scholarly activity. On the empirical level, it has provided the framework for numerous studies of urban hierarchies and market area systems in different parts of the world. Those studies of the central United States completed by the geographer Brian Berry and of northern China by the anthropologist G. W. Skinner are among the most widely cited. Berry showed also how the theory could be used to analyze the hierarchy of retail centers within a large metropolitan area such as Chicago. On the theoretical front, many have sought to outline mathematical statements of the theory, to elaborate upon and extend the economic arguments that underpin it, and to demonstrate how it can be integrated with other forms of theoretical spatial analysis. The contributions, among many, of Hendricus Bos, Andrew Krmenec, and Adrian Esparza, Michael Kuby, Gordon Mulligan, and John Parr illustrate these continuing lines of investigation. Central place theory also has provided the underpinnings for regional planning schemes in different countries around the world. Notable among these efforts were those of Swedish geographers who in the 1950s and 1960s helped shape national planning policies for the locations of schools, hospitals, and regional centers. Alan Pred has suggested that "this redrawing of the map of Sweden unquestionably represents the most significant contribution of central place research to that country's planning" (1973).

See also: *Cities, Systems of; Density and Distribution of Population; Geography, Population; Lösch, August.*

BIBLIOGRAPHY

Berry, Brian J. L. 1967. *Geography of Market Centers and Retail Distribution.* Englewood Cliffs, NJ: Prentice-Hall.

Bos, Hendricus C. 1965. *Spatial Dispersion of Economic Activity.* Rotterdam: University Press.

Christaller, Walter. 1966 (1933). *Die zentralen Orte in Süddeutschland,* trans. Carlisle W. Baskin. Englewood Cliffs, NJ: Prentice-Hall.

Jefferson, Mark. 1931. "Distribution of the World's City Folks." *The Geographical Review* 21: 446–465.

King, Leslie J. 1984. *Central Place Theory.* Beverly Hills, CA: Sage.

Kolb, J. H. 1923. "Service Relations of Town and Country." *University of Wisconsin Agricultural Experiment Station Bulletin* No. 58.

Krmenec, Andrew J., and Adrian Esparza. 1993. "Modeling Interaction in a System of Markets."*Geographical Analysis* 25(4): 354–368.

Kuby, Michael. 1989. "A Location-Allocation Model of Lösch's Central Place Theory: Testing on a Uniform Lattice Network." *Geographical Analysis* 21(4): 316–337.

Lösch, August. 1954 (1939). *Die räumliche Ordnung der Wirtschaft,* trans. W. H. Woglom and W. F. Stolper. New Haven, CT: Yale University Press.

Mulligan, Gordon. 1982. "Tinbergen-type Central Place Systems." *International Regional Science Review* 7(1): 83–91.

Parr, John B. 1978. "Models of the Central Place System: A More General Approach." *Urban Studies* 15(1): 35–49.

Pred, Alan R. 1973. "Urbanization, Domestic Planning Problems and Swedish Geographic Research." *Progress in Geography* 5: 1–76.

Skinner, G. William. 1964–65. "Marketing and Social Structure in Rural China, Parts I and II." *Journal of Asian Studies* 24: 32–43, 195–228.

LESLIE J. KING

CHILDLESSNESS

Childlessness, according to the International Union for the Scientific Study of Populations (IUSSP) demographic dictionary, "refers to the state of a woman, man or couple who have been so far infertile." It should be distinguished from sterility or infecundity, terms which describe impairment of the capacity to conceive or the capacity to produce a live child. Childlessness can be measured for any person or couple in position to have (or to have had) a child, whatever the reason they did not do so. Definitive childlessness, measured at the end of reproductive life, will be treated here. As with other demographic phenomena, proportions childless can be measured in a population at a given time or for a particular cohort (set of individuals with a certain statistical characteristic in common). This entry will focus on the latter.

Causes of childlessness belong to two main categories:

- Involuntary childlessness—the consequence of sterility or infecundity, which may be congenital or caused by malnutrition or disease, especially sexually transmitted disease.
- Voluntary childlessness—the outcome of a deliberate choice, resulting from sexual abstinence, contraception, or abortion, or a consequence of social circumstances such as the absence of an available partner, or inability to provide for a family.

Involuntary childlessness is more frequent in less developed countries but is decreasing with their development; voluntary childlessness is the dominant form in most developed countries and is increasing.

Sources of Data and Measurement

Information on childlessness can be drawn from censuses and surveys or from vital registration. Most censuses and many specialized surveys have questions about the number of children ever born to women or couples, allowing calculation of the proportions childless for a cross-section of the population by various criteria, such as age or duration of marriage at the time of the census or survey. If they contain questions on the reproductive histories of women or couples, or if consecutive censuses are close enough, it is possible to study trends of childlessness by such criteria over time and for birth or marriage cohorts. These trends can also be observed from vital registration data on annual numbers of live births by birth order. In this case, the study of childlessness is the complement of the study of first birth order fertility. Both data sources have measurement problems. In censuses and surveys, the quality of responses, especially on retrospective questions, diminishes with age, especially for older respondents as a result of memory alteration and selection effects. With vital statistics, difficulties come from the multiplicity of definitions used to classify births according to birth order. Births may refer only to those within the current marriage or to all births of the mother. Birth order classification can refer to live births only or to all births (live births and stillbirths), in the latter case underestimating the level of childlessness; in the same manner, to define the order of a live birth, only live births or all births can be taken into account, the latter overestimating childlessness.

The most serious measurement difficulty comes from the definition of birth order used by some countries, especially some in Western Europe, such as France (until recently), Germany, or the United Kingdom: birth order among all the live births of the current marriage. This definition made sense when births outside marriage, and divorces and remarriages, were rare; the increase of births to unmarried women, the high proportion of marriages ended by divorce, and the frequency of remarriages, lead to a larger and larger gap between measurements based on each definition. The very high proportion of first births born out of wedlock, and the frequency of marriages entered into after the beginning of family formation, lead to overestimation of the rate of first births and consequently an underestimation of permanent childlessness. Another group of countries, including Bulgaria, Croatia, Slovenia, Yugoslavia, Portugal, and Romania, use the concept of biological birth order. In these countries, childlessness proportions based on annual data from civil registration and annual population estimates typically yield values well below 5 percent—the level which would be considered the absolute minimum for the incidence of sterility in a population. These very low estimates may reflect not only the questionable quality of data collected, but also the effect of selection through migration. The latter leads to overestimating the first-birth fertility rate if childless women leave the country or if nonresident women come to the country to give birth.

Trends and Levels

Differences in data availability between developed and developing countries mean that trends and levels of childlessness are much better known in low-fertility societies than under high-fertility conditions. In the developed countries childlessness, defined as the proportion of women who had had no live birth by the end of their reproductive life, was at a low level among cohorts experiencing the baby boom years of the 1950s and 1960s. For women born in the early 1940s childlessness was around 10 percent. It rose rapidly for successive later cohorts. The 1960s birth cohorts exceed 20 percent childlessness in a number of European countries, including England and Wales, Austria, Italy, Finland, and Ireland, and in the western part of Germany. This level, however, is still lower than that of cohorts born in the early twentieth century. In Central and Eastern Europe, childlessness has been at a much lower level

(5–10 percent) until recent years when it has been converging to Western European patterns. This is indicated by the proportions childless in cohorts that are approaching the end of reproductive life. Thus, for example, the proportions were as high as 20 percent for the early 1970s cohorts in Poland and Slovakia. (The rise is much smaller in Russia.) At least some of the increase in childlessness is probably due to reduced marriage frequency not offset by a corresponding rise in the frequency of consensual unions and extra-marital births.

The United States experienced an upward trend in childlessness similar to Western Europe's and preceding it by about ten years. It reached 17 percent among women born in 1953, only to level off and even decrease slightly thereafter (15.5 percent among the 1965 cohort).

In some countries, especially those with substantial emigration, the level of childlessness, measured from vital statistics, may have been somewhat underestimated. This may be the case for Portugal, the former Yugoslavia, Bulgaria, and Romania.

The postponement of motherhood in all European countries increases the risk of childlessness because of decreasing fecundability after age 30. The rising infecundity caused by postponed motherhood cannot be fully compensated by medical techniques, as shown by surveys such as the 1998 Netherlands Fertility and Family Survey. The development of in vitro fertilization and similar medical procedures have allowed some women to have children that they would not have had otherwise, but many women who postponed childbearing will never have a birth even with the help of the new techniques.

Social Implications of Childlessness

High rates of childlessness in developed countries create the potential for social conflict. The state (and parents) on the one hand and the childless on the other have differing interests on matters such as the financing of social welfare, pensions, aged care institutions, and education. If children are consumer goods for their parents they are also investments in the future for society. The developed world might encounter a situation familiar in developing countries, where women are often blamed for childlessness regardless of the cause of their infertility. Alternatively, there is the possibility of further institutionalization of a childless lifestyle, entrenching high levels of childlessness.

See also: *Adoption; Family Size Intentions; Fecundity; Fertility, Below-Replacement; Infertility.*

BIBLIOGRAPHY

Frinking, Gerald. 1988. "Childlessness in Europe: Trends and Implications." In *Lifestyles, Contraception and Parenthood: Proceedings of a Workshop,* eds. Hein Moors and Jeannette Schoorl. The Hague: Netherlands Interdisciplinary Demographic Institute.

Poston, Dudley L. 1982. "International Variability in Childlessness: A Descriptive and Analytical Study." *Journal of Family Issues* 3 (4): 473–491.

Poston, Dudley L., and Baochang Gu. 1983. "Measurement of Childlessness with World Fertility and National Census Data." In *American Statistical Association, Proceeding of the Social Statistics Section* 401–406.

Prioux, France. 1993. "L'infécondité en Europe." In *European Population,* Vol. 2: *Demographic Dynamics,* ed. Alain Blum and Jean-Louis Rallu. Paris: INED; John Libbey Eurotext.

Rowland, Donald T. 1998. "Cross-National Trends in Childlessness." Working paper in demography 73; Australian National University, Canberra.

Steehof, Liesbeth, and Andries De Jong. 2001. "Infecundity: A Result of Postponed Childbearing." European Population Conference 2001, June 7–9. Theme A, Session A3, Helsinki.

Jean-Paul Sardon

CHILD MORTALITY

See *Infant and Child Mortality*

CHINESE, OVERSEAS

Over the five thousand years of Chinese civilization, Chinese people have migrated to virtually all the areas in the world. Ethnic Chinese living outside mainland China (including Hong Kong and Macao) and Taiwan, usually referred to as the overseas Chinese, reside in almost every country. Their total number, according to the estimate cited below, exceeds 30 million. A famous Chinese poem notes that, "wherever the ocean waves touch, there are overseas Chinese."

Who Are the Overseas Chinese?

Definitions of the overseas Chinese vary from country to country and from scholar to scholar. Decisions on who is overseas Chinese are made by governments, both Chinese and foreign, by the individual persons concerned, by the larger societies alongside and within which the Chinese settlers live, and by individual scholars.

The scholar Lynn Pan represents the Chinese people in a series of four concentric circles. The innermost circle refers to Chinese living permanently in the People's Republic of China (PRC). The next circle consists of Chinese living in Taiwan, Hong Kong, and Macao, as well as Chinese citizens living or studying outside China. The third circle includes those "unequivocally identified as overseas Chinese"; these are what she calls the hyphenated Chinese (e.g., Chinese-Americans or Sino-Thais) (Pan, 1999). They are people who are "Chinese by descent but whose non-Chinese citizenship and political allegiance collapse ancestral loyalties." The last circle contains persons of "Chinese ancestry who have, through intermarriage or other means of assimilation, melted into another people and ceased calling themselves Chinese."

The term *hua ren* is commonly used to refer to overseas Chinese who have been naturalized by their host countries, and the term *hua qiao* to overseas Chinese who have retained their Chinese nationality and would likely consider themselves as sojourners. The 30 million-plus estimate of overseas Chinese is based on a broad definition that includes all persons with Chinese ancestry living outside the mainland and Taiwan, including *hua ren, hua qiao,* and *hua yi* (the descendants of Chinese parents).

Patterns of Chinese Emigration

According to scholars such as Gungwu Wang and Wen Zhen Ye, there have been four major patterns of Chinese migration during the past two centuries. The first is the *Huashang* (Chinese trader) pattern, which is characterized by merchants and artisans—often with their colleagues and members of their extended families—going abroad and eventually setting up businesses. The migrants are usually males, and over one or two generations many of them settled down and brought up local families (Wang, 1991, p. 5). *Huashang* migration has been the dominant pattern of Chinese emigration to other Asian countries, particularly to Southeast Asia before 1850. It is likely that the earliest Chinese emigration, which was to Japan or the Philippines during the Qin Dynasty (221–207 B.C.E.), was of the *Huashang* type. And whereas the other three patterns have definite temporal periods associated with them, *Huashang* has always been important.

The second is the *Huagong* (Chinese coolie) pattern, which existed from about the 1850s through the 1920s. This migration involved the "coolie trade," supplying labor for gold mining and railway building in North America and Australia. Chinese emigrants under the *Huagong* pattern were often men of peasant origin, and the migrations were usually non-permanent in that a "large proportion of the contract laborers returned to China after their contract came to an end" (Wang, 1991, p. 6).

The third is the *Huaqiao* (Chinese sojourner) pattern. Sojourners included migrants of all social levels, but most were well-educated professionals. This pattern emerged after the downfall of Imperial China in 1911 and was strongly tied to feelings of nationalism. Beginning in the 1920s many teachers left China for Southeast Asia to instruct the children of earlier Chinese immigrants in these countries. The pattern continued until the 1950s.

The fourth is the *Huayi* (Chinese descent) pattern, a more recent phenomenon that has been prevalent since the 1950s. It involves persons of Chinese descent, *Huayi,* in one foreign country migrating or re-migrating to another foreign country.

Most of the global migration of Chinese in the early twenty-first century is of the *Huashang* type, and it will likely continue to be so in the future.

Size and Distribution of the Overseas Chinese Population

Data on the numbers of overseas Chinese are assembled from several sources, mainly issues of the *Overseas Chinese Economy Year Book* and the *Encyclopedia of Overseas Chinese.* The estimated total number of overseas Chinese at the end of the twentieth century was about 32 million, living in 130 countries. Their distribution around the world is uneven, with more than 98 percent of overseas Chinese living in

76 countries. About 24 million (85% of the total) are found in 21 Asian countries, three-quarters of whom are in just three countries: Indonesia (7 million), Thailand (6 million), and Malaysia (over 5 million). Nearly 4 million Chinese live in the Americas, almost 2.5 million of whom are in the United States.

Origins of the Overseas Chinese

The largest numbers of Chinese emigrants have historically been from the Guangdong and Fujian provinces, with fewer from the Zhejiang province, Shanghai, and other parts of southeastern China. Since the closing decades of the twentieth century, however, the origins of the emigrants have differed depending on whether their migration is legal or illegal. Legal migrants mainly hail from the large urban areas such as Beijing, Shanghai, Guangzhou, and Tianjin. The illegal migrants are mainly from Fujian and Zhejiang provinces. Currently, most of the migration from China is illegal. In several years of the 1990s, there were as many as 180,000 persons leaving China each year, most of them illegal. As of 2002, there are an estimated 250,000 illegal Chinese immigrants in the U.S. The illegal migrants are assisted by human smugglers, known as snakeheads (*shetou*). Although cargo ship, or container truck, smuggling has been the dominant image of human smuggling from China to the United States and Europe, increasing numbers of illegal migrants leave China by air. The smuggling industry is made up of international networks, many based in Taiwan, that are deeply entrenched in the infrastructure of the sending communities in China and in many transit countries. The fees paid the shetou and their associates ranged from $18,000 per person in the 1980s, up to $35,000 to $40,000 per person in the 1990s, to $60,000 or more around 2000. The smuggling business is a very lucrative enterprise. One snakehead in the U.S. began her business in the 1980s and twenty years later had netted in excess of $40 million.

The Future

The future growth of the overseas Chinese population will be affected more by trends in international migration than by natural increase. Controls on immigration in the major host countries restrict the scale of legal migration from China, but there is a sizable flow of unauthorized migrants, especially to the United States. There is a possibility of rapid increase in those numbers: The migration expert Douglas Massey has written that "China's movement towards markets and rapid economic growth may contain the seeds of an enormous migration . . . that would produce a flow of immigrants [to the United States and other countries] that would dwarf levels of migration now observed from Mexico" (p. 649). The political sociologist Jack Goldstone calls the potential for international migration from China a "tsunami on the horizon" (1997). But even conservative forecasts see the numbers of overseas Chinese becoming steadily larger in future decades.

See also: *Ethnic and National Groups.*

BIBLIOGRAPHY

Campbell, Persia Crawford. 1923. *Chinese Coolie Emigration to Countries Within the British Empire.* London: P.S. King and Son.

Fitzgerald, Charles P. 1965. *The Third China: The Chinese Communities in South-East Asia.* London: Angus and Robertson.

———. 1972. *The Southern Expansion of the Chinese People.* New York: Praeger.

Goldstone, Jack A. 1997. "A Tsunami on the Horizon? The Potential for International Migration from the People's Republic of China." In *Human Smuggling: Chinese Migrant Trafficking and the Challenge to America's Immigration Tradition,* ed. Peter J. Smith. Washington, D.C.: The Center for Strategic and International Studies.

Guillon, Michelle, and Emmanuel Ma Mung, eds. 1992. "The Chinese Diaspora in Western Countries." *Revue européenne des migrations internationales* 8(3).

Kung, Shien Woo. 1962. *Chinese in American Life.* Seattle: University of Washington Press.

Kwong, Peter. 1987. *The New Chinatown.* New York: Hill and Wang.

Legge, James. 1886. *A Record of Buddhist Kingdoms: Being an Account by the Chinese Monk Fa-hein of His Travels in India and Ceylon (a.d. 399–414) in Search of the Buddhist Books of Discipline.* Oxford: Clarendon Press.

Massey, Douglas S. 1995. "The New Immigration and Ethnicity in the United States." *Population and Development Review* 21: 631–652.

McKenzie, Roderick D. 1925. "The Oriental Invasion." *Journal of Applied Sociology* 10: 120–130.

Mei, June. 1979. "Socioeconomic Origins of Emigration: Guangdong to California, 1850–1882." *Modern China* 5: 463–501.

Overseas Chinese Economy Year Book Editorial Committee. 1996 and 2000. *Overseas Chinese Economy Year Book 1995 and 1999.* Taipei: Overseas Chinese Affairs Commission.

Pan, Lynn. 1989. "Fewer but Richer." *Far Eastern Economic Review* 143: 44.

———. 1999. *The Encyclopedia of the Chinese Overseas.* Cambridge, MA: Harvard University Press.

Poston, Dudley L., Jr., and Mei-Yu Yu. 1992. "The Distribution of the Overseas Chinese." In *The Population of Modern China,* ed. Dudley L. Poston, Jr. and David Yaukey. New York: Plenum Press.

Poston, Dudley L., Jr., Michael Xinxiang Mao, and Mei-Yu Yu. 1994. "The Global Distribution of the Overseas Chinese Around 1990." *Population and Development Review* 20: 631–645.

Purcell, Victor. 1965. *The Chinese in Southeast Asia.* London: Oxford University Press.

Renmin, Ribao (overseas edition). 1985. "Why Are There So Many Overseas Chinese?" (In Chinese) August 29: 8.

Shen, Yiyao 1970. *A Century of Chinese Exclusion Abroad.* Hong Kong: You Lian Printing House.

So, Alvin Y., Nan Lin, and Dudley L. Poston, Jr., eds. 2001. *The Chinese Triangle of Mainland China, Taiwan and Hong Kong.* Westport, CT: Greenwood Press.

Stewart, Watt. 1951. *Chinese Bondage in Peru: A History of the Chinese Coolie in Peru, 1849–1874.* Durham, NC: Duke University Press.

Uchida, Naosaku. 1960. *The Overseas Chinese: A Bibliographical Essay Based on the Resources of the Hoover Institution.* Stanford, CA: Stanford University Press.

Wang, Gungwu. 1991. *China and the Chinese Overseas.* Singapore: Times Academic Press.

Williams, Lea E. 1960. *Overseas Chinese Nationalism: The Genesis of the Pan-Chinese Movement in Indonesia, 1900–1916.* Glencoe, NY: The Free Press.

Ye, Wen Zhen. 2000. "International Migration Patterns." In *The Changing Population of China,* ed. Xi Zhe Peng and Zhi Gang Guo. Malden, MA: Blackwell Publishers.

Dudley L. Poston, Jr.

CITIES, DEMOGRAPHIC HISTORY OF

Before the twentieth century, the populations of urban places, and especially the great cities, faced at least one important problem: how to replace themselves. Conventional wisdom has it that ancient, medieval, early-modern, and early-industrial cities were incapable of growing naturally, that mortality was normally in excess of fertility, and that a net balance of in-migrants was necessary to keep the population at even a stationary level, let alone allow its numbers to grow. This has been called the "urban graveyard effect." Eighteenth-century English economist T. R. Malthus, in the second edition of his *Essay on the Principle of Population* (1803) provides the following description:

> There certainly seems to be something in great towns, and even in moderate towns, peculiarly unfavourable to the early stages of life: and the part of the community upon which the mortality principally falls, seems to indicate that it arises more from the closeness and foulness of the air, which may be supposed to be unfavourable to the tender lungs of children, and the greater from the superior degree of luxury and debauchery usually and justly attributed to towns. (Malthus, pp. 256–257)

And,

> To fill up the void occasioned by the mortality in towns, and to answer all further demands for population, it is evident that a constant supply of recruits from the country is necessary; and the supply in fact always flowing in from the redundant births of the country. Even in those towns where the births exceeded the deaths, this effect is produced by the marriages of persons not born in the place. (Malthus, p. 257)

These brief passages also reflect a vocabulary about cities and the countryside that was commonly used. While towns display "luxury" and "debauchery," there are "redundant births" in the country ready and willing to fill up the urban void. And in towns, those who suffer most from excess mortality are the children with their "tender lungs." And how else can urban growth be supported but by the offspring of those not born in the towns, that is, the children of migrants?

Such observations required an empirical foundation. Among European populations, it became possible to examine the balance of births and deaths in some detail only after an effective system of parish registers had been established. In England, this means after 1538, and in France, after 1685. Parish registers provide demographers with the number of baptisms, burials, and marriages that can be used to approximate the numbers of births and deaths, and to estimate the general size of the population responsible for those vital events. From such data it is possible to judge the potential for natural population growth in urban compared with rural parishes and thereby to establish the extent to which there is likely to have been excess mortality in the towns.

Many studies exist on seventeenth-, eighteenth-, and nineteenth-century European towns (including those in the Americas, southern Africa, and Australia and New Zealand) based on parish registers, or complemented by Bills of Mortality, which illustrate Malthus's observations. Broadly speaking, urban mortality was higher and fertility lower than in rural areas. In the centuries before the introduction of such registration, however, it is very difficult to discern demographic trends in any detail and it is particularly difficult to identify differences between urban and rural places. In medieval and ancient cities, the assumption that mortality was very high was based on literary references to plagues, invasions, and natural disasters, but it has proved difficult to quantify these events, just as it has been difficult to assess the population sizes of towns in this period. However, there is ample evidence, for fifteenth- and sixteenth-century Italy, to show that its towns were severely affected by outbreaks of bubonic plague; they were far more vulnerable to repeated and severe demographic crises than the countryside. This is true of early modern towns in general.

The development of family reconstitution, a form of nominal record linkage, in the 1950s and 1960s revolutionized historical demographic studies. Estimates of age-specific mortality and fertility rates from parish register data became possible and a far more detailed picture was drawn, especially of the demography of rural parishes. Family reconstitution techniques work to greatest advantage where there is low population turnover so that individuals named in baptism, marriage, and burial registers may be linked within the same parish. If migration is at a high level, individuals will disappear since they may move among parishes between vital events. In these circumstances, the ideal outcome is that baptism and burial registers can be linked to establish estimates of early childhood mortality, especially infant mortality rates.

Researchers' current understanding of urban historical demography rests, therefore, on the following: a long-standing assumption regarding the existence of an urban graveyard effect; many examples of negative natural growth in individual early modern and late medieval towns; and detailed evidence of excess early childhood mortality in urban places.

There are also several points of continuing disagreement. In 1978 historian Allan Sharlin challenged the view that early modern cities were bound to have had natural population decline, and instead focused attention on migration. He argued that while the permanent residents of a city may have been capable of replacing themselves, thereby generating natural growth, the temporary migrants attracted to the city as unmarried workers were likely to add substantially to the number of prematurely deceased, since they confronted, for the first time, the high-risk urban disease environment. In this model, the natural decrease of populations in early modern towns is associated with the mortality of migrants rather than that of the city-born. Many urban historians believe the model overstates the reality, although they accept that attempts to test Sharlin's hypothesis have added considerably to an appreciation of the role of migrants and their potentially distinct demography. The debate on the hypothesis has also encouraged some demographers to challenge the graveyard assumption. They ask:

1. Were the largest cities at all times subject to natural decline and dependent for their growth on in-migrants from the countryside?;
2. At what level in the urban hierarchy were the effects of size or population density so substantial that natural decline was likely to

be experienced? (In other words, did small towns often escape this problem?);

3. What particular diseases were involved and which sections of the population were most affected?; and
4. What was the role of marriage, new household formation, and fertility among migrants and permanent residents?

None of the questions raised are easy to answer. Studies of eighteenth-century London and Paris demonstrate clearly that both cities had birth deficits: They depended on rural migrants to sustain themselves and to grow. In Paris, population increased from 510,000 to 581,000 in the century between 1700 and 1800, and in London, from 575,000 to 865,000 during the same period. But for a town like York (with a population of 12,000 in 1600), there is evidence, for a period in the second half of the sixteenth century during which slow natural growth did occur, that the total number of baptisms exceeded that of burials. This effect may have been repeated in other smaller towns. It is not possible to describe accurately the demographic characteristics of places at different levels in the urban hierarchy until the nineteenth century when many states developed their own civil systems of vital registration. For Victorian England and Wales, there was, in general, an inverse association between life expectancy at birth and both population size and density of the town in which a person lived. Life expectancy was from five to ten years lower in the large towns than in the small towns, and the latter had life expectancies, in turn, a further five to ten years lower than the rural districts. There was a clear urban-rural mortality gradient.

The nineteenth century was also the period in which efforts were first made to record cause of death in a systematic fashion, data which show the effect of water- and air-borne infectious diseases, especially in creating excess early childhood mortality in urban places. For example, measles was an epidemic disease with a particular sensitivity to variations in population density. Children aged from six months up to ten years that lived in towns were especially vulnerable. Measles alone would have made a considerable contribution to the urban-rural mortality gradient, but its effect was accentuated by scarlet fever and whooping cough among children, and diarrhea among infants. Similar patterns may have existed in earlier centuries when smallpox, for example, would have added to the childhood mortality rate.

Apart from the methodological revolutions brought about by family reconstitution and computer-based analysis of large and complex data sets, urban historical demography has also been influenced by the shift in research emphasis away from work on demographic crises and mortality toward nuptuality and fertility. Age at marriage, proportions marrying and re-marrying, marital and non-marital fertility, and the practices of breastfeeding or using wet nurses are factors drawn on in explaining long-term changes in the population growth rates of cities, as well as differences among urban environments.

Cities as Parasites or Growth Engines?

Economic historians have long debated whether cities should be regarded as parasites or engines of economic growth. This debate reflects a sense of ambivalence in Western culture toward the city. While the city states of ancient Greece and Rome, and renaissance Italy, represented the pinnacle of civilization—indeed they were its defining expressions—the merchant and industrial cities of more recent centuries generated strong and mixed emotions. Malthus regarded Georgian London as rich yet debauched, while to lexicographer and author Samuel Johnson (1709–1784) it exemplified the very vitality of life. Demographers have also expressed mixed feelings. In 1987 economic historian E. A. Wrigley, for example, depicted seventeenth and eighteenth century London as a "death trap," but he also demonstrated its importance for economic and social change in preindustrial England. London absorbed England's surplus rural population; it acted as a single, integrated market for food products and consumer goods as well as finance; it stimulated agricultural production especially in its region; and it set the social fashions and was the center of political power. Until the rise of the industrial cities of the English midlands, London had no rivals, and even afterward the competition was relatively short lived. Florence in the fifteenth century, on the other hand, has been likened to a shining sun in a countryside drained of wealth and enterprise.

Urbanization

Urbanization depends on the ability of the urban population of a country or region to grow at a faster rate than its non-urban population. Usually this implies that the urban sector is experiencing natural growth and net in-migration from the rural sector, although it may also involve reclassification of places from rural to urban as they acquire larger populations or non-agricultural functions. In principle, it is possible for urbanization to progress while the graveyard effect persists, but rapid urbanization requires rapid urban growth and that demands both net transfers from the rural to the urban population and the capacity of city dwellers to more than replace themselves. In the past, rates of urbanization have been slow, although with considerable variations between regions. Western Europe was perhaps 8 to 10 percent urban by 1800 and 30 to 35 percent urban by 1900, whereas China only reached 36 percent urbanization in 2000. These varying historical levels of urbanization are difficult to interpret. Apart from the problem of different definitions of "urban," they probably reflect both variations in the progress of economic development and culturally based attitudes to the urban way of life: tolerated in Europe, restricted in China.

See also: *Family Reconstitution; Historical Demography; Urbanization; World Population Growth.*

BIBLIOGRAPHY

de Vries, Jan. 1984. *European Urbanization, 1500–1800.* London: Methuen.

Galley, Chris. 1998. *The Demography of Early Modern Towns: York in the Sixteenth and Seventeenth Centuries.* Liverpool: Liverpool UniversityPress

Malthus, Thomas Robert. 1989 (1803). *An Essay on the Principle of Population.* Cambridge, Eng.: Cambridge University Press.

Sharlin, Allan. 1978. "Natural Decrease in Early Modern Cities: A Reconsideration." *Past and Present* 79: 126–138, and 92: 175–80.

van der Woude, Ad, Jan de Vries, and Akira Hayami, eds. 1990.*Urbanization in History.* Oxford: Clarendon Press.

Woods, Robert. 2000. *The Demography of Victorian England and Wales.* Cambridge, Eng.: Cambridge University Press.

Wrigley, E. A. 1987. *People, Cities and Wealth.* Oxford: Blackwell.

Robert Woods

CITIES, FUTURE OF

The twenty-first century will be the first urban century, as the world largely completes its "urban transition." With the proportion of the world's population living in urban areas projected to pass the 50 percent mark in 2007, cities are increasingly the arena for the most important developments affecting people's lives, such as globalization, economic transformation, cultural diversification, ecological change, political movements, and even warfare. As the rural-to-urban shift continues, attention has been switching from simple measures of urbanization toward the redistribution of population among different sizes and types of urban settlement, the physical and social restructuring of individual cities and their wider urban regions, the quality of life offered by these places, and the governance issues raised by these changes, not least the challenge of ensuring their sustainability and reducing their vulnerability.

Distribution of Urban Population by City Size

According to the United Nations, 39.5 percent of the world's urban population were living in agglomerations of at least 1 million residents in the year 2000. According to projections, this proportion is expected to grow, at least in the first fifteen years of the twenty-first century, reaching 43 percent by 2015. The share of the urban population accounted for by "megacities" of at least 10 million residents more than doubled between 1975 and 2000, but even then stood at less than 1 in 10 and is projected to increase only marginally by 2015. At the other end of the scale, urban settlements with under 500,000 inhabitants were home to half of the world's urban people in 2000, indicating that the median city size of urban areas stood at 500,000. Further details are provided in Table 1.

The distribution of urban populations by city size varies among world regions. The share accounted for by cities of at least 10 million residents in the Less Developed Regions (LDRs) had already overtaken that in the More Developed Regions (MDRs) by 2000 (Table 1). At 15.1 percent, it was then highest in Latin America and the Caribbean, but through to 2015 it is expected to fall in all major regions except Asia. Meanwhile, Europe is distinctive in its large share of urban residents living in agglomerations of under 500,000 inhabitants, but is similar to

North America in that the share is expected to grow. Great care, however, is needed in interpreting these figures, especially where planning controls have restricted the continuous built-up area of a settlement but not its functional reach.

The Largest Urban Agglomerations

The rise in the number of agglomerations with at least 5 million inhabitants was one of the major demographic trends of the late twentieth century and is continuing in the twenty-first. Rising from a mere eight in 1950 to 22 in 1975, the number reached 41 in 2000 and is expected to grow to 59 by 2015, according to the United Nations. Moreover, this growth has become almost entirely a phenomenon of the LDRs. In 1950 LDRs accounted for only two of the eight, but by 2015 their tally will have risen to 48, including all but one of the extra 18 expected to be added to this roster between 2000 and 2015.

Many of these large agglomerations are growing rapidly, but the population of some has stabilized, at least within their defined boundaries (Table 2). Bombay (Mumbai), Lagos, and Dhaka are expected to experience spectacular growth, putting them in a position to pass Tokyo in size soon after 2015. On current trends Tokyo is expected to have the same number of residents in 2015 as in 2000, while New York, fifth in 2000, is expected to slip to eighth in the list by 2015. Even some LDR agglomerations that previously grew rapidly are now gaining at more modest rates, including São Paulo, Mexico City, and Buenos Aires. The numbers living in agglomerations of 5 million people or over are expected to increase by 205 million between 2000 and 2015, but little more than half of this increase is due to population growth in the cities in this category in 2000; the rest will be due to additional cities entering the category.

Counterurbanization and Reurbanization

The slowing growth rate of some of the largest urban agglomerations, along with the expected decrease in the share of the urban populations living in megacities, can be related to the phenomenon of counterurbanization. The term itself is normally restricted to the shift in population distribution down the city-size hierarchy, though it can also refer to above-average population growth in rural, or non-metropolitan, areas. Population deconcentration away from large-city regions to smaller ones, or at least a slowing of the rate of metropolitan concentration, was observed quite widely across the developed world in the 1970s. This led to suggestions that a new postindustrial pattern of human settlement was emerging, based principally on more footloose forms of economic activity and aided by improvements in transportation and communications.

A subsequent slowdown in population deconcentration, allied with signs of renewed large-city growth in some MDR countries, has prompted a lively debate about the validity of this interpretation. One suggestion is that all cities go through cycles of development that progress from strong core growth through internal decentralization to a stage when the city as a whole loses out to newer settlements before undergoing a period of reurbanization, as its obsolescent economy and infrastructure are rejuvenated in a new wave of investment. Most cases of renewed large-city growth in the MDRs can be linked to economic restructuring, especially employment increases in service sector activities such as finance, media, government, research, and higher education,

TABLE 1

Distribution of Urban Population by Size of Urban Settlement for Selected Areas of the World, Estimates and Projections, 1975–2015

Area	Population Size Class (millions)	1975	2000	2015
		(percent of urban population)		
World	10.0 or more	4.4	9.2	9.8
	5.0-10.0	8.2	5.4	6.5
	1.0-5.0	21.2	24.7	26.3
	0.5-1.0	11.4	10.5	9.8
	Under 0.5	54.8	50.0	47.6
More developed regions	10.0 or more	4.9	7.4	7.1
	Under 0.5	57.4	53.2	51.9
Less developed regions	10.0 or more	4.0	10.1	10.7
	Under 0.5	52.5	48.6	46.1
Africa	10.0 or more	0.0	8.1	7.4
	Under 0.5	68.0	56.9	53.2
Asia	10.0 or more	5.3	11.1	12.4
	Under 0.5	49.1	46.1	43.2
Europe	10.0 or more	0.0	0.0	0.0
	Under 0.5	63.6	63.0	63.3
Latin America & Caribbean	10.0 or more	10.8	15.1	13.0
	Under 0.5	55.9	47.7	45.4
North America	10.0 or more	8.8	12.5	11.4
	Under 0.5	44.1	38.7	40.7
Oceania	10.0 or more	0.0	0.0	0.0
	Under 0.5	42.6	44.1	42.5

Note: Size class is based on millions of inhabitants. Urban settlements are classified according to size in the year shown (i.e. a floating definition). Except for the world, only the top and bottom of the five size classes are shown.

SOURCE: United Nations (2000).

TABLE 2

Population of the World's Twelve Largest Urban Agglomerations in 2000 and Projected to 2015

	2000		2015	
Rank	Name	Population (millions)	Name	Population (millions)
1	Tokyo	26.4	Tokyo	26.4
2	Mexico City	18.1	Bombay/Mumbai	26.1
3	Bombay/Mumbai	18.1	Lagos	23.2
4	Sao Paulo	17.8	Dhaka	21.1
5	New York	16.6	Sao Paulo	20.4
6	Lagos	13.4	Karachi	19.2
7	Los Angeles	13.1	Mexico City	19.2
8	Calcutta	12.9	New York	17.4
9	Shanghai	12.9	Jakarta	17.3
10	Buenos Aires	12.6	Calcutta	17.3
11	Dhaka	12.3	Delhi	16.8
12	Karachi	11.8	Metro Manila	14.8

SOURCE: United Nations (2000).

and, often, to acceleration in international immigration. Sociodemographic factors have also played a part. A period of high fertility and family building occurring between the 1950s and the 1970s was followed by one with lower fertility, greater frequency of divorce and separation, and the rapid growth of non-family households with a decreased preference for suburban and small-town lifestyles.

The Changing Internal Form of Cities

The traditional, preindustrial form of an urban settlement is one with a central meeting place for transactional activities such as commerce, government, and worship, surrounded by housing, workshops, and neighborhood services and with the wealthiest, most influential inhabitants living closest to the center. Industrial cities also tended to grow around a single center, though in this case the focus was the zone of factories that were the reason for their growth, and it was the low-paid, including recent immigrants, that lived closest to the center amid the factory-generated pollution and squalor. Better-off people, with more secure jobs, higher incomes, and shorter working hours, tended to move to lower-density areas toward the edge of these cities—a process that accelerated with improvements in passenger transport, especially the development of the automobile. Suburbs—so named because these areas were situated beyond the main urban core and lacked employment opportunities and urban facilities such as high-level services—dominated the physical growth of cities through most of the twentieth century.

The twenty-first-century city looks as if it will be very different from the inherited monocentric city with its surrounding suburbs. Suburbs have altered in character as manufacturing has been relocated there to take advantage of larger sites and better access to intercity highways and as shopping and office centers have grown up close to the wealthier residents and to mothers wanting to work while raising their families. Cities that are essentially products of the automobile age, of which Los Angeles remains the classic example, developed a more polycentric urban form from the outset. Similarly, older established cities have seen the emergence of "edge cities" and similar out-of-town retail/office complexes that have drawn trade and jobs from their main cores and in some cases threatened to eclipse them. At the same time, the industrial city's distinction between wealthier suburbs and poorer central city has been breaking down as lower-income families have found homes in more peripheral locations through government-subsidized housing schemes and illegal squatter settlements. Low-income migrants arriving in cities are less likely than in the past to settle in their core, now tending to be spread more evenly across the whole metropolitan area.

There remains, however, intense speculation over the future form of cities. At one extreme is the possibility of a return to the form of the preindustrial city, with an acceleration of the back-to-the-city movement of younger professional people and also perhaps of the wealthier elderly wishing to participate in a resurgence of cultural activities there. In direct contrast is the idea that, with further improvements in transport and telecommunications, exurban development will become the norm, incorporating the further growth of edge cities but leading on to an even more dispersed pattern of settlement than traditional urban sprawl. Melvin Webber's "nonplace urban realm" or what Edward Soja calls the "exopolis" would be characterized by lack of structure and absence of cores, where the only type of center that individuals would be able to experience is their own home. Possibly both these patterns will be represented in some parts of some countries, but the norm is more likely to be some amalgam comprising an extensive urban field with a set of interlinked components that vary in terms of their functional specialization and population characteristics—like the Megalopolis as originally articulated by Jean Gottmann.

Quality of Life in Cities

The stereotypical image of cities includes congestion, high costs, worn-out infrastructure, and a generally poor quality of life, to be contrasted with notions of a "rural idyll." The large city, even before the nineteenth century, was a place to be avoided on account of its problems in dealing with human and animal waste and the attendant problems of disease, which gave rise to sudden demographic crises as well as underlying high mortality. The suburban marrying of the urban and the rural, most consciously articulated in the notion of the "garden city," has traditionally been seen to offer the best of both worlds. Moreover, by primarily involving the middle class, the middle-aged, and the dominant ethnic group, the suburban movement has reinforced the negative image of the "inner city," leaving behind those with fewer resources to support both their own households and communal services. The resultant higher levels of deprivation, morbidity, and ethnic tension, and also crime, violence, and other antisocial behavior, have only served to fuel the urban exodus.

This picture of the "urban penalty" has, however, been challenged, not just by the changing form of the city but most notably by the experience of LDRs. The introduction of modern medicine and the basic public-health infrastructure to LDRs, proceeding faster in larger urban areas than in more remote rural regions, has given rise to an "urban advantage." This has been most marked in terms of health and longevity, but has affected the quality of life more generally, aided by the availability there of greater opportunities for work and education. Urban areas have also been associated with fuller emancipation of women and declining fertility. On the other hand, the urban advantage in the LDRs is now seen as being under threat from several quarters, including the deterioration of economic conditions, reductions in government spending on urban health infrastructure, the rise of virulent communicable diseases including HIV/AIDS, and not least the continuing urban population explosion. The general vulnerability of the least developed countries to problems that include economic uncompetitiveness, social inequalities, environmental pressures, internal ethnic tension, terrorism, and international political conflict, are increasingly being focused on their cities, raising questions about the long-term sustainability of their recent gains in living standards.

Governance Issues

Political and administrative factors have always had a major influence on the growth and nature of cities and on the living standards enjoyed by their residents, even if more immediate events led to the wholesale collapse of cities in earlier civilizations. Even without the military operations that have engulfed cities in such troubled parts of the globe as the Balkans, the Middle East, the former Soviet Union, and Afghanistan, the quality of governance can make a huge difference. Notable examples in the past include Singapore's drive toward "world city" status under the leadership of Prime Minister Lee Kwan Yew and the salvaging of New York City's reputation and pride by Mayor Rudolph Giuliani, helping it to withstand the trauma of the terrorist attack on September 11, 2001.

Even in MDRs, the future pattern of urban governance is by no means clear. Probably the most contentious issue is whether the larger urban agglomerations should be administered by a single elected body, albeit with a lower tier of local government. Where central cities are administered separately from their suburbs, it appears that greater social inequalities develop and overall metropolitan performance can suffer. Except perhaps in the smallest or most centralized countries, neither national governments nor provincial authorities, where they exist, have proven adequate to secure the required extent of internal redistribution of resources or to achieve the needed degree of inter-agency coordination for these complex urban regions. Throughout the urban system, however, issues arise concerning the level to which government should be decentralized, whether single authorities should control all aspects of governance or if tasks should be split between separate boards, and the manner in which the executive powers should be subject to democratic accountability.

Given the fragile state of affairs prevailing in many LDRs, these issues would seem to be even more crucial for their cities; and they are probably more intractable. A key problem is the sheer pace of urbanization, which renders obsolete the forms of governance that for generations had generally served well for what were largely rural territories, and makes it difficult for city boundaries to keep up with the mushrooming reality on the ground. One challenge is the unifying of urban and rural jurisdictions in order to take account of the increasingly close interaction between city cores and their hinterlands. Since these evolving metropolitan regions tend to be central to national economic prosperity, there is a strong argument that if they are to reach their full potential they should not remain under the restrictive control of local government. And the hierarchical nature of traditional governance does not fit well with the emerging structures based on networks and horizontal relationships.

See also: *Residential Segregation; Suburbanization; Urbanization; World Population Growth.*

BIBLIOGRAPHY

Batten, David F. 1995. "Network Cities: Creative Urban Agglomerations for the 21st Century." *Urban Studies* 32 (7): 313–327.

Brockerhof, Martin. 2000. "An Urbanizing World." *Population Bulletin* 55 (3): 1–44.

Castells, Manuel. 1997. *The Rise of the Network Society.* Oxford: Blackwell.

Champion, Tony. 2001. "Urbanization, Suburbanization, Counterurbanization and Reurbanization." In *Handbook of Urban Studies,* ed. Ronan Paddison. London: Sage.

Garreau, Joel. 1991. *Edge City: Life on the New Frontier.* New York: Doubleday.

Gottmann, Jean. 1961. *Megalopolis: The Urbanized Northeast Seaboard of the United States.* New York: Twentieth Century Fund.

National Academy of Science Panel. 2002. *Report of the NAS Panel on Urban Population Dynamics.* Washington, D.C.: National Academy of Sciences.

National Research Council. 2002. *Cities Transformed: The Dynamics of Urban Demographic Change in Developing Countries.* Panel on Urban Population Dynamics, Mark Montgomery and Richard Stren, ed. Washington D.C.: National Academy Press.

Pacione, Michael. 2001. *Urban Geography: A Global Perspective.* London and New York: Routledge.

Soja, Edward. 1992. "Inside Exopolis." In *Variations on a Theme Park: The New American City and the End of Public Space,* ed. Michael Sorkin. New York: Hill and Wang.

United Nations. 2000. *World Urbanization Prospects: The 1999 Revision.* New York: United Nations.

United Nations Centre for Human Settlements. 1996. *An Urbanizing World: Global Report on Human Settlements, 1996.* Oxford: Oxford University Press for United Nations Centre for Human Settlements (Habitat).

———. 2001. *Cities in a Globalizing World: Global Report on Human Settlements, 2001.* London and Sterling, VA: Earthscan Publications Ltd. for United Nations Centre for Human Settlements (Habitat).

Webber, Melvin M. 1964. "The Urban Place and the Nonplace Urban Realm." In *Explorations into the Urban Structure,* eds. Melvin. M. Webber et al. Philadelphia: University of Pennsylvania Press.

Tony Champion

CITIES, SYSTEMS OF

Systems of cities are human interaction networks and their connections with the built and natural environments. The study of city systems is a subcategory of the more general topic of settlement systems. Once humans began living in fairly permanent hamlets and villages, it became possible to study the interactions of these settlements with one another. It is rarely possible to understand such settlements without knowing their relationships with the rural and nomadic populations that interact with them. Archaeologists and ethnographers map out the ways in which human habitations are spread across space, providing a fundamental window on the lives of the people in all social systems. The spatial aspect of population density is perhaps the most fundamental variable for understanding the constraints and possibilities of human social organization. The settlement size distribution—the relative population sizes of the settlements within a region—is an important and easily ascertained aspect of all sedentary social systems. The functional differences among settlements are a fundamental aspect of the division of labor that links households and communities into larger polities and systems of polities. The emergence of social hierarchies is often related to size hierarchies of settlements; the monumental architecture of large settlements is related to the emergence of more hierarchical social structures, such as complex chiefdoms and early states.

The Growth of City Systems

Uruk, built in Mesopotamia on the floodplain between the Tigris and Euphrates Rivers about 5,000 years ago, was the first large settlement that we call a city. Other cities soon emerged on the floodplain, and this first system of cities materialized in a region that had already developed hierarchical settlement systems based on complex chiefdoms. For seven centuries after the emergence of Uruk, the Mesopotamian world-system was an interactive network of city-states competing with one another for glory and for control of the complicated transportation routes that linked the floodplain with the natural resources of adjacent regions. The relationship between cities and states is a fundamental aspect of all complex social systems. The political boundaries of states are rarely coterminous with the interaction networks in which settlements are embedded, and so settlement systems must be studied internationally.

Both cities and states got larger with the development of social complexity, but they did not grow smoothly. Cycles of growth and decline and sequences of uneven development are observed in all the regions of the world in which cities and states emerged. The invention of new techniques of power and production made possible more complex and hierarchical societies. The processes of uneven development by which smaller and newer settlements overcame and transformed larger and older ones has been a fundamental aspect of social evolution since the invention of sedentary life.

The role of city systems in the reproduction and transformation of human social institutions has been altered by the emergence and eventual dominance of capitalist accumulation. Whereas the most important cities of agrarian tributary states were primarily centers of control and coordination for the extraction of labor and resources from vast empires by means of institutionalized coercion, the most important cities in the modern world have increasingly supplemented the coordination of force with the manipulations of money and the production of commodities.

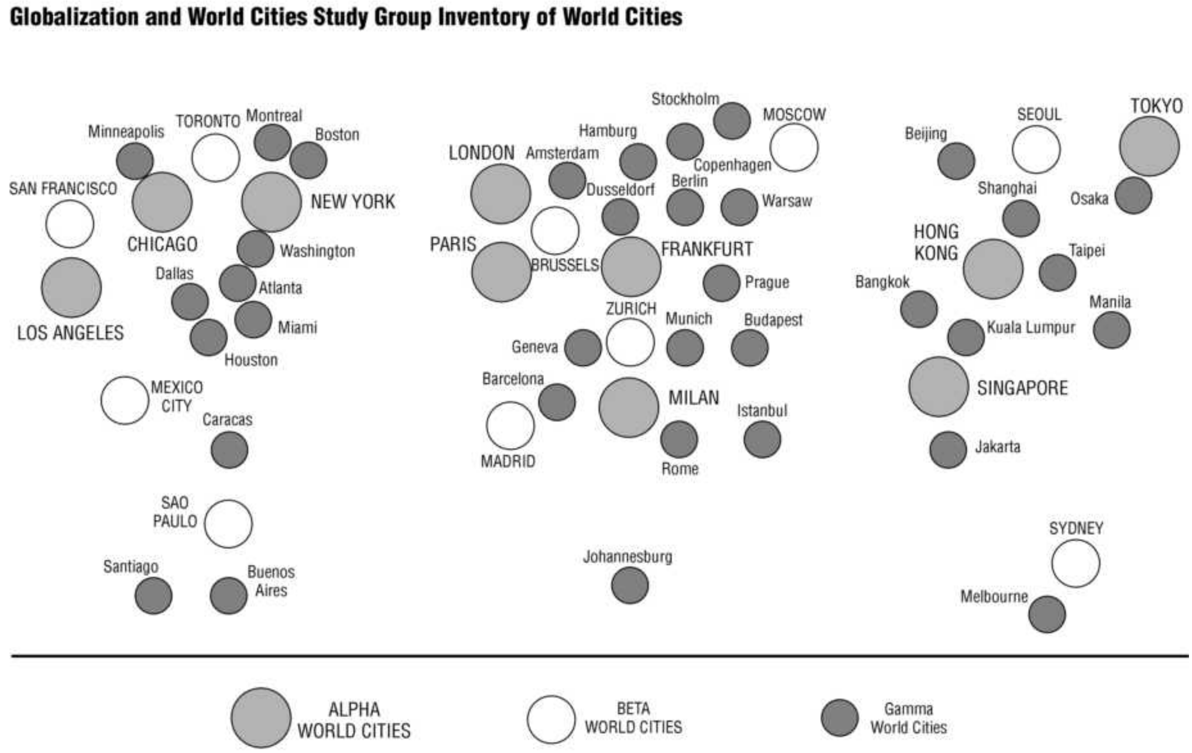
The long rise of capitalism was promoted by semiperipheral capitalist city-states, usually maritime coordinators of trade protected by naval power. The fourteenth century Italian city-states of Venice and Genoa are perhaps the most famous of these, but the Phoenician city-states of the Mediterranean exploited a similar interstitial niche within a larger system dominated by tributary empires. The niche pioneered by capitalist city-states expanded and became more dominant through a series of transformations from Venice and Genoa to the Dutch Republic (led by seventeenth-century Amsterdam) and eventually the nineteenth-century *Pax Britannica,* coordinated by Victorian London, the great world city of the nineteenth century. Within London the functions mentioned above were spatially separated: empire in Westminster and money in the City. In the twentieth-century hegemony of the United States these global functions became located in separate cities (Washington, DC and New York City).

Global Cities

The great wave of globalization in the second half of the twentieth century has been heralded (and protested) by the public as well as by social scientists as a new stage of global capitalism with allegedly unique qualities based on new technologies of communication and information processing. Some students of globalization claim that they do not need to know anything about what happened before 1960 because so much has changed that the past is not comparable with the present. Most of the burgeoning literature on global cities and the world-city system joins this breathless present-ism. But claims about the uniqueness of contemporary globalization can only be empirically evaluated by studying change over time, and by comparing the post–World War II wave of globalization with the great wave of international trade and investment that occurred in the last decades of the nineteenth century. All social systems have exhibited waves of spatial expansion and intensification of large interaction networks followed by contractions. Researchers should investigate which aspects of the current wave are unique and which are repetitions of earlier pulsations. Historical comparison is essential for understanding the most recent incarnation of the system of world cities.

According to theorists of global capitalism, during the 1960s the organization of economic activity entered a new period expressed by the altered structure of the world economy: the dismantling of industrial centers in the United States, Europe, and Japan; accelerated industrialization of several Third

FIGURE 1



SOURCE: Beaverstock, Taylor, and Smith (1999).

World nations; and increased internationalization of the financial industry into a global network of transactions. With the emerging spatial organization of the "new international division of labor," John Friedmann identified a set of theses known as the "world city hypotheses" concerning the contradictory relations between production in the era of global management and political determination of territorial interests. Saskia Sassen and others have further elaborated the "global city hypotheses." Global cities, it is argued, have acquired new functions beyond acting as centers of international trade and banking. They have become: concentrated command points in the organization of the world-economy that use advanced telecommunication facilities, important centers for finance and specialized producer service firms, coordinators of state power, sites of innovative post-Fordist forms of industrialization and production, and markets for the products and innovations produced. During the 1990s New York City specialized in equity trading, London in currency trading, and Tokyo in large bank deposits. Jon Beaverstock, Peter Taylor, and Richard Smith use Sassen's focus on producer services to classify 55 cities as alpha, beta, or gamma world cities based on the presence of accountancy, advertising, banking/finance, and law firms (see Figure 1). The website of the Globalization and World Cities Study Group and Network at Loughborough University is a valuable resource for the study of systems of world cities.

The most important assertion in the global cities literature is the idea that global cities are cooperating with each other more than world cities did in earlier periods. The most relevant earlier period is that of the *Pax Britannica,* especially the last decades of the nineteenth century. If this hypothesis is correct, the division of labor and institutionalized cooperative linkages between contemporary New York City, London, and Tokyo should be greater than were similar linkages between London, Paris, Berlin, and New York City in the nineteenth century. Obviously communications technologies were not as developed in the nineteenth century, though intercontinental telegraph cables had already been laid, and Japan was not yet a core power in the world-system. But support for the hypothesis would require fuller investigation of the nature and strength of coordination among nineteenth-century world cities.

Another important hypothesis of the global cities literature is based on Sassen's (1991) observations about class polarization and the part-time and temporary employment within globalizing cities. The research of Gareth Stedman Jones on Irish immigration into London's East End in the nineteenth century shows that a somewhat similar process of peripheralization of the core was occurring during the *Pax Britannica.*

Analyzing Global Cities

Much of the research on the global city system is based on case studies of particular cities that seek to identify the processes leading to their emergence and positioning within the larger system. Janet Abu-Lughod traces the developmental histories of New York City, Chicago, and Los Angeles through their upward mobility in the world city system. While these U.S. metropolises share similar characteristics with other world cities, they have substantial differences in geography, original economic functions, transportation, and political history and serve as fascinating cases for comparative analyses of globalization.

With appropriate data, social network analysis can be a valuable tool for studying the webs of flows and connections among cities, including flows of capital, commodities, information, and people. Network analysis produces quantitative indicators of structural characteristics of networks and of nodes (cities) within networks. For example, measures of network centrality are useful for examining the hierarchical aspects of the world city system. Quantitative measurement of the structures of connections and dominance relations among cities—whether these are based on links to global commodity chains, international business, financial and monetary transactions, or critical flows of information, can provide an important window on change over time in the global urban hierarchy.

The data necessary for analyzing the structure of the world city system are difficult to obtain because most statistical information is aggregated at the national level rather than at the city level. But researchers are making heroic efforts to locate data on characteristics of and interactions among cities. For example, using airline passenger flows between the world's leading cities for 1977 through 1997, David Smith and Michael Timberlake offer evidence of change in the structure of the world city system. These data estimate the frequency of face-to-face contacts among corporate executives, government officials, international financiers, and entrepreneurs that grease the wheels of global production, finance, and commerce. Among other findings, their results place London, New York City, and Tokyo at the top of the global city hierarchy, supporting Sassen's views. Further, while many core cities continue to occupy central positions in the global hierarchy, network roles of other cities have shifted during this time. Latin American world cities have declined in their central positioning and strength in network linkages, while Asian cities and secondary cities on the West Coast of the United States (the Pacific Rim) have moved into more central positions within the world city system.

Settlement systems continue to be a fundamental framework for the analysis of social change. The megacities in powerful and more minor countries, and the high density of cities on most continents that is revealed by satellite photos of city lights at night would seem to portend Isaac Asimov's *Trantor,* a planet entirely encased by a single steel-covered city. But if the reaction against twentieth-century globalization resembles the reaction against nineteenth-century globalization, the Earth's settlement system may be soon facing difficulties that even Asimov did not envision. The global village needs to invent mechanisms of integration that can transcend the centrifugal forces that have so often beset the modern system of cities in recent centuries.

See also: *Central Place Theory; Cities: Future; Density and Distribution of Population; Geography, Population; Geopolitics; Urbanization.*

BIBLIOGRAPHY

Abu-Lughod, Janet L. 1999. *New York, Chicago, Los Angeles: America's Global Cities.* Minneapolis: University of Minnesota Press.

Baum, Scott. 1997. "Sydney, Australia: A Global City? Testing the Social Polarization Thesis." *Urban Studies* 34(11): 1881–1901.

Beaverstock, Jon V., Peter J. Taylor, and Richard G. Smith. 1999. "A Roster of World Cities." *Cities* 16: 445–458.

Brenner, Neil. 1998. "Global Cities, Global States: Global City Formation and State Territorial Restructuring in Contemporary Europe." *Review of International Political Economy* 5: 1–37.

Chase-Dunn, Christopher. 1992. "The Changing Role of Cities in World-Systems." In *World Society Studies,* ed. Volker Bornschier and Peter Lengyel. Frankfurt and New York: Campus Verlag.

Friedmann, John. 1986. "The World City Hypothesis." *Development and Change* 17: 69–84.

———. 1995. "Where We Stand: A Decade of World City Research." In *World Cities in a World-System,* ed. Paul Knox and Peter Taylor. New York: Cambridge University Press.

Grosfoguel, Ramon. 1994. "World Cities in the Caribbean: the Rise of Miami and San Juan." *Review* 17: 351–381.

Hall, Peter. 1996. "The Global City." *International Social Science Journal* 48: 15–23.

Jones, Gareth Stedman. *A Study in the Relationship Between Classes in Victorian Society. Part 1: The London Labour Market and the Causal Labour Problem.* London: Penguin.

Kowarick, L., and M. Campanario. 1986. "San Paulo: the Price of World City Status." *Development and Change* 17: 159–174.

Machimura, Takashi. 1992. "The Urban Restructuring Process in the 1980s: Transforming Tokyo into a World City." *International Journal of Urban and Regional Research* 16: 114–128.

Sassen, Saskia. 1991 and 2001. *The Global City: New York, London, Tokyo.* 2nd edition Princeton, NJ: Princeton University Press.

———. 2000. *Cities in a World Economy.* Thousand Oaks, CA: Pine Forge Press.

Slater, Eric. 2000. "The Return of the Capitalist City: Global Urbanism in Historical Perspective." Ph.D. diss., State University New York, Binghamton.

Smith, David A. 2000. "Urbanization in the World-System: A Retrospective and Prospective." In *A World-Systems Reader: New Perspectives On Gender, Urbanism, Cultures, Indigenous Peoples, And Ecology,* ed. Thomas D. Hall. Boulder, CO: Rowman and Littlefield.

Smith, David A., and Michael Timberlake. 1995. "Cities in Global Matrices: Toward Mapping the World-System's City System." In *World Cities in a World-System,* ed. Paul L. Knox and Peter J. Taylor. New York: Cambridge University Press.

———. 1998. "Cities and the Spatial Articulation of the World Economy through Air Travel." In *Space and Transport in the World-System,* ed. Paul Ciccantell and Stephen G. Bunker. Westport, CT: Greenwood Press.

———. 2001. "World City Networks and Hierarchies, 1977–1997: An Empirical Analysis of Global Air Travel Links." *American Behavioral Scientist* 44: 1,656–1,678.

Todd, Graham. 1995. "Going Global in the Semi-periphery: World Cities as Political Projects, the Case of Toronto." In *World Cities in a World-System,* ed. Paul L. Knox and Peter J. Taylor. New York: Cambridge University Press.

Yeoh, Brenda. 1999. "Global/Globalizing Cities." *Progress In Human Geography* 23: 607–616.

INTERNET RESOURCE.

Globalization and World Cities Study Group and Network, Loughborough University. 2002. <http://www.lboro.ac.uk/gawc/>.

Christopher Chase-Dunn
Andrew Jorgenson

CLIMATE CHANGE AND POPULATION

HISTORY	Roderick J. McIntosh
FUTURE	Brian C. O'Neill

HISTORY

Climate change results from alterations (sometimes quite subtle) to the heat and mass exchange between land, ocean, atmosphere, ice sheets, and space. The major driving forces of climate change are those generated by plate tectonics (the distribution of mass around the world) and variation in incoming solar radiation (*insolation*).

Relatively small changes in plate tectonics can have large and geographically distant consequences.

The beginning of the northern hemisphere ice ages, for example, can be linked to uplift between 4 and 5 million years ago (abbreviated Ma) that shut off the Isthmus of Panama and altered flow of the seas around Indonesia and Iceland. Around 5.9 Ma, the shift and crunch of the African land mass moving against Europe produced the Messinian Salinity Crisis. The Mediterranean Sea dried out to a stark salt desert, then refilled with water and redried multiple times. The familiar Mediterranean climate ended, disrupting eastern African forests and, apparently, changing the trajectory of primate evolution—these climate changes yielded the divergence of the evolutionary lines, leading to chimpanzees and humans.

Seemingly small deviations in the amount of incoming solar radiation can have enormous and sometimes abrupt effects on climate. Overlapping solar cycles of different periods produce a complex rhythm of solar radiation reaching the earth. Terrestrial cycles in turn influence how much of that insolation strikes different latitudes. Further complicating matters, heat is transported along the ever-changing land-ocean-atmospheric system, and water vapor and other gasses keep some fraction of heat from reradiating out into space.

There are solar production cycles with periods of 11.2, 22, 66, 80, 150, and 405 years. Total insolation passed to the Earth is also affected by a 2,400-year cycle in the Earth's magnetic field and (perhaps) by a return, about every 100,000 years, of intergalactic dust clouds. However, the climate effects are often unpredictable. For example, the well-attested 11.2 year sun-spot cycle is correlated with an approximately 11 year cycle of oscillations in the global monsoonal system, upon which a majority of the world's populace depends for its rains. While the Indian Ocean and Asian monsoons generally correlate well with the West African monsoons, sometimes the latter can be out of phase with the sun-spot cycle. This happened in 1985, frustrating predictions of an early end to the Sahelian Drought.

Three other driving mechanisms of climate change, all well-researched, are the variations in insolation controlled by the so-called Milankovitch or orbital-beat cycles. These are:

1. Eccentricity (changes in the shape of Earth's orbit), cycling at 100,000 years, overlain by an important 413,000 year "complementary eccentricity" cycle;
2. Obliquity (changes to the tilt of the Earth's axis), cycling at 41,000 years; and
3. Precession (shifting schedule of the equinoxes), with a paired cyclicity of 23,000 and 19,000 years.

The overlay of these cycles produces a complex rhythm. For example, new dating for the majority of ice ages blanketing the high latitudes over the last several million years reveals a remarkably regular orbit-beat. If continued, this pattern would suggest that the Earth is nearing an end to the current Holocene (interglacial) warm conditions, which have lasted 10,000 years. However, the last time these cycles aligned as they do today (around 420,000 years ago, abbreviated 420 Ka), there was a 30,000-year super-Holocene—more than double the usual duration, very much hotter, and with sea level 15 meters above today's. Whatever the extent of future global warming based on human activities, it is possible that there will be a natural warming trend for another 20,000 years.

Measuring Climate Change

Advances in observation methods, modeling, and research methods, particularly deep-sea drilling and ice-cap or glacial coring, have made the measurement of climate change possible. No less important are advances in absolute dating. Scientists are able to date variability resolvable at the annual and decadal time-scales by dendrochronology, counting the yearly growth of tree rings. Tree-ring growth can also be used to reconstruct annual precipitation—a process called dendroclimatology. Coral, ice cores, and laminated marine drift also allow year-by-year dating in addition to bearing evidence of climate effects. At the century time-scale, climatologists can count the layers in deep-sea cores and begin to explore the record of global temperature change by measuring relative proportions of oxygen isotopes ^{18}O and ^{16}O in the annual strata of ice cores or in shells of marine organisms. For dating at the millennial time-scale, investigators rely upon radiocarbon (^{14}C). At the 100,000 year time-scale, dates can be derived from thermoluminescence, amino acid racemization, and uranium series.

In most parts of the world, precise instrument-measured data on precipitation, temperature, sea surface temperature (SST), and other climate indicators do not extend far back in time. With rare exceptions, such as some Chinese compilations, even the best long-term historical records tend to be anecdotal or refer only to extreme events. However, the combination of these fragmentary records with the accumulating information from ice and coral cores, dendroclimatology, and other seasonal to centennial measures such as oxygen isotope proportions, have revolutionized the study of normal climate variability over the last 10,000 years. These are the foundational data for the global warming debates.

While climatologists cannot directly measure the timing and severity of the hundreds of ice ages that have occurred during the past several million years, they can measure proxies, such as isotopes of oxygen in the ocean waters. Higher levels of ^{18}O oxygen isotopes in the oceans correlate with larger ^{16}O oxygen isotope-enriched ice sheets. The shells or skeletons of phytoplankton or zooplankton that fall to the sea bottom form layers of stratified ooze, identifiable in ocean-bottom cores. Figure 1, based on a 20,000 year long core lifted from the northwest coast of Africa, illustrates the temperature reconstruction of the sea surface as it recovered from its −8.5°C minimum at the Last Glacial Maximum. The same core yields indirect measures of intensified monsoon rains, inferred from decreases in wind-blown dust, and of disintegrating ice, inferred from debris—called *lithics*—carried long distances on ice floes and eventually dropped to the ocean floor as the floes melt. These jagged variations in rainfall and sea surface temperature contrast with the smooth and gradual changes in the Milankovitch values for solar radiation, underscoring the complexity of the Earth's climate systems.

Climate Change in History

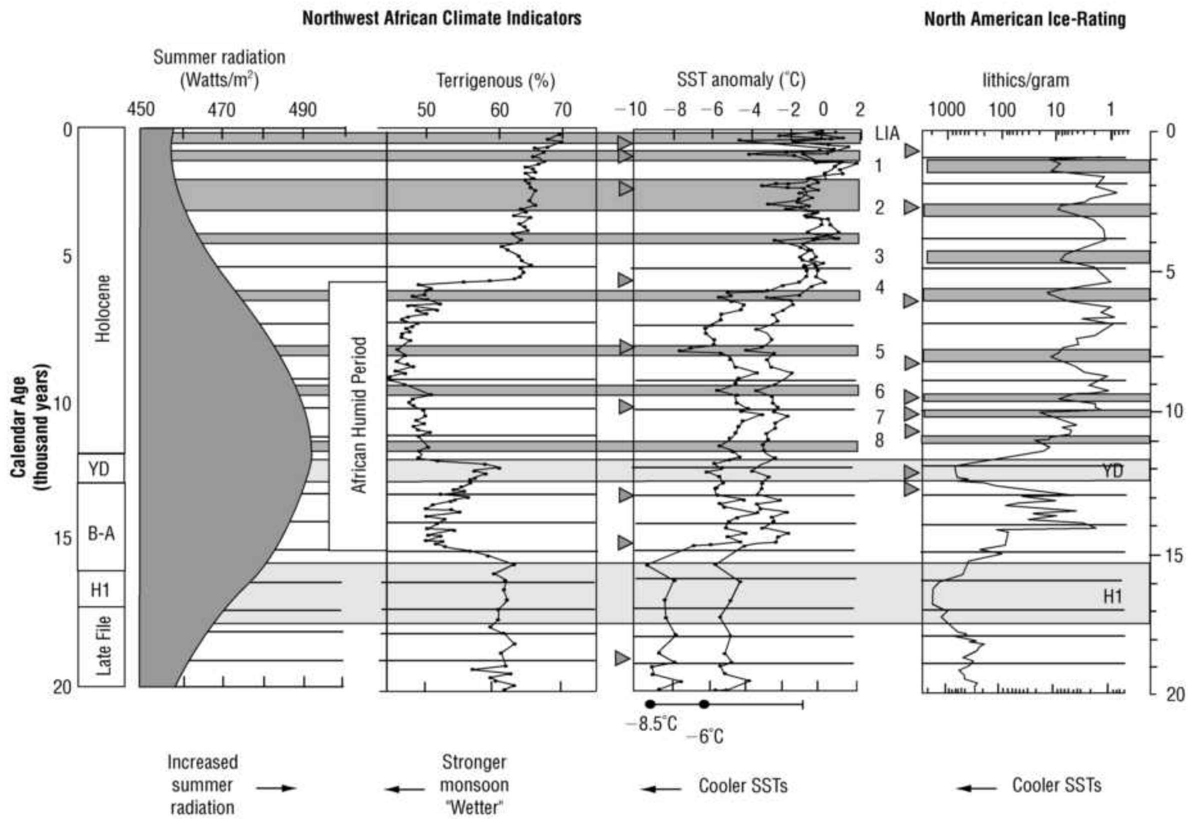
Environmental determinism, popular in the 1920s and 1930s, sought to find climatic and environmental causes for broad historical trends such as the rise or fall of civilizations. Historians and archaeologists now totally reject such efforts. Even at a much more modest level, attempts to correlate climate or habitat variability with societal characteristics (such as ethnic diversity) must be hedged with numerous qualifications. The case for *Homo climaticus* founders on the complexities of culture. Nevertheless, some observations on how humans respond to climate-induced stress and risk are broadly applicable over time and space. The growing field of historical ecology investigates how communities adapt to *normal* conditions, even though these conditions may be characterized by large interannual or interdecadal unpredictability.

The most consequential demographic event in human history occurred during the last glaciation, maybe as recently as 30 Ka Cold-adapted *Homo neanderthalensis* became extinct, perhaps at the hands of his close cousins—*Homo sapiens sapiens,* or modern humans—recently arrived from Africa. Hominids became a mono-species for the first time in over 6 million years. The demographic consequences of this extinction, in terms of territorial and resource competition, are incalculable.

The monumental changes occurring not long after the Late Glacial Maximum of 18 to 16 Ka are apparent in Figure 1. The abrupt and global climate change episodes, called Heinrich Events, would have had devastating effects on non-adaptive communities. Greenland coring shows a severe warming spike at around 15,000 years before the present (abbreviated B.P.), followed by almost 4,000 years of alternating, rapid-onset warm and cold phases, each lasting at least several hundred years. The coldest such phase was the Younger Dryas, which lasted over 1,000 years, beginning c. 13 Ka. At around 11,650 B.P., the Earth warmed five to ten degrees Celsius within perhaps 20 years, an astonishingly sudden increase. A steady rise in sea level—from a low of 121 meters below modern levels around 18 Ka—accompanied this change in global climate at the end of the last glaciation. Archaeology records population dislocations throughout this period, including the movement of Siberian peoples over the Bering Strait land bridge to North America. Archaeology also suggests that c. 15,000 B.P. was a beginning, in the Near East and elsewhere, of radical new dietary and resource habits. Humans showed a new interest in previously ignored plants and animals, matched by migratory ferment as people searched out these new resources—the so-called Broad Spectrum Exploitation. These new habits, the new tools invented for the new foods, and attendant "folk genetic" observations (experience-based knowledge about the effects of purposeful manipulation on future generations of various species) anticipate the first experiments in plant and animal domestication that occur over wide arcs of the Far East, Mesopotamia, Mesoamerica, and savanna Africa at c. 10,000 B.P. With food production came village life, slowly increasing population densities, poor early city sanitation and other public health conditions, and epidemic-scale

FIGURE 1

Proxy Measures of 20,000 Years of Climate Change



Note: Reconstruction of climate change based on a deep-sea core from northwest coast of Africa. Terrigenous - wind-blown dust in core originating from land; SST - sea surface temperature; LIA - Little Ice Age(s). Indicator marks show position of radiometrically-dated samples within the core.

SOURCE: Courtesy of P. DeMenocol.

evolutionary epidemiology, arising from the new intimacy of humans and their animal partners.

While it is not possible to say that these early Heinrich Events *caused* agriculture and pastoralism, the intensified adjustments humans made to climate change clearly included experiments in food production. Globally, the oceanic conveyor system had stabilized in the warm Holocene mode after around 10,000 B.P.; however, there were hiccups in the system at 7,500 B.P. (warm Hypsithermal), at 4,500 to 4,000 B.P. (cold sub-Boreal), at 2,760 to 2,510 B.P. (sub-Atlantic), and at 950 to 1100 C.E. (Medieval Warm Epoch). Some dramatic regional excursions, such as the European Little Ice Ages of the late 1500s to early 1800s C.E., were not global in reach, however profound their effect upon the economies, political life, and social world of the affected communities. While historians cannot say that the Roman Empire collapsed because of the end of the Mediterranean climatic optimum at around 450 C.E., imperial industrial farming in what is now the North African Sahara was effectively shut down by this global change. That change had its contrasting counterpart south of the Sahara in growing populations and trade, including a thriving urban civilization along the Middle Niger.

Beyond these abrupt shifts of global or sub-global climate, populations throughout history have had to adjust to shorter-duration, but equally abrupt stress conditions. Peter DeMenocol (2001) documents the massive collapse of long-established complex state systems associated with drought or instability at around 2200 B.C.E. (Akkadian, Mesopotamia), 600 C.E. (Mochica, Peruvian coast), and 800 to

1000 C.E. (Classic Maya, Yucatan). Although these appear to be climate-caused collapses, other high-density, centralized states safely pass through analogous stresses. The thirteenth century collapse of the pueblo societies of the American Southwest, with precipitous population declines from warfare and out-migration, was plausibly a consequence not of a single event—the Great Drought of 1276 to 1299 C.E.—but of longer episodes of climate unpredictability and environmental degradation at 1130 to 1180 C.E. and 1270 to 1450 C.E. These were communities that had endured severe droughts before, but they lacked the economic and political resilience to counter multi-decade periods of unpredictability.

Even more recently at a still shorter time-scale, but reaching far back in prehistory, populations in large regions of the globe have had to deal with another unpredictable system, made familiar through contemporary weather forecasting: El Niños (in full, El Niño Southern Oscillations, or ENSO) and La Niñas. These are just the most notorious of several global barimetric pressure oscillation systems. ENSO have an apparent period of 3.5 to 4.0 years, but regularly skip a beat. Moreover, they appear to fall into clusters of high or low intensity. In spite of great advances in understanding, ENSO are not entirely predictable. The maize farmer in Zimbabwe may have sufficient advance warning after the onset of an ENSO year, but the anchovy fisherman in Peru may not. The fates of Peru's pre-Columbian civilizations have turned on the interacting quasi-periodicity of the ENSO, as have those of millions of South Asians, the victims of monsoonal-driven periods of drought and plenty.

There is, fortunately, a realistic hope that recognition of the rhythms and causes of climate change can be linked to knowledge of natural and human ecology, alleviating a great deal of suffering. Much is already known about regional modes of rainfall variability: The infamous Sahelian Drought is now known to be one of six recurrent African modes. Twenty-first century research is investigating what causes the abrupt shifts from one mode to another, with the aim of finding means of predicting the next mode shift. Such indicators may one day allow governments and international agencies to devise early warning mechanisms that are not only predictive, but preemptive.

See also: *Paleodemography; Peopling of the Continents; Prehistoric Populations; World Population Growth.*

BIBLIOGRAPHY

Bradley, Raymond S. 1999. *Paleoclimatology. Reconstructing Climates of the Quaternary,* 2nd edition. San Diego: Harcourt.

Cashdan, Elizabeth. 2001. "Ethnic Diversity and Its Environmental Determinants: Effects of Climate, Pathogens, and Habitat Diversity." *American Anthropologist* 103(4): 968–991.

Crumley, Carole L. 1994. *Historical Ecology: Cultural Knowledge and Changing Landscapes.* Santa Fe, NM: School of American Research Press.

Dean, Jeffrey S. 2000. "Complexity Theory and Sociocultural Change in the American Southwest." In *The Way the Wind Blows: Climate, History and Human Action,* ed. Roderick J. McIntosh, Joseph A. Tainter, and Susan Keech McIntosh. New York: Columbia University Press.

DeMenocol, Peter B., Joseph Ortiz, Tom Guilderson, Jess Adkins, Michael Sarnthein, Linda Baker, and Martha Yarusinsky. 2000. "Abrupt Onset and Termination of the African Humid Period: Rapid Climate Response to Gradual Insolation Forcing." *Quaternary Science Reviews* 19: 347–361.

DeMenocol, Peter B. 2001. "Cultural Responses Top Climate Change during the Late Holocene." *Science* 292(5517): 667–673.

Dunbar, Robert B. 2000. "Climate Variability During the Holocene: An Update." In *The Way the Wind Blows: Climate, History and Human Action,* ed. Roderick J. McIntosh, Joseph A. Tainter, and Susan Keech McIntosh. New York: Columbia University Press.

Droxler, Andre, and J. Farrell. 2000. "Marine Isotope Stage 11 (MIS 11): New Insights for a Warm Future." *Global and Planetary Change* 24: 1–5.

Fagan, Brian M. 1999. *Floods, Famines, and Emperors: El Niño and the Fate of Civilizations.* New York: Basic Books.

———. 2000. *The Little Ice Age, How Climate Made History, 1300–1850.* New York: Basic Books.

Hsu, Cho-yun. 2000. "Chinese Attitudes Towards Climate." In *The Way the Wind Blows: Climate, History and Human Action,* ed. Roderick J. McIntosh, Joseph A. Tainter, and Susan Keech McIntosh. New York: Columbia University Press.

Krijgsman, W., F. J. Hilgen, I. Raffi, F. J. Sierro, and D. S. Wilson. 1999. "Chronology, Causes and Progression of the Messinian Salinity Crisis." *Nature* 40: 652–655.

McIntosh, Roderick J., Joseph A. Tainter, and Susan Keech McIntosh, eds. 2000. *The Way the Wind Blows: Climate, History and Human Action.* New York: Columbia University Press.

National Research Council. 1999. *Global Environmental Change: Research Pathways for the Next Decade.* Washington, D.C.: National Academy Press.

Nicholson, Sharon E. 2000. "The Nature of Rainfall Variability over Africa on Time Scales of Decades to Millennia." *Global and Planetary Change* 26: 137–158.

Taylor, Kendrick. 1999. "Rapid Climate Change." *American Scientist* 87(4): 320–327.

RODERICK J. MCINTOSH

FUTURE

The threat of human-induced climate change, popularly known as global warming, presents a difficult challenge to society. The production of so-called greenhouse gases. (GHG), as a result of human activity, mainly due to the burning of fossil fuels such as coal, oil, and natural gas, is expected to lead to a generalized warming of the Earth's surface, rising sea levels, and changes in precipitation patterns. The potential effects of these changes are many and varied—more frequent and intense heat waves, changes in the frequency of droughts and floods, increased coastal flooding, and more damaging storm surges—all with attendant consequences for human health, agriculture, economic activity, biodiversity, and ecosystem functioning. Some of these consequences could be positive—for example, increased agricultural productivity in some areas—but most are expected to be negative. Responding to this challenge is complicated by the considerable uncertainty that remains in projections of how much climate will change, how severe, on balance, the effects will be, how they will be distributed geographically, and how costly it would be to reduce greenhouse gas emissions. In addition, the long-term nature of the effects of climate change means that if emissions are reduced now, the costs will be borne in the near term while the (uncertain) benefits will be realized largely in the long term—decades and even centuries into the future. Moreover, because sources of emissions are widely dispersed among nations, no single country can significantly reduce future global climate change just by reducing its own emissions. Any solution to the problem must eventually be global. Demographic factors are important to all of the key aspects of the climate change issue: they play important roles as drivers of greenhouse gas emissions, as determinants of the effects of climate change on society and ecosystems, and in considerations of climate change policy.

Population and Greenhouse Gas Emissions

Most studies of the influence of population on energy use and greenhouse gas emissions focus on population size and fall into one of two categories: decomposition analyses and sensitivity analyses. A smaller number consider additional compositional variables such as age structure and household type. Limited attention has been given to the potential role of urbanization.

Decompositions of emissions rates into components attributable to each of several driving forces have been performed on national and regional data on historical emissions, on scenarios of future emissions, and on cross-sectional data. All such decompositions begin with a multiplicative identity, a variation of the well-known *I-PAT* equation as applied to greenhouse gas emissions. *I-PAT* describes the environmental impact (*I*) of human activities as the product of three factors: population size (*P*), affluence (*A*), and technology (*T*). The goal in such exercises is to quantify the importance of the *P, A,* and *T* variables in producing environmental impacts, usually in order to prioritize policy recommendations for reducing them. However, such exercises suffer from a long list of ambiguities inherent in decomposing index numbers (such as the *I* in *I-PAT*) that make results difficult, if not impossible, to compare.

There are a number of ways to perform the decomposition, and each method leads to a different result. In addition, the choice of variables to include in the decomposition, differences in the level of disaggregation, the need to consider interactions between the variables on the right-hand side of the equation, and the inertia built into trends in individual variables all affect the results and complicate interpretation. These ambiguities have been the basis of attacks on methods of quantitative analysis and have generated heated scientific debates about the relative importance of various factors without, however, resulting in any clear resolutions.

An alternative approach to analyzing the role of population in energy use and carbon dioxide emissions has been sensitivity analysis—that is, comparing scenarios from an energy-emissions model in which various assumptions about driving forces are tested in a systematic way. Models used in such studies have ranged from simple *I-PAT*-type formulations to more complex energy-economy models. Most work to date has focused on the influence of population size: On balance, the results indicate that although population momentum limits the plausible range of population sizes over the next several decades, in the longer term alternative patterns of population growth could exert a substantial influence on projected emissions. Incorporating relationships between population growth and income growth can substantially change the emissions expected from particular demographic and economic scenarios, but does not significantly change the sensitivity of results to alternative population growth assumptions.

Work focused on both direct energy use by households and indirect use (energy used in the production and transport of other goods consumed by the household) has identified household characteristics as key determinants of residential energy requirements. Household size appears to have an important effect (independently from income), most likely due to the existence of substantial economies of scale in energy use at the household level. Age is also important: Other things equal, households headed by the middle-aged tend to have higher consumption and energy requirements than those headed by the young or the old. These patterns, when combined with projected changes in the composition of populations by age and living arrangements, imply that compositional change may have an important effect on aggregate energy use and emissions above and beyond the scale effect of population size.

There have been few studies of the potential for urbanization (and spatial patterns of settlement in general) to affect future greenhouse gas emissions. Generally, this factor is considered only implicitly in emissions scenarios by assuming it to be essentially an income effect. However, analysis of cross-national variation in energy use and emissions suggests that urbanization leads to greater emissions above and beyond the influence of per capita income.

Population and the Effects of Climate Change

Demographic factors will strongly influence the effects that climate change may have on society, as well as influencing the ways that societies respond to those effects. Perhaps most directly, the expected increase in the population of low-lying coastal areas as urbanization (and urban deconcentration) proceeds is likely to exacerbate the effects of future sea level rise associated with global warming, including increased damage from extreme weather events. In addition, there are potential impacts—some of which might be positive—on agricultural production, one of the most intensively studied areas of climate change consequences; at the same time, population growth will raise the demand for food and fiber. The potential for climate change to expand the numbers of environmental refugees has also attracted wide interest. While global climate change may not presage a century of massive refugee movement, stresses associated with global change may intensify the pressures that already drive internal, regional, and intercontinental migration.

Future levels of fertility, population growth, and age structure will each play a role in societal responses to the effects of climate change. For the remaining high-fertility countries, a case can be made that lower fertility at the household level and slower population growth at the regional and national levels would ease the challenges faced by countries in the areas of health, migration, and food production. A qualification specific to health is that lower fertility accentuates population aging and thus puts pressure on health resources. Another, general, qualification is that policies affecting fertility are unlikely to be key strategies, since more direct means of improving social resilience under conditions of stress are available. Among these are better management of agricultural resource systems, more vigorous development and equitable distribution of health resources, and elimination of institutional rigidities that trap impoverished populations in environmentally unstable environments.

Population and Climate Change Policy

Many population-related policies—such as voluntary family planning and reproductive health programs, and investments in education and primary health care—improve individual welfare among the least well-off members of the current population. They also tend to lower fertility and slow population growth, reducing GHG emissions in the long run and improving the resilience of populations vulnerable to climate change. Therefore, they qualify as win-win policies of the sort identified for priority action in analyses of the potential effects of climate change. The existence of a climate-related external cost to fertility decisions lends support to such programs, not only because they assist couples in having the number of children they want, but also because they tend to lower desired fertility. Several studies have estimated the magnitude of these external factors to be on the order of hundreds to thousands of dollars per birth. These estimates depend on a number of factors, including geographical location (on average, births in developing countries where consumption is lower have a smaller external effect than births in industrialized countries), the magnitude of assumed future greenhouse gas emissions reductions, the costs of emissions reductions, and the discount rate. Nonetheless, the conclusion that the external costs are substantial appears to be robust, partly because meeting long-term climate change limitation goals will eventually require steep emissions reductions, and a smaller population inevitably reduces the need for the most expensive emissions reductions at the margin.

These conclusions do not imply that population policies are the most effective or equitable policies for addressing potential problems of climate change. More direct means of reducing GHG emissions and enhancing the functioning of institutions are available. Arguably, however, policies related to population should be part of a broad range of policies to reduce greenhouse gas emissions and to improve social resilience to the expected effects of climate change, and of global environmental change in general. Population-related policies have not yet entered explicitly into serious discussions of climate change policy. Little consideration has been given even to differential population growth among industrialized countries when negotiating country-specific emissions reduction targets. This is likely due to the sensitivity of the issue, given the long-running debate over the relative importance of population size and growth, as compared to high levels of per capita consumption, in affecting the environment in a deleterious fashion.

See also: *Ecological Perspectives on Population; Energy and Population; Natural Resources and Population.*

BIBLIOGRAPHY

Bongaarts, John., Brian C. O'Neill, and Stuart R. Gaffin. 1997. "Global Warming Policy: Population Left Out in the Cold." *Environment* 39(9): 40–41.

Dietz, Thomas, and Eugene A. Rosa. 1997. "Effects of Population and Affluence on CO2 Emissions." *Proceedings of the National Academy of Sciences USA* 94, pp. 175–179.

Ehrlich, Paul R., and John Holdren. 1971. "Impact of Population Growth." *Science* 171: 1212–1217.

MacKellar, F. Landis, Wolfgang Lutz, Christopher Prinz, and Anne Goujon. 1995. "Population, Households, and CO2 Emissions." *Population and Development Review* 21(4): 849–865.

MacKellar, F. Landis, Wolfgang Lutz, Anthony J. McMichael, and Astri Suhrke. 1998. "Population and Climate Change." In *Human Choice and Climate Change,* Vol. 1: *The Societal Framework,* ed. Steve Rayner and Elizabeth L. Malone. Columbus, OH: Battelle Press.

O'Neill, Brian C., F. Landis MacKellar, and Wolfgang Lutz. 2001. *Population and Climate Change.* Cambridge, Eng. Cambridge University Press.

O'Neill, Brian C., and Lee Wexler. 2000. "The Greenhouse Externality to Childbearing: A Sensitivity Analysis." *Climatic Change* 47: 283–324.

O'Neill, Brian C., and Belinda Chen. 2002. "Demographic Determinants of Household Energy Use in the United States." In *Methods of Population-Environment Analysis, A Supplement to Population and Development Review* 28: 53–88.

Parikh, Jyoti, and Vibhooti Shukla. 1995. "Urbanization, Energy Use and Greenhouse Effects in Economic Development." *Global Environmental Change* 5(2): 87–103.

Schipper, Lee. 1996. "Lifestyles and the Environment: The Case of Energy." *Daedalus* 125: 113–138.

Yang, Christopher, and Stephen Schneider. 1998. "Global Carbon Dioxide Emissions Scenarios: Sensitivity to Social and Technological Factors in Three Regions." *Mitigation and Adaptation Strategies for Global Change* 2: 373–404.

BRIAN C. O'NEILL

COALE, ANSLEY JOHNSON

(1917–2002)

American demographer Ansley Johnson Coale was educated entirely at Princeton University (where he earned a B.A., M.A., and Ph.D.) and spent his entire academic career at its Office of Population Research, serving as director from 1959 to 1975. He served as president of the Population Association of America from 1967 to 1968 and as president of the International Union for the Scientific Study of Population from 1977 to 1981.

He was remarkably prolific, publishing more than 125 books and articles on a wide variety of demographic topics. He also trained and served as mentor to many students who later became leaders in the field.

His first influential work was *Population Growth and Economic Development in Low-Income Countries* (1958), coauthored with the economist Edgar Hoover. The results, which showed that slowing population growth could enhance economic development, had a major impact on public policy and set the research agenda in this field. This was followed by *Regional Model Life Tables and Stable Populations* (1966), coauthored with Paul Demeny. These model life tables established new empirical regularities and proved invaluable in the development of later techniques for estimating mortality and fertility in populations with inaccurate or incomplete data. Coale, along with demographer William Brass (1921–1999), pioneered the development and use of these techniques, first explicated in the United Nations manual *Methods of Estimating Basic Demographic Measures from Incomplete Data* (Coale and Demeny, 1967), and in *The Demography of Tropical Africa* (1968).

Coale was an accomplished mathematician (he taught radar at the Massachusetts Institute of Technology during World War II), and his *The Growth and Structure of Human Populations* (1972) is an essential textbook in formal demography. The publication of this book was more remarkable in view of the circumstance that the original source materials (notes, hand-drawn figures, tables), carefully collected over the course of many years, were accidentally discarded by a new custodian who did not recognize their significance; everything had to be reconstructed from scratch.

Perhaps Coale's major scientific contribution was to the understanding of the demographic transition. He was the intellectual architect of the European Fertility Project, which examined the historical decline of marital fertility in Europe. Initiated in 1963, the Project eventually resulted in the publication of eight major country monographs and a concluding volume, *The Decline of Fertility in Europe* (1986), edited by Coale and Susan Watkins, summarizing the change in childbearing over a century in 700 provinces in Europe.

See also: *Demographic Transition; Demography, History of; Fertility Transition, Socioeconomic Determinants of; Renewal Theory and the Stable Population Model.*

BIBLIOGRAPHY

SELECTED WORKS BY ANSLEY J. COALE.

Brass, William, Ansley J. Coale, Paul Demeny, Don Heisel, Frank Lorimer, Anatole Romaniuk, and Etienne van de Walle. 1968. *The Demography of Tropical Africa.* Princeton, NJ: Princeton University Press.

Coale, Ansley J. 1965. "Factors Associated with the Development of Low Fertility: An Historic Summary." In *Proceedings of the World Population Conference, Belgrade, 1965,* Vol. 2. New York: United Nations. 205–209.

———. 1970. "Man and His Environment." *Science* 170 (October 9): 132–136.

———. 1972. *The Growth and Structure of Human Populations: A Mathematical Investigation.* Princeton, NJ: Princeton University Press.

———. 1973. "The Demographic Transition Reconsidered." In *International Population Conference, Liège,* Vol. 1, pp 53–72. Liège: IUSSP.

———. 1974. "The History of the Human Population." *Scientific American* 231(3): 41–51.

Coale, Ansley J., and Paul Demeny. 1966. *Regional Model Life Tables and Stable Populations.* Princeton, NJ: Princeton University Press. (2nd edition, New York: Academic Press, 1983.)

———. 1967. *Methods of Estimating Basic Demographic Measures from Incomplete Data.* New York: United Nations.

Coale, Ansley J., and Edgar M. Hoover. 1958. *Population Growth and Economic Development in Low-Income Countries.* Princeton, NJ: Princeton University Press.

Coale, Ansley J., and Susan Cotts Watkins, eds. 1986. *The Decline of Fertility in Europe.* Princeton, NJ: Princeton University Press.

James Trussell

COHABITATION

Cohabitation can be defined as a nonmarital coresidential union—that is, the relationship of a couple who live together in the same dwelling but who are not married to each other. Such relationships can also be called informal unions, since, unlike marriages, they are normally not regulated by law, nor is the occurrence of a cohabiting relationship officially registered. Cohabitation seems to be increasing in prevalence all over the Western world. The trend is regarded as an inherent part of the transformation of Western family patterns that has been called the second demographic transition. Less is known about cohabitation than about most other demographic phenomena. Detailed information about it, typically focusing on or limited to women only, comes mainly from surveys.

Levels and Trends

The Scandinavian countries have the highest levels of cohabitation in Europe. At the other extreme are the Southern European countries, together with Ireland. The rest of Europe falls in between. In the mid-1990s 32 percent of Swedish women 20 to 39 years old were cohabiting, and 27 percent of Danish women. In southern Europe less than 10 percent of women in this age group were cohabiting—in Italy, only two percent. Countries in the intermediate category show figures in the range 8 to 18 percent, with France, the Netherlands, Austria, and Switzerland at the high end, and Belgium, Great Britain, and Germany at the low end. Where cohabitation is well established, the first union is almost always a cohabiting union. (In Sweden, less than five percent of young women start their partnered life by getting married.)

Cohabitation in the United States has been increasing, both within cohorts and over time. By 1995 about a quarter of unmarried women between the ages 25 and 39 were living with an unmarried partner. This would place the United States near the lower end of the intermediate European group. Australia and Canada (with the exception of the province of Quebec, where cohabitation occurs more frequently than in the rest of the country) are similarly positioned, while New Zealand is at the upper end of that group.

Trends over time are difficult to assess. It seems likely that cohabitation started to become common in Sweden in the 1960s, followed by Denmark, and somewhat later by Norway. According to Ron Lesthaeghe, there was a second phase, roughly between 1970 and 1985, when premarital cohabitation spread from the Nordic countries to other parts of the developed world. Children born within cohabiting unions also first became a significant share within all births in the Nordic countries. There, by the 1990s, roughly half of all births were nonmarital. (Among first births in Sweden, two-thirds are nonmarital; 84 percent of those are born to cohabiting parents.) Outside Scandinavia, except for a few countries (France, Austria, and New Zealand), cohabiting unions are typically childless. In both Sweden and Austria, the median age at first birth is lower than the median age at first marriage.

Cohabitation everywhere is most common among young people, primarily those in their twenties, but there is also a noticeable trend in many countries for older women increasingly to choose to cohabit instead of marrying after the dissolution of a marriage (postmarital cohabitation).

Cofactors and Explanations

In contemporary Western countries, many choices that were largely socially prescribed in the past have become options. This creates a new set of risks and a higher degree of uncertainty for individuals. New stages in the life course have emerged, resulting in a "destandardization" of family formation patterns. Cohabitation and living independently without a partner before moving into a couple relationship are such stages. Cohabitation can thus be seen as one component in a process in which individual behavior is becoming less determined by tradition and institutional arrangements and more open to individual choice.

It has been argued that those who cohabit desire something fundamentally different from a marital union. Cohabitors may demand more personal autonomy, gender equity, and flexibility; they may have chosen cohabitation in order to avoid binding commitments. However, these desires are likely to change over the life course. Cohabiting couples in Sweden tend to marry at a stage in their life course connected with a preference for union stability. This stage is usually reached after less than five years spent cohabiting and becoming a parent. Attitude surveys confirm that despite the existence of widespread and widely accepted nonmarital cohabitation (even when children are born into those unions), marriage remains a positive option among young adults in Sweden.

Demographers disagree on whether country differences in the prevalence of cohabitation are likely to disappear over time, or if they represent fundamental structural and cultural differences between societies that will persist. Within a society, diffusion theory can describe the spread of the practice. In a first phase, unmarried cohabitation is a distinct deviation from norms, practiced only by those who oppose the institution of marriage or have insufficient means for marriage. In a second phase cohabitation becomes a short-lived (and childless) introduction to marriage. Finally, when social acceptance for cohabitation has become established, cohabiting relationships of long duration become common, as well as childbearing within these unions.

Cohabitation, Union Dissolution, and Fertility

It is well known that cohabiting unions are more fragile than marriages. Differences seem to be most marked at short durations. It has also been shown that married couples who began their relationship by cohabiting face an increased risk of marital dissolution. It is likely that this is due to self-selection of more dissolution-prone individuals into cohabitation before marriage.

With the exception of Sweden, levels of cohabitational childbearing are low in most countries even when cohabitation is common. Within the foreseeable future it does not seem likely that marriage will be replaced by cohabitation as the preferred type of union for procreation. Antonella Pinelli and co-authors have found that cohabitation favors childlessness and postpones the arrival of the first child. Thereby it contributes to lower overall fertility. However, many cohabiting unions are transformed into marriages, and this favors fertility. These complex interrelationships make definite conclusions difficult. On the one hand, the weakening of the norms upholding marriage is likely to have some negative effects on fertility. On the other hand, in egalitarian countries with extensive institutional supports for parenthood, "modern" patterns of behavior, such as cohabitation, may be more compatible with fertility.

Legal Status

As of 2000 France and the Netherlands were the only countries to have instituted formal registration of partnerships for both heterosexual and homosexual couples, making registered cohabitation functionally and legally equivalent to marriage in most respects. Sweden, Denmark, and Finland have taken a more pragmatic approach to cohabiting couples. Over time family law has come to be applied to married and cohabiting couples in much the same way, without completely erasing the differences. For example, cohabiting couples do not automatically acquire inheritance rights on a partner's property, nor do they have the legal responsibility to provide for each other. However, the relationship between parents and their children is regulated in the same way for cohabiting couples as for married couples.

See also: *Family: Future; Fertility, Nonmarital; Marriage; Second Demographic Transition.*

BIBLIOGRAPHY

Bernhardt, Eva. 2002. "Cohabitation and Marriage among Young Adults in Sweden: Attitudes, Expectations and Plans." In *Scandinavian Population Studies,* Volume 13: *Nordic Demography: Trends and Differentials.* Oslo, Norway: Unipub Forlag.

Bumpass, Larry, and Hsien-Hen Lu. 2000. "Trends in Cohabitation and Implications for Children's Family Contexts in the United States." *Population Studies* 54(1): 29–41.

Duvander, Ann-Zofie. 1999. "The Transition from Cohabitation to Marriage: A Longitudinal Study of the Propensity to Marry in Sweden in the Early 1990s." *Journal of Family Issues* 20(5): 698–717.

Kiernan, Kathleen. 2002. "The State of European Unions: An Analysis of FFS Data on Partnership Formation and Dissolution." In *Partnership and Fertility: Unity and Diversity*, ed. Miroslav Macura and Gijs Beets. New York and Geneva: United Nations.

Klijzing, Eric, and Miroslav Macura. 1997. "Cohabitation and Extra-Marital Childbearing: Early FFS Evidence." In *Proceedings of the IUSSP General Conference, Beijing.* Liège: International Union for the Scientific Study of Population.

Lesthaeghe, Ron. 1995. "The Second Demographic Transition in Western Countries: An Interpretation." In *Gender and Family Change in Industrialized Countries*, ed. Karen O. Mason and Ann-Magritt Jensen. New York: Oxford University Press.

Lillard, Lee A. et al. 1995. "Premarital Cohabitation and Subsequent Marital Dissolution: A Matter of Self-Selection?" *Demography* 32: 437–497.

Mills, Melinda. 2000. *The Transformation of Partnerships: Canada, the Netherlands and the Russian Federation in the Age of Modernity.* Amsterdam: Thela Thesis Population Studies Series.

Noack, Turid. 2001. "Cohabitation in Norway: An Accepted and Gradually More Regulated Way of Living." *International Journal of Law, Policy and the Family* 15: 102–117.

Pinelli, Antonella, Alessandra DeRose, Paola Di Guilio, and Alessandra Rosina. 2002. "Interrelations Between Partnership and Fertility Behaviours." In *Partnership and Fertility: Unity and Diversity*, ed. Miroslav Macura and Gijs Beets. New York and Geneva: United Nations.

Eva Bernhardt

COHORT ANALYSIS

A cohort is a set of individual items (usually persons) that have in common the fact that they all experienced a given event during a given time interval. For example, the "U.S. marriage cohort 1995–1999" consists of all persons who got married in the United States in the period from 1995 to 1999. In demography birth cohorts are of particular importance and frequently are referred to simply as cohorts (e.g., "the 1960 cohort" or "cohort 1960," indicating all persons born in 1960).

Cohort analysis is the study of dated events as they occur from the time of the event that initiated the cohort. For example, one can analyze the first births of marriage cohort 1995–1999 or the mortality of birth cohort 1960 (and compare this with the mortality of, say, birth cohort 1930). Cohort analysis often is contrasted with *period analysis*, the study of events occurring in multiple cohorts at a particular historical time, such as during a specified calendar year.

Applications

There are two main applications of cohort analysis. The first could be termed cohort analysis in its own right: the study of how behavior develops over the life course, with the initiating event (e.g., marriage) serving as a key explanatory factor, marking the start of the exposure to risk of the dependent event of interest (e.g., marital fertility). Since the 1980s powerful statistical techniques have been available that allow, using micro-level data, a much more detailed study of how behavior develops over the life course: Besides the event initiating the cohort, a wide range of additional explanatory variables (including time-varying ones) can easily be included.

The second main application is to study temporal variation at the level of the aggregate population through changes in life course behavior over successive cohorts. For example, research seeking to explain the baby boom of the 1960s may focus on the fertility level of the cohorts that were of reproductive age during the 1960s. The underlying idea is that aggregate demographic events cannot be properly understood without paying attention to the conditioning life course situation of the individual members of the population. It is in this sense that the term *cohort analysis* is especially well known in demography, in particular because of the pioneering work of the demographer Norman B. Ryder in the 1950s and 1960s.

Ryder stressed the crucial importance of the flow of successive cohorts into the population (which he termed demographic metabolism) for adapting modern society to changed external conditions. Cohorts differ because they have experienced certain key historical events (e.g., economic conditions, the introduction of the contraceptive pill) at different and sometimes critical ages. History determines a cohort's destiny. Because of this, it is important to differentiate by cohort when one is studying aggregate behavior. An example in demography is the presence of cohort effects in mortality (e.g., Barker 1994): Experiencing a famine or war at younger ages has a permanent impact on survival for the cohorts that are involved.

Demographic Translation

Ryder was also concerned with the relationship between time series of fertility measures on a period basis and those on a cohort basis. Fertility is most commonly measured by demographers in terms of the schedule of age-specific fertility rates (ASFRs) and derived summary statistics, notably the total fertility rate (TFR)—the sum of the ASFRs—and the mean age at childbearing (MAC). ASFRs can be arranged in a Lexis surface, with the period (calendar year) on the horizontal axis and age on the vertical axis. Each ASFR belongs to a period (vertical section) and a cohort (diagonal section). As a consequence, summary statistics such as the TFR can be calculated in two ways: on a period basis, summing ASFRs vertically, and on a cohort basis, summing ASFRs diagonally. If the level (quantum) and timing (tempo) of fertility are constant over time, period and cohort indicators are exactly equal. However, if level and/or timing are not constant, period and cohort indicators are not identical. For example, if subsequent cohorts have their children at increasingly higher ages (fertility postponement; that is, MAC rises over time), the annual number of births is depressed and the period TFR becomes smaller than the cohort TFR for all the cohorts involved.

Ryder investigated the mathematical relationships between such period and cohort time series of fertility indicators, establishing what is now known as demographic translation theory. A famous translation formula is $TFR_{period} = TFR_{cohort} /(1 + \text{annual change in } MAC_{cohort})$, linking period and cohort TFRs under the conditions of a constant quantum of cohort fertility but with the cohort tempo shifting linearly over time. Using this formula, one can calculate the drop in period fertility that results from a postponement of childbearing that does not alter ultimate family size.

Some researchers believe that such translation formulas can be used to estimate cohort fertility from period fertility. The inherent problem in calculating cohort fertility indicators is that one has to wait until the cohort has finished childbearing: For cohorts still of reproductive age, one observes only part of their fertility career (i.e., up until now). It is tempting to try to use the full period information to make statements about these cohorts' future fertility. Unfortunately, such attempts are hazardous. Any procedure used in an attempt to estimate cohort quantum from period quantum is based on simplifying assumptions, the justifiability of which can only be verified empirically: by comparing the estimated cohort fertility with the actual cohort fertility. But if actual cohort fertility is known, the translation procedure is no longer needed.

Hypothetical Cohort

Age-specific indicators of demographic behavior, such as fertility rates and mortality rates, that are all measured during a single period refer to different cohorts. Nevertheless, one can ask what would happen to a cohort if over its lifetime it were to behave according to the age-specific indicators observed during this particular period. For example, it is possible to calculate the average life span of a fictitious group of persons surviving according to the age-specific mortality rates observed in the United States during the year 2002. Such calculations on period data are then interpreted as if they applied to a cohort. Such a cohort is known as a hypothetical cohort or synthetic cohort. Hypothetical cohorts can be very useful analytically but should never be confused with true cohorts, which experience age-specific rates that are typically not independent from one year to the next.

Period versus Cohort?

The work of Ryder and others has initiated a heated and unresolved debate between followers of the cohort approach and adherents of the period approach. In their extreme forms these two approaches as they are applied to fertility can be described as follows:

Cohort approach: Each cohort, shaped by the historical conditions under which it reaches reproductive age, follows its own fertility career. Year-by-year changes in fertility are caused by new cohorts replacing old cohorts in the reproductive age span. Period fertility measures are just the average of the underlying cohort fertility measures.

Period approach: Aggregate fertility is driven by current conditions. If conditions change, period fertility changes also. Cohorts shape their fertility career as they go through time. Cohort fertility measures are just the average of the underlying period fertility measures.

As is always the case with extreme positions, the truth lies in between. The extreme cohort position ignores the fact that cohorts (in fact, individual persons) do not start their reproductive career with cast-iron fertility targets but instead modify their fertility behavior as period conditions change. The extreme period position ignores the fact that family formation is a lifetime enterprise, and as a consequence, period effects affect cohorts differently, depending on the life course position the cohorts currently hold and the fertility choices they have made. For example, a period effect such as the introduction of reliable contraceptives will have a much larger effect on the fertility of cohorts currently 20 years old than on the fertility of cohorts currently 40 years old.

Indeed, a birth cohort is not only a set of individuals born during the same period in the past but also a set of individuals each of whom experiences a period effect at the same stage of the life course (current year = birth year + age). This double significance of the cohort concept alone should make it clear that both the period perspective and the cohort perspective are needed to understand aggregate fertility or any other type of demographic behavior.

Period measures of fertility indicate how many children are born each year and, consequently, how the age structure of the population changes over time. Cohort measures of fertility indicate the extent to which individual members of the population reproduce themselves. Although both sets of measures are taken from the same Lexis surface and therefore refer to the same babies and mothers, the exact relationship between period and cohort measures depends on so many factors (notably, shifts over time in the age pattern of fertility) that it is sensible to treat them as two fundamentally different concepts of the quantum of fertility.

See also: *Baby Boom; Easterlin, Richard A.; Event-History Analysis; Henry, Louis; Lexis Diagram; Life Course Analysis; Ryder, Norman B.*

BIBLIOGRAPHY

Barker, David. 1994. *Mothers, Babies, and Disease in Later Life.* London: British Medical Journal Publishing Group.

Elo, Irma, and Samuel H. Preston. 1992. "Effects of Early-Life Conditions on Adult Mortality: A Review." *Population Index* 58: 186–212.

Hobcraft, John, Jane Menken, and Samuel H. Preston. 1982. "Age, Period and Cohort Effects in Demography: A Review." *Population Index* 48: 4–43.

Ní Bhrolcháin, Maire. 1992. "Period Paramount? A Critique of the Cohort Approach to Fertility." *Population and Development Review* 18: 599–629.

Pressat, Roland. 1972. *Demographic Analysis.* Chicago: Aldine.

Ryder, Norman B. 1964. "The Process of Demographic Translation." *Demography* 1: 74–82.

———. 1965. "The Cohort as a Concept in the Study of Social Change." *American Sociological Review* 30: 843–861.

———. 1968. "Cohort Analysis." In *International Encyclopedia of the Social Sciences,* ed. D. L. Sills. New York: Macmillan and Free Press.

van Imhoff, Evert. 2001. "On the Impossibility of Inferring Cohort Fertility Measures from Period Fertility Measures." *Demographic Research* 5: 23–64.

Wunsch, Guillaume J., and Marc G. Termote. 1978. *Introduction to Demographic Analysis: Principles and Methods.* New York: Plenum.

Evert van Imhoff

COMMON PROPERTY RESOURCES

Throughout the world there are assets that are neither private nor state property, but common property. The term denotes a class of institutions that govern the ownership and rights-of-access to assets. Common property assets are to be distinguished from "public goods," in that, unlike the latter, use by someone of a unit of a common property asset typically reduces the amount available to others by one unit (in economic terminology, such an asset is rivalrous in use). The institution of common property creates and harbors reciprocal externalities. As some of the most interesting examples of common property assets are natural resources, this entry is restricted to them.

Global and Local Commons

Broadly speaking, there are two types of common property resources. Assets that are mobile and have a global reach are subject to "open access," in that everyone in principle has access to them. Earth's atmosphere, as both a source of human well-being and a sink for depositing effluents, is the classic example: For physical reasons, the atmosphere cannot be privatized, nor can it be expropriated by any state. In a pioneering article published in 1954, H. Scott Gordon argued that an asset that is everyone's property is in fact no one's property. He showed that resources under open access are overused, in that it is in the public interest to restrict their use. His reasoning was simple—given that resource bases are finite in size, they have positive social worth. But an open access resource is free to all who use it. So, the cost that each user incurs is less than what it ought ideally to be. Under open access the rents attributable to the resource base are dissipated; there is excessive use. A user tax (or, alternatively, a quota) suggests itself as public policy.

It will be noticed that the production of public goods and the use of open access resources reflect features that are mirror opposites of one another: In the absence of collective action, there is an undersupply of public goods and an overuse of open access resources. Garrett Hardin's admirable metaphor, "the tragedy of the commons" (Hardin, 1968, pp. 1,243–1,248), is applicable to open access resources. Climate change owing to anthropogenic causes is a an example of such a "tragedy." In earlier millennia demand would have been small, and such resource bases as the atmosphere and the open seas would legitimately have been free goods. But in the twenty-first century the matter is different.

However, there are geographically localized resources that are common property to well-defined groups of people, but to which people not belonging to the groups do not have a right of access. It has now become customary to refer to such assets as "common-property resources," or CPRs, which is an unfortunate usage, since open access resources are common property too. In what follows, CPRs are refered to as "local commons."

The theory characterizing the use of local commons was developed by Partha Dasgupta and G. M. Heal (1979, pp. 55–78) as a timeless, noncooperative game involving N players (N>1). Their model took the form of a modified version of the Prisoners' Dilemma game. They showed that if N is smaller than the number who would have exploited the resource had it been open access, rents do decrease to some extent, but not entirely. The authors noted however, that, as the local commons are spatially confined, monitoring one another's use of the resource is possible. The authors thereby argued that communities should in principle be able not only to reach agreement on the use of the local commons, they should also be able to implement the agreement. Dasgupta and Heal explored both taxes and quotas as possible regulatory mechanisms. A large and rich empirical literature on the local commons in poor countries has grown since then, confirming those predictions of the theory (Murphy and Murphy, 1985; Wade, 1988; Ostrom, 1990, 1996; Feeny et al., 1990; Baland and Platteau, 1996; among many others).

Examples of Local Commons

The local commons include grazing lands, threshing grounds, lands temporarily taken out of cultivation, inland and coastal fisheries, irrigation systems, woodlands, forests, tanks, ponds, and recreation grounds. In poor countries property rights to the local commons have been found most often to be based on custom and tradition; they are usually not backed by the kind of deeds that would pass scrutiny in courts of law. Therefore, tenure is not always secure—a vital problem.

Are the local commons extensive? As a proportion of total assets, their presence ranges widely across ecological zones. There is a rationale for this, based on the human desire to reduce risk. Communal property rights enable members of a group to reduce individual risks by pooling their risks. An almost immediate empirical corollary is that the local commons are most prominent in arid regions, mountain regions, and unirrigated areas, and least prominent in humid regions and river valleys. Another corollary is that income inequalities are less in those locations where the local commons are more prominent. Aggregate income is a different matter, though; it is the arid and mountain regions and unirrigated areas that are the poorest.

Studies in a number of dry rural districts in India by N. S. Jodha, published in 1986, have revealed that the proportion of household income based directly on the local commons is in the range 15 to 25 percent. W. Cavendish has arrived at even larger estimates from a study of villages in Zimbabwe published in 2000. The proportion of household income based directly on local commons is 35 percent, the figure for the poorest quintile being 40 percent. Such evidence as Jodha and Cavendish have unearthed does not, of course, prove that the local commons in their samples were well managed, but it does show that rural households would have strong incentives to devise arrangements whereby they *would* be managed.

Are the local commons managed communally? Not invariably, but in many cases they are, or have been in the past. The local commons are typically open only to those having historical rights, through kinship ties or community membership. Their management is mediated by social norms of behavior that arose in long-term relationships among members of the community. An empirical corollary is that, unless the local commons assume a legal status, in the contemporary sense, their management would be expected to break down if members become separately mobile during the process of economic development. Theories of social capital, much discussed in recent years, have found an apt testing ground in the local commons. The management structures of local commons have been found to be shaped by the character of the natural resource under their jurisdiction. For example, communitarian institutions governing coastal fisheries have been discovered to be different in design from those governing local irrigation systems.

That the local commons have often been managed is the good news. There are, however, two unfortunate facts. First, a general finding is that entitlements to products of the local commons is, and was, frequently based on private holdings: richer households enjoy a greater proportion of the benefits from the commons, a finding that is consonant with cooperative game theory. In extreme cases access is restricted to the privileged in the community (for example, caste Hindus in India as shown by Beteille in 1983).

The second unfortunate fact is that the local commons have degraded in recent years in many poorer parts of the world. One reason for this was previously noted: growing mobility among members of rural communities. Another reason has been population pressure, making opportunistic behavior among both locals and outsiders the inevitable response of economic desperation. Yet another reason has had to do with the state establishing its authority by weakening communitarian institutions, but unable or unwilling to replace them with an adequate structure of governance; this situation is observed especially in the Sahel region of Africa.

Fertility Response

Theoretical considerations suggest that there is a connection between common property management and household size. The point is that part of the cost of having children is passed on to others whenever a household's access to common property resources is independent of its size. Moreover, if social norms bearing on the use of the local commons degrade, parents pass some of the costs of children on to the community by overexploiting the commons. This is an instance of a demographic free-rider problem—an externality.

The poorest countries are in great part agriculture-based subsistence economies. Much labor is needed there even for simple tasks. Moreover, households lack access to the sources of energy available to households in advanced industrial countries. In semi-arid and arid regions water supply is often not even close at hand, nor is fuelwood nearby when the forests recede. From age six or so, children in poor households in the poorest countries must help care for their siblings and domestic animals; soon afterwards, they are required to fetch water and collect fuelwood, dung (in the Indian subcontinent), and fodder. Very often, they do not go to school. Children of age from 10 to 15 years old have been routinely observed to work at least as many hours as adult males (Bledsoe 1994; Filmer and Pritchett 2002).

When poor households are further impoverished owing to the deterioration of the commons, the cost of having children increases even though the benefit increases too. D. Loughran and L. Pritchett in their work published in 1998, for example, found in Nepal that households believed that resource scarcity raised the net cost of children. Apparently, increasing firewood and water scarcity in the villages did not have a strong enough effect on the relative productivity of child labor to induce higher demand for children, given the effects that worked in the opposite direction. Degradation of the local commons acted as a check on population growth.

However, theoretical considerations suggest that in certain circumstances, increased resource scarcity (brought about, perhaps, by institutional deterioration) induces population growth. Households find themselves needing more "hands" when the local commons begin to be depleted. No doubt additional hands could be obtained if the adults worked even harder, but in many cultures customary roles do not permit men to gather fuelwood and fetch water for household use. No doubt, too, additional hands could be obtained if children at school were withdrawn and put to work, but in the poorest countries many children do not go to school anyway. When all other sources of additional labor become too costly, more children would be expected to be produced, thus further damaging the local commons and, in turn, providing the household with an incentive to enlarge yet more. Of course, this does not necessarily mean that the fertility rate will increase; if the infant mortality rate were to decline, there would be no need for more births in order for a household to acquire more hands. However, along this pathway poverty, household size, and degradation of the local commons could reinforce one another in an escalating spiral. By the time some countervailing set of factors diminished the benefits of having further children and stopped the spiral, many lives could have been damaged by worsening poverty.

Kevin Cleaver and Götz Schreiber, in a study published in 1994, have provided rough, aggregative evidence of a positive link between population increase and degradation of the local commons in the context of rural sub-Saharan Africa, and N. Heyser (1996) for Sarawak, Malaysia. In a statistical analysis of evidence from villages in South Africa, R. Aggarwal, S. Netanyahu, and C. Romano (2001) have found a positive link between fertility increase and environmental degradation; while D. Filmer and Pritchett (2002) have reported a weak positive link in the Sindh region in Pakistan. Such studies are suggestive of the ways reproductive behavior in poor countries is related to the performance of institutions that govern the local commons.

See also: *Externalities of Population Change; Hardin, Garrett; Natural Resources and Population; Water and Population.*

BIBLIOGRAPHY

Agarwal, Anil, and Sunita Narain. 1989. *Towards Green Villages: A Strategy for Environmentally Sound and Participatory Rural Development.* New Delhi: Centre for Science and Environment.

Agarwal, Bina. 1986. *Cold Hearths and Barren Slopes: The Woodfuel Crisis in the Third World.* New Delhi: Allied Publishers.

Aggarwal, R., S. Netanyahu, and C. Romano. 2001. "Access to Natural Resources and the Fertility Decision of Women: The Case of South Africa." *Environment and Development Economics* 6(2): 209–36.

Baland, Jean-Marie, and Jean-Philippe Platteau. 1996. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* Oxford: Clarendon Press.

Béteille, André, ed. 1983. *Equality and Inequality: Theory and Practice.* Delhi: Oxford University Press.

Bledsoe, C. 1994. "'Children Are Like Young Bamboo Trees': Potentiality and Reproduction in Sub-Saharan Africa." In *Population, Economic Development and the Environment,* eds. K. Lindahl-Kiessling and H. Landberg. Oxford: Oxford University Press.

Cavendish, W. 2000. "Empirical Regularities in the Poverty-Environment Relationships of Rural Households: Evidence from Zimbabwe." *World Development* 28: 1979–2003.

Chopra, Kanchan, Gopal K. Kadekodi, and M. N. Murty. 1990. *Participatory Development: People and Common Property Resources.* New Delhi: Sage.

Cleaver, Kevin M., and Götz A. Schreiber. 1994. *Reversing the Spiral: The Population, Agriculture, and Environment Nexus in Sub-Saharan Africa.* Washington, D.C.: World Bank.

Dasgupta, Partha. 1999. "Social Capital and Economic Progress." In *Social Capital: A Multifacet-*

ed Perspective, ed. P. Dasgupta and I. Serageldin. Washington, D.C.: World Bank.

———. 2000. "Population and Resources: An Exploration of Reproductive and Environmental Externalities." *Population and Development Review* 26(4): 643–689.

Dasgupta, Partha, and G. M. Heal. 1979. *Economic Theory and Exhaustible Resources.* Cambridge: Cambridge University Press.

Dasgupta, P., and K.-G. Mäler. 1991. "The Environment and Emerging Development Issues." *Proceedings of the Annual World Bank Conference on Development Economics 1990* (Supplement to the *World Bank Economic Review*) 101–132.

Feeny, D., F. Berkes, B. J. McKay, and J. M. Acheson. 1990. "The Tragedy of the Commons: Twenty-two Years Later." *Human Ecology* 18(1): 1–19.

Filmer, D., and L. Pritchett. 2002. "Environmental Degradation and the Demand for Children: Searching for the Vicious Circle in Pakistan." *Environment and Development Economics* 7(1): 123–146.

Gordon, H. Scott. 1954. "The Economic Theory of Common-Property Resources." *Journal of Political Economy* 62: 124–142.

Hardin, G. 1968. "The Tragedy of the Commons." *Science* 162: 1,243–1,248.

Heyser, N. 1996. *Gender, Population and Environment in the Context of Deforestation: A Malaysian Case Study.* Geneva: United Nations Research Institute for Social Development.

Jodha, N. S. 1986. "Common Property Resources and the Rural Poor." *Economic and Political Weekly* 21: 1,169–1,181.

Lopez, R. 1998. "The Tragedy of the Commons in Côte d'Ivoire Agriculture: Empirical Evidence and Implications for Evaluating Trade Policies." *World Bank Economic Review* 12: 105–132.

Loughran, D., and L. Pritchett. 1998. "Environmental Scarcity, Resource Collection, and the Demand for Children in Nepal." Poverty, Environment and Growth Working Paper Series 19. Washington, D.C.: World Bank.

McKean, M. 1992. "Success on the Commons: A Comparative Examination of Institutions for Common Property Resource Management." *Journal of Theoretical Politics* 4: 256–268.

Murphy, Yolanda, and Robert Murphy. 1985. *Women of the Forest.* New York: Columbia University Press.

Nerlove, M. 1991. "Population and the Environment: A Parable of Firewood and Other Tales." *American Journal of Agricultural Economics* 75(1): 59–71.

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge: Cambridge University Press.

———. 1996. "Incentives, Rules of the Game, and Development." *Proceedings of the Annual World Bank Conference on Development Economics, 1995* (Supplement to the *World Bank Economic Review* and the *World Bank Research Observer*).

———. 1999. "Social Capital: A Fad or a Fundamental Concept?" In *Social Capital: A Multifaceted Perspective,* ed. P. Dasgupta and I. Serageldin. Washington, D.C.: World Bank.

Ostrom, Elinor, and R. Gardner. 1993. "Coping with Asymmetries in the Commons: Self-Governing Irrigations Can Work." *Journal of Economic Perspectives* 7: 93–112.

Wade, Robert. 1988. *Village Republics: Economic Conditions for Collective Action in South India.* Cambridge: Cambridge University Press.

Partha Dasgupta

COMMUNISM, POPULATION ASPECTS OF

Communist rule was the twentieth century's most dramatic, distinctive, and fateful political innovation. Armed with a utopian but atheist ideology and with powerful, far-reaching state apparatuses built to actualize their official ideals, Communist governments were expressly committed to upending existing earthly economic and political arrangements and constructing in their stead a socialized paradise—that is, "communism"—free from the injustice, alienation, and exploitation that humanity had heretofore suffered under "capitalism" and all other previous historical orders.

Communist governance was distinguished by the absolute and unchallenged primacy of a ruling

Marxist-Leninist party, state ownership of major national industries and other critical "means of production," and a command-style system of "central economic planning" through which political decisions (rather than market forces) allocated goods and services within the national economy. Communist power was initially established over the Russian Empire (renamed the Union of Soviet Socialist Republics [USSR], also known as the "Soviet Union") through the Bolshevik Revolution of 1917; over the following seven decades, war and revolution brought many more populations under Communist sway.

At its zenith—a decade or so before the 1989–1991 collapse of Eastern European socialism and of the Soviet Union—the reach of Communist-style governments stretched across Eurasia from Berlin and Prague to Vladivostok and Shanghai, and from the frozen Siberian tundra down to Indochina; additional Communist outposts could be found in the New World (Cuba) and in sub-Saharan Africa (Ethiopia). In 1980, the world's 17 established Marxist-Leninist states presided over roughly 1.5 billion persons (out of a total world population of approximately 4.4 billion). At that apogee, over a third of humanity lived under regimes that professed the "communist" intent. The encompassed populations represented a remarkable variety of cultures, ethnicities, levels of material attainment, and demographic structures.

Communist Ideology and Its Bearing on Population Policy

Despite their prolixity, the founding theoreticians of Communism offered little concrete guidance to their adherents regarding population affairs. The German political philosopher Karl Marx (1818–1883) railed against the English economist T. R. Malthus (1766–1834) and his demographic theories, calling him "a shameless sycophant of the ruling classes" (Marx 1953, p. 123). However, Marx was completely Delphic about the purported "special laws of population" that he foresaw for socialist and communist society. The German socialist Friedrich Engels (1820–1895) was only slightly more forthcoming. According to his vague assurance, "if . . . communist society finds itself obligated to regulate the production of human beings, just as it does the production of things, it will be precisely this society and this society alone which can carry this out without difficulty" (Engels 1881, p. 109). (Perhaps Marx's and Engels's most important contribution to demographic discourse lay in popularizing the term *proletariat;* interestingly enough, their chosen designation for what they saw as history's destined "class" drew on the Latin word for the lowest rung of classical Rome's citizenry—those viewed as contributing to the state only through having children.)

V. I. Lenin (1870–1924), leader of the Bolshevik Revolution and draftsman of the Soviet state, had almost nothing to say about demographic questions in his small library of writings (apart from a passing observation that the weight of sheer human numbers could bear on the international class struggle). He did, however, famously pronounce that "we [Communists] recognize nothing private" (Schapiro 1972, p. 34)—and that declaration of principle, more than anything else, prefigured the Communist approach to population issues.

For in country after country, Communist regimes eager to reconstitute society through their own variants of "scientific socialism" avowed that there were no legitimate limits on their authority. Given the awesomely ambitious mandate it conferred upon itself, and the essentially unrestricted means it granted itself for accomplishing its own objectives, Communist rule naturally had far-reaching demographic repercussions—though these repercussions were often entirely inadvertent and quite unanticipated by the states that set them in motion.

Mortality

"It is time to realize that of all the valuable capital the world possesses, the most valuable and most decisive is people," the Soviet ruler Joseph Stalin (1879–1953) once declared (Stalin 1945, p. 773). In the spirit of this dictum, Communist governments, after securing power, typically attempted to augment the welfare and productivity of the more disadvantaged classes from the old order through such measures as land redistribution, mass primary schooling and literacy campaigns, and expansion of medical access through an extensive system of state health workers (e.g., *feld'sher* in the Soviet Union, "barefoot doctors" in the People's Republic of China). Under these and allied interventions, local mortality levels usually declined—often at a rapid pace.

Within eight years of China's 1949 Communist victory, for example, reliable estimates suggest the country's life expectancy may have soared by as much as 20 years, while its infant mortality rate may have dropped by half or more. Dramatic progress against disease and mortality was likewise registered in many other, disparate regions under Communist rule. In the late 1950s and early 1960s, for example, estimated life expectancy at birth was 10 to 25 years higher in the Soviet Union's five Central Asian republics than in nearby Afghanistan, Pakistan, or India. In the 1970s, Cuba enjoyed one of the very lowest official infant mortality rates, and one of the very highest expectations of life at birth, of any Caribbean or Latin American country. Perhaps most interesting, independent estimates indicate that the Soviet Union's pace of postwar health progress was so robust that, by the early 1960s, life expectancy in the USSR was almost equal to that in the United States—and Soviet life expectancy was poised to surpass America's if trends continued just a few more years.

But any appreciation of Communism's genuine achievements in improving public health and lowering general mortality also requires an appreciation of the powerful, independent historical factors at play in these outcomes. In both the postwar Soviet Union and early postliberation China, for example, life expectancy was clearly buoyed by the restoration of civil order after prolonged and devastating periods of war and upheaval; mortality levels, in other words, almost certainly would have fallen during those very years, regardless of the particular health policies the governments implemented. Cuba, for its part, could indeed claim to be one of the healthiest Latin countries in the 1970s, but before the 1959 revolution, by the criteria of life expectancy and infant mortality, Cuba had been the *healthiest* country in the tropical Americas. In Eastern Europe, infant mortality rates did decline swiftly in the 1950s under new Communist regimes, but infant mortality rates had also been dropping rapidly beforehand, in the 1920s and 1930s, under the region's previous and now officially reviled ancien régimes. In the Korean peninsula, partitioned after World War II between a Communist North and non-Communist South, something approaching a controlled experiment on the independent contribution to health progress of Communist policies had accidentally been framed; demographic reconstructions suggest the level and pace of improvement in life expectancy in the two Koreas over the quarter century following the 1953 Korean War armistice were virtually identical.

Under the best of circumstances, Communist claims to a superior systemic competence in ministering to the health of the masses were thus somewhat debatable. And the best of circumstances did not always obtain, because under Communist rulers, the radical reconstitution of "feudal" or "capitalist" society very often involved the embrace of ruthless measures that doomed their citizens to death en masse. A precise tally of the human cost of these deadly interventions will probably never be possible, but demographic reconstructions and historical records provide approximate magnitudes.

The collectivization of agriculture in the Soviet Union in 1932–1933 (which resulted in estimated excess mortality of perhaps 4 million in the Ukraine and an additional 2 million elsewhere in the USSR) was but one of numerous deliberate Communist economic campaigns that resulted in massive loss of life for Communist citizens. Virtually every Communist state in Asia suffered famine when its rulers collectivized agriculture. In the case of China, the death toll in the wake of the 1958–1959 "Great Leap Forward" is estimated to be in the range of 30 million. (North Korea's famine, which struck in the mid-1990s, was caused by catastrophic economic mismanagement rather than collectivization. Tentative estimates of its toll range between 600,000 and 1 million or more.) Ethiopia's 1984–1985 food disaster, which may have killed 700,000 people, should also be included in the tally of Communist famines. It can be safely stated that if someone died of famine in the course of the twentieth century, that person probably lived under a Communist government.

State-made famine was not the only form of mortality crisis visited upon the populations of Communist states. State-sponsored violence was also pervasive in Communist regimes and was often meted out to the disfavored and suspect strata of the new society with particular enthusiasm. Under Stalin's absolute rule (1929–1953), millions of Soviet citizens were executed during successive terror campaigns or perished as prisoners under the murderous conditions of the "Chief Administration of Corrective Labor Camps" (better known as the Gulag). In Yugoslavia, Marshal Tito's regime may have killed as many as a million of its ostensible citizens in the 1940s—as many as half a million of them after World War II was over. In China, at least several million landlords and other "bad elements" were slaughtered during the land reform of the early 1950s. Many sources guess that a million or more victims were later claimed by Red Guard terror during Mao Zedong's "Cultural Revolution" that commenced in 1966, with some respectable guesses placing the death toll from the Cultural Revolution as high as 7 million. In Cambodia, the Khmer Rouge's 1975–1979 reign may have consigned a fifth or even more of the country's 7 million people to death by starvation or execution. In theory human beings may indeed be the most valuable capital in the world, as Stalin averred, but in practice under Communist governments many human lives were evidently assigned an official value of zero.

A final noteworthy characteristic of Communist mortality patterns were the long-term increases in death rates that beset the Soviet Bloc in the decades immediately preceding the collapse of the Soviet Union. After rapid and pronounced general mortality declines in the 1950s and early 1960s, age-specific mortality rates for various Soviet age groups began to rise: first middle-aged men, then almost all adult male age groups, then many adult female age groups. In the early 1970s, the official Soviet infant mortality rate recorded significant increases—after which point Moscow forbade release of this bell-weather statistic, and increasingly restricted publication of other mortality data. When Soviet leader Mikhail Gorbachev's glasnost campaign in the late 1980s unveiled, among other things, the previously suppressed mortality figures, it became apparent that Soviet male life expectancy was actually lower, and Soviet female life expectancy only barely higher, than they had been in the early 1960s—an extraordinary outcome for a literate, urbanized, and industrial society during peacetime.

Anomalous though it may have been, the Soviet Union's mortality experience was not unique. By the late 1980s prolonged stagnation or even retrogression in health and mortality levels were being reported in every other Warsaw Pact state in Eastern Europe—and in Communist Yugoslavia as well. (In the decade following the collapse of the Soviet Union, life expectancy in the Soviet Union's former Eastern European satellite states seemed to return to the familiar industrial-society pattern of steady, secular improvements; in every one of the 15 former Soviet republics, however, overall life expectancy was estimated by the U.S. Bureau of the Census to have been lower in 2001 than it was in 1991, the final year of Soviet rule.)

Fertility

Fertility levels under Communism spanned a wide range. At one extreme were populations with extraordinarily high fertility rates, such as Mongolia in the late 1960s and early 1970s, with an estimated total fertility rate of 7.3; at the other extreme were societies where sub-replacement fertility prevailed, such as Hungary from the late 1950s onward. At particular times in given countries, Communist governments have attempted to elicit increases, or alternatively decreases, in national fertility levels, and at still other junctures or in other locales have indicated no particular preference for the course that fertility trends and childbearing patterns should take.

Among the instruments that Communist governments used in pronatal policy (especially in postwar Eastern Europe, with its relatively low levels of fertility) were child bonuses and allowances, increased maternity benefits, and preferential housing allocations. As best as can be determined, however, these incentives provided only a modest stimulus to childbearing, a result quite in keeping with the limited success of pronatal policies attempted in non-Communist countries. On the other hand, Communist governments typically relaxed restrictions on divorce, liberalized access to abortion, and encouraged the use of birth control and family planning techniques. All of these policies might be expected to constrain or perhaps reduce fertility levels to some degree, although again, the demographic impact of such essentially "voluntary" policies was probably modest in most cases.

The swiftest and surest means of altering a population's fertility levels, of course, is *involuntary* family planning. In principle, Communist governments had no objections to such measures, and when specific Communist regimes chose to engineer major and rapid changes in local childbearing patterns, they grasped for precisely these sorts of options.

In Communist Romania, the government of Nicolae Ceausescu limited parental volition over childbearing in an attempt to raise the birth rate. In late 1966, abortion, which had been the primary means of national birth control, was suddenly and unexpectedly proscribed. The following year, Romania's birth rate nearly doubled, though only temporarily; infant and maternal mortality also surged as a result of the surprise decree.

Elsewhere—most notoriously, in China—Communist rulers used coercion to press the birth rate down. In 1979, after a decade of strong antinatal pressure that saw fertility nearly halved, Beijing unveiled the so-called One Child Policy, under which parents had to receive the permission of the state before bringing a pregnancy to term, facing legal, financial, and physical punishments if they failed to comply. Under the One Child Policy, China's fertility level is believed to have fallen below the replacement level (a by-product of the policy was increased underreporting of births)—a result pleasing to China's birth planners, but one purchased through widespread human rights abuses, including involuntary abortions and delivery-room destruction of unapproved newborns. In effect for over two decades (although enforced with varying severity), the One Child Policy received a formal legal basis, as well as reaffirmation, with the adoption of a national law on population and birth planning in December 2001.

Migration

Communist governance came to some societies, such as the German Democratic Republic (East Germany), that were already largely urbanized and industrialized, and to others—Cambodia, Ethiopia, and Mongolia among them—in which urban and industrial transitions had barely begun. Because Communist regimes favored forced-pace modernization—and evidenced a particular fondness for the augmentation of heavy industry—their economic plans correspondingly sought to engineer the movement of people from country to city and from farm to factory. In a very real sense, massive internal migration was indispensable for the success of the Communist planned economy.

What was most distinctive about migration patterns under Communist governance, however, was not the scope of planned migration per se, but rather the scale of *involuntary* migration. In every new Communist regime, a network of political prison camps was established for the newly designated "enemies of the people." Archival documents suggest that in 1953, the year of Stalin's death, the Soviet Gulag and its annexes may have contained over 5 million of the Soviet Union's 190 million people; China's *laogai* likewise processed many millions of political convicts. In Vietnam and elsewhere, distrusted elements of the population were detained for indefinite durations in "reeducation camps." Unlike other Marxist-Leninist governments, the Khmer Rouge in Cambodia forcibly de-urbanized the nation (Cambodia's cities had been temporarily swollen by a wartime exodus from the countryside) and relocated the country's population into a system of makeshift communes and prison camps.

Communist governance also generated large streams of refugees—escapees fleeing from the new order or driven out by some particular policy or practice promoted by the regime. In the wake of the Russian Revolution, for example, out-migration from the Soviet Union is thought to have totaled about 2 million; roughly 2 million Chinese likewise relocated from Mainland China to the island of Taiwan with the Communist victory over the Nationalists in 1949. Between 1945 and 1950, approximately 12 million ethnic Germans (known as *die Vertriebene,* or "the expellees") relocated to West Germany and Austria from regions to the east that had fallen under Communist power. Between 1949 and 1961—when the East German government built the Berlin Wall to stanch its demographic hemorrhage—over 3.5 million citizens of the German Democratic Republic, nearly a fifth of its original population, walked over to West Germany. A roughly similar fraction of the local population fled from North Korea to South Korea after the peninsula's 1945 partition and before the 1953 Korean War ceasefire. It is thought that in the late 1970s about 2 million of Ethiopia's 33 million people fled the incoming *Dergue* (the revolutionary junta that took power in 1974), and that in the decade after Saigon's surrender to Hanoi in 1975, a million or more South Vietnamese left their newly Communized homeland, many as desperate "boat people." And over a million Cubans have emigrated or fled from Cuba since Fidel Castro's seizure of power—a figure that compares with a total Cuban population of about 7 million at the time of the 1959 revolution. Apart from annexation of nearby territories, not a single Marxist-Leninist state experienced any appreciable in-migration of outsiders during its tenure in power.

Population Structure

Given the great variety of mortality schedules and childbearing patterns observed under Communist governments in the twentieth century, it follows that there was no "typical" population structure for a Communist society. But the population structures of Communist societies did nevertheless tend to bear one distinguishing feature: an unusual degree of irregularity. Due in large part to demographic perturbations caused or encouraged by the leadership—many of these perturbations having already been noted above—the age-sex pyramids of Communist countries were typically disfigured by unexpected deficits in particular birth cohorts or by peculiar and biologically aberrant imbalances in the sex ratio. Russia and China offer contrasting examples of the latter phenomenon.

In the Soviet Union's January 1989 census, the sex ratio in the Russian Soviet Federated Socialist Republic (predecessor to the Russian Federation) was just over 88 males per 100 females. That compared with the U.S. sex ratio of about 97. Although part of the difference can, of course, be attributed to Russia's catastrophic losses in World War II, not all of the difference can be so explained: Poland also suffered grievously in World War II, but its 1990 sex ratio was about 95. The Russian Republic's deficit of men spoke not only to World War II (and Stalin's rule) but also to extreme excess male mortality during the peacetime years of the 1960s, 1970s, and 1980s.

In China, on the other hand, the November 2000 census reported a countrywide sex ratio of nearly 107—almost 10 percentage points higher than that of the contemporary United States. Historically, China's population, like that of some other Asian societies, has been marked by a curious deficit of "missing females," due to unusually high differential mortality. Yet in large measure, the current discrepancy is due to an "excess" of males—especially younger males. According to official Chinese reports, China's sex ratio at birth in 2000 was nearly 117; this figure compares with a ratio of 104 to 107 in most other historical human populations. This biologically extraordinary disproportion was an unexpected by-product of the One Child Policy—or more specifically, the conjuncture of extreme pressure for small families, a continuing cultural preference for sons, and the availability of sex-selective abortion. As a result of China's past and continuing population plans, China's future leaders will have to cope with an enormous army of unmarriageable young men.

See also: *Famine in China; Famine in the Soviet Union; Forced Migration; Marx, Karl; Mortality Reversals; One-Child Policy; Optimum Population; Population Policy.*

BIBLIOGRAPHY

Ashton, Basil, Kenneth Hill, Alan Piazza, and Robin Zeitz. 1984. "Famine in China, 1958–61." *Population and Development Review* 10: 613–645.

Banister, Judith. 1987. *China's Changing Population.* Palo Alto, CA: Stanford University Press.

Courtois, Stéphane, Nicolas Werth, Jean-Louis Panne, Andrzej Paczkowski, Karel Bartosek, and Jean-Louis Margolin. 1999. *The Black Book of Communism: Crimes, Terror, Repression.* Cambridge, MA: Harvard University Press.

Eberstadt, Nicholas. 1988. *The Poverty of Communism.* New Brunswick, NJ: Transaction Publishers.

———. 2000. *Prosperous Paupers and Other Population Problems.* New Brunswick, NJ: Transaction Publishers.

Engels, Friedrich. 1953 (1881). "Letter to Kautsky, February 1, 1881," In *Marx and Engels on Malthus,* ed. Ronald L. Meek. New York: International Publishers.

Goodkind, Daniel M., and Loraine A. West. 2001. "The North Korean Famine and Its Demographic Impact." *Population and Development Review* 27: 219–238.

Heuveline, Patrick. 1998. "'Between One and Three Million': Towards the Demographic Reconstruction of a Decade of Cambodian History (1970–79)." *Population Studies* 52(1): 49–65.

Lutz, Wolfgang, Sergei Scherbov, and Andrei Volkov, eds. 1994. *Demographic Trends and Patterns in the Soviet Union before 1991.* New York: Routledge.

Marx, Karl. 1954 (1863). *Theories of Surplus Value,* Vol. II. In *Marx and Engels on Malthus,* ed. Ronald L. Meek. New York: International Publishers.

Meek, Ronald L., ed. 1954. *Marx and Engels on Malthus: Selections from the Writings of Marx and Engels Dealing with the Theories of Thomas Robert Malthus.* New York: International Publishers.

Nydon, Judith A. 1984. "Public Policy and Private Fertility Behavior: The Case of Pronatalist Policy in Socialist Romania." Ph.D. diss., University of Massachusetts.

Petersen, William. 1975. *Population.* New York: Macmillan.

Rummel, R. J. 1998. *Statistics of Democide: Genocide and Mass Murder since 1900.* New Brunswick, NJ: Transaction Publishers.

Schapiro, Leonard B., ed. 1972. *Totalitarianism.* New York: Praeger.

Stalin, J. V. 1945. *Problems of Leninism.* Moscow: Foreign Languages Publishing House.

NICHOLAS EBERSTADT

CONDORCET, MARQUIS DE

(1743–1794)

Marie Jean Antoine Nicolas de Caritat, marquis de Condorcet, was a mathematician, politician, educational reformer, and utopian philosopher in the period leading up to and during the French Revolution. His works in mathematics include a recasting of the mathematical portion of Denis Diderot's *Encyclopédie* in a supplement, *Encyclopédie méthodique* (1784–1785). In the most memorable of his mathematical books, *Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité des voix méthodique* (1785), he argued that in moral sciences the mathematical base of all analysis has to be probability.

While thousands were being conscripted and there were food riots in Paris, Condorcet wrote pamphlets on public education, the rights of women, and other hotly debated issues of the time. In his view inequality in learning fostered tyranny, and it was education that had engendered the Enlightenment. He was a member of the governing group of the Girondins, a party, as Thomas Carlyle put it, of "the respectable washed Middle Classes." A Girondin constitution that Condorcet wrote was rejected in favor of the Jacobin alternative.

In October 1793 the Committee of Public Safety under Maximilien Robespierre (1758–1794) executed the Girondin leaders; Condorcet was tried in absentia and sentenced to death. While in hiding, with revolutionary soldiers and loaded tumbrels passing under his window, he wrote his most famous work, *Esquisse d'un tableau historique des progrès de l'esprit humain,* a history of human progress from its outset to its imminent culmination in human perfection. Soon the human race would attain universal truth, virtue, and happiness. All inequalities of wealth, education, opportunity, and sex would disappear. The earth would provide sustenance without limit, and all diseases would be conquered. "Man will not become immortal," he stated, but "we do not know what the limit is [or even] whether the general laws of nature have determined such a limit."

This book, published posthumously in 1795, is remembered largely because along with the works of William Godwin, it was a target of Thomas Robert Malthus's *Essay on the Principle of Population* (1798). The *Equisse* was, in Malthus's words, "a singular instance of the attachment of a man to principles, which every day's experience was so fatally for himself contradicting." In particular, Malthus objected to Condorcet's belief that the shortage of subsistence brought about by population growth would be automatically canceled. In Malthus's mature theory he also offered a similarly optimistic future, but he believed that the lower classes would adopt the small family typical of the middle class, thus elimination any population crisis.

Condorcet was arrested, reportedly because although he was disguised as a commoner, he ordered an omelet with "an aristocratic number of eggs," and died in prison, possibly by suicide.

See also: *Malthus, Thomas Robert; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY CONDORCET.

Condorcet, Marie Jean Antoine Nicolas de Caritat, marquis de. 1767–1789/1994. *Arithmétique politique: textes rares ou inédits.* Paris: Institut National d'études démographiques and Presses Universitaires de France.

———. 1795. *Esquisse d'un tableau historique des progrès de l'esprit humain.* [Paris: Agasse]. Paris: Dubuisson et Cie., 1864. Translated as *Sketch for a Historical Picture of the Progress of the Human Mind.* Westport, CT: Hyperion Press, 1955.

———. 1846–1849. *Oeuvres,* 12 vols., ed. A. Condorcet O'Connor and M. F. Arago. Paris: Firmin-Didot.

———. 1976. *Condorcet: Selected Writings,* ed. Keith Michael Baker. Indianapolis: Bobbs-Merrill Co.

SELECTED WORKS ABOUT CONDORCET.

Baczko, Bronislaw, ed. 1982. *Une èducation pour la démocratie: Textes et projets de l'époque révolutionnaire.* Paris: Èditions Garnier Fréres.

Dumazedier, Joffre, ed. 1994. *La Leçon de Condorcet: Une conception oubliée pour tous nécessaire à une république.* Paris: Éditions l'Harmattan.

Frazer, James George. 1933. *Condorcet on the Progress of the Human Mind.* Oxford: Clarendon Press.

Goodell, Edward. 1994. *The Noble Philosopher: Condorcet and the Enlightenment.* Buffalo, NY: Prometheus.

Palmer, R. R. 1985. *The Improvement of Humanity: Education and the French Revolution.* Princeton, NJ: Princeton University Press.

Rothschild, Emma. 2001. *Economic Sentiments: Adam Smith, Condorcet, and the Enlightenment.* Cambridge, MA: Harvard University Press.

Schapiro, J. Salwyn. 1978. *Condorcet and the Rise of Liberalism.* New York: Octagon.

William Petersen

CONFERENCES, INTERNATIONAL POPULATION

International conferences have a long history in the affairs of nations, but it was not until a quarter-century after the birth of the United Nations that international conferences began to assume a central role in formulating social policies on a global scale. Since the environmental conference held in Stockholm in 1972, a meeting regarded as highly successful, thematic conferences have become an established mechanism to guide the United Nations and member states in addressing a diverse array of social problems. Participation in these conferences, initially confined to government representatives and technical experts, has increasingly become more open to a broad spectrum of nongovernmental organizations (NGOs).

The Early Years

In the period between World Wars I and II, participants at numerous scientific meetings discussed the perceived dangers inherent in the uneven distribution of world population, and canvassed the possible role for organized migration as a safety valve. The World Population Conference held in Geneva in 1927, though not a League of Nations (predecessor to the United Nations) meeting, was pivotal in moving the League toward engaging with population questions. The conference was organized by Margaret Sanger, who recognized that scientific attention and the mantle of the League of Nations could legitimize "overpopulation" as a subject for discussion in international forums. Sanger invited eminent scientists, but found that their acceptance was conditional on there being no propagandizing for Malthusian ideas or birth control; indeed, she was led to remove her name from the official documentation.

The League was officially unable to accept Sanger's invitation to be represented as an institution, but interested staff were permitted to attend in their personal capacities and the International Labour Office displayed keen interest. An outcome of the meeting was the creation of the International Union for the Scientific Investigation of Population Problems (IUSIPP), a non-governmental organization comprised mainly of demographers and others with a strong interest in population issues. IUSIPP convened three meetings in Europe prior to the outbreak of World War II, meetings marred by Franco-German rivalry and the efforts of Nazi Germany to legitimize its anti-Semitism and demands for lebensraum.

The Scientific Conferences

Birth control remained a sensitive topic in the early years of the United Nations, although there was some support from influential actors and agencies within the U.N. system to move the issue cautiously forward. The United Nations Population Commission sponsored two world population conferences—in Rome in 1954 and Belgrade in 1965—devoted to scientific and technical subjects and structured around research on demographic trends and methods. They were jointly convened with the International Union for the Scientific Study of Population (IUSSP, the successor to IUSIPP) and interested U.N. Specialized Agencies. The conference participants were invited as individual experts rather than as representatives of governments, and the meetings were not authorized to approve resolutions or make recommendations to governments. Nevertheless, while focusing on research aspects of population issues, the meetings allowed some discussion of family planning programs to take place without arousing controversy.

The Inter-Governmental Conferences

The United Nations, with strong support from the United States as well as from some western European and Asian nations, convened the first of three decennial intergovernmental population conferences at Bucharest in 1974. In this conference, and in its successors in Mexico City (1984) and Cairo (1994), representatives of governments replaced the individual experts of earlier years, a change appropriate for discussion of population policy. The context had changed markedly between 1965 and 1974. A number of countries were now feeling the pressures of rapid population growth, and several Asian countries had long since implemented family planning programs. As early as 1961, the UN Economic Commission for Asia and the Far East (ECAFE, later ESCAP) had convened an intergovernmental meeting in New Delhi that had productively discussed population policy. And in 1969, the United Nations Population Fund (UNFPA) had been established with the expectation that it would encourage the United Nations and its agencies to become more active in confronting problems of rapid population growth. Significantly, initial support for the creation of UNFPA came from a voluntary contribution from the United States.

The Bucharest and Mexico City conferences provided the occasion for governments to advance their own political and ideological agendas, often at variance from the organizers' plans and expectations. At Bucharest, a large group of Third World states presented a quasi-Marxist analysis: they argued that population problems were really symptoms of imbalances in the world economic system, and strenuously urged the establishment of a more equitable New International Economic Order responsive to the needs of developing nations. They were also distrustful of the Draft Plan of Action that was submitted for the conference's approval as undermining national sovereignty by laying down a global policy to which all countries would be expected to adhere.

Ten years later at Mexico City, the United States government unexpectedly departed from its earlier stance by rejecting the premise that rapid population growth hindered development. In the midst of President Ronald Reagan's campaign for reelection, in what was widely interpreted as a move to solidify the support of the Republican right wing, the head of the American delegation at Mexico City declared that "population growth is, in itself, a neutral phenomenon" and advocated the adoption of market economies as the answer to rapid population growth (United States 1984). Less government interference in the economy, according to this line of reasoning, would foster economic growth and thereby lower fertility. Additionally, in what turned out to be the most contentious part of the Reagan administration's statement at the Conference, the United States articulated its Mexico City Policy—to withhold U.S. government funds from organizations that performed or promoted abortion in foreign countries using money from non-U.S. sources, extending the prohibition on using U.S. funds for abortion that was already in effect.

Despite the political and ideological differences aired on the floor, both the Bucharest and Mexico City conferences concluded by approving, by a near-consensus, documents that were supportive of family planning programs. Characteristic of recommendations emanating from UN conferences, these action programs failed to elicit a greater commitment to broad population policies, and donor contributions ceased to grow in real terms.

Responding to a general dissatisfaction with developing-country governance, the United Nations and its more influential member states sought to engage more fully with non-government organizations as providers of services and watchdogs of government programs. This was a role that NGOs themselves increasingly were demanding, and for which they were already organizing.

Consistent with this perspective, the secretariat for the International Conference on Population and Development (ICPD)—held in Cairo in September 1994—accredited a total of 1,254 NGOs, the largest number being American. Building on the experience of other UN conferences, especially the Conference on the Human Environment in Rio de Janeiro in 1992, the Cairo secretariat gave NGOs unprecedented access to the conference preparations and proceedings. Already highly organized and supported by several western governments and foundations, the NGOs redefined "population policy," shunning demographic objectives and replacing them with a very broad agenda of women's issues, including women's reproductive and sexual health, gender equality, and women's rights and empowerment. For the first time, the Cairo Programme of Action also included chapters on funding, follow-up activities, and the monitoring of implementation—and allowed for the continued involvement of NGOs. Once the conference was over, the Women's Caucus (organized by NGOs prior to the ICPD) pursued a strategy aimed at ensuring that the Cairo agenda would be endorsed by subsequent UN conferences—notably the Social Summit, the Conference on Human Rights, and the Beijing Conference on Women.

A Retrospective View

With hindsight, the most significant effect of the Cairo conference was the renewed vigor it brought to a somewhat weary field in need of new allies and supporters. While the conference reinvigorated population policy and engendered a high degree of support, especially among women's health groups and feminists, the new dynamism came at a certain cost. At Bucharest and Mexico City, both the ability of individual women to regulate their own fertility and the needs of society to limit population growth were central to the discourse and disagreements. The Cairo process, by contrast, was less concerned with the problems associated with population size and growth. In their place, the Cairo Programme of Action recommended a wide range of reproductive and sexual health services, as well as education, primarily for women and girls. Thus, the turn of the twenty-first century saw two of the great social revolutions of modernity—birth control and women's emancipation—part ways in important respects. It is likely that future international population conferences will recognize these differences and may, of necessity, attempt to bridge them.

See also: *Population Organizations: United Nations System; Population Policy; Population Thought, Contemporary; Sanger, Margaret.*

BIBLIOGRAPHY

Finkle, Jason L., and Barbara B. Crane. 1975. "The Politics of Bucharest: Population, Development and the New International Economic Order." *Population and Development Review* 1(1): 87–114.

———. 1985. "Ideology and Politics at Mexico City: The United States at the 1984 International Conference on Population." *Population and Development Review* 11(1): 1–28.

McIntosh, C. Alison, and Jason L. Finkle. 1995. "The Cairo Conference on Population and Development: A New Paradigm?" *Population and Development Review* 21(2): 223–260.

Notestein, Frank W. 1954. "World Population Conference, Rome, August 31–September 10." *Population Index* 20(4): 241–249.

Singh, Jyoti Shankar. 1998. *Creating a New Consensus on Population.* London: Earthscan Publications.

Symonds, Richard, and Michael Carder. 1973. *The United Nations and the Population Question, 1945–1970.* New York: McGraw Hill.

United Nations. 1995. *Report of the International Conference on Population and Development: Cairo, 5–13 September 1994.* New York: United Nations.

United States. 1984. "Policy Statement of the United States of America at the International Conference on Population." In *Population and Development Review* 10(3): 574–579.

C. Alison McIntosh
Jason L. Finkle

CONTRACEPTION, MODERN METHODS OF

Human reproduction is regulated by a synchronized series of events that result in the production of mature sperm and eggs and the preparation of the woman's reproductive tract to establish and maintain a pregnancy. With a growing understanding of the links in the chain of reproductive events, opportunities to advance contraceptive technology have also increased.

Throughout human history, most societies and cultures have understood that sexual intercourse introduces the male factor responsible for fertilization. Consequently, for centuries people attempted to prevent pregnancy by the simple and direct procedure of withdrawing the penis prior to ejaculation. This practice, termed withdrawal or *coitus interruptus,* has a slang name in virtually every language. In relatively recent times, mechanical barriers or chemicals introduced into the vagina in various formulations have been employed to thwart the sperm. Sperm have been confronted with vulcanized roadblocks or been plunged into creams, ointments, gels, foams, or effervescent fluids containing mercurial compounds, weak acids, soaps, or biological detergents. Strange concoctions used or recommended have ranged from crocodile dung in antiquity to Coca Cola in the twentieth century. Post-coital douching also became popular early in history.

Contraceptive technology finally caught up with modernity when hormones were discovered and scientists turned their attention to the woman's ovulatory cycle. The principle of periodic abstinence timed to avoid coitus near the day of ovulation was the first method of fertility regulation that relied on this new knowledge. This contraceptive method was developed in the 1920 when, independently, two scientists, a Japanese, Kyusaka Ogino, and an Austrian, Herman Knaus, in 1925 recognized that a woman should avoid sex around the middle of a menstrual month if she did not intend to become pregnant.

The Ogino-Knaus method was based on emerging understanding about the endocrinology of the ovarian cycle in women, establishing that ovulation occurs about fourteen days before the first day of the next expected menstrual flow. These pioneer endocrinologists understood when the egg would be released although they did not know how long it remained fertilizable, or how long sperm survive in the fallopian tube. Scientists now estimate that the egg remains viable for one day after its release from the ovary and that the sperm retains its viability in the female tract for six or seven days.

Hormonal Contraceptives for Women

It was several decades before the necessary knowledge was marshaled to develop effective means to prevent ovulation medically and launch the era of hormonal contraception.

The pill. Gregory Pincus, Director of the Worcester Foundation for Experimental Biology in Massachusetts, led the scientific effort that resulted in the first oral contraceptive, recognized around the world simply as *the pill.* Before the pill, twentieth century couples had a limited choice of contraceptive methods, largely ineffective unless used with great diligence. A 1935 survey revealed that contraceptive use in the United States was evenly divided among the condom, douche, rhythm, and withdrawal. Failure rates must have been high, forcing many women to choose between high fertility or illegal and unsafe abortions. Since 1960, when the U.S. Food and Drug Administration (FDA) first approved the pill, more than 130 million women have used the method, avoiding multitudes of unwanted pregnancies and abortions.

Oral contraceptives suppress ovulation using a combination of estrogen and progestin. By 2000, over 50 products with different progestins, lower doses, and various schedules of administration had supplanted the original pill. Some products offer a change in dose over the month, attempting to mimic the hormonal levels of the ovarian cycle. The main modification has been a significant lowering of the amounts of both hormones delivered. Modern oral contraceptives contain less than one-twentieth of the dose of the original pill, which results in a lower incidence of side effects.

The pill has been the subject of greater post-marketing surveillance for safety than any other pharmaceutical product. A study published in 1999 reported on 25 years of follow-up of over 45,000 women. Countless other studies have documented not only the safety but also the non-contraceptive health benefits of oral contraceptives: decreased risk of endometrial and ovarian cancer; decreased risk of colon cancer; decreased anemia; decreased dysmenorrhea; and maintenance of bone density. Oral contraception use also reduces the incidence of benign breast disease (cysts) and does not increase the overall risk of breast cancer, but there are uncertainties regarding long-term use for those who start using the method when they are teenagers. If there is an added health risk, it appears to be small and may be offset by careful surveillance.

Since it was first introduced, the pill has been marketed as a three-week-on and one-week-off method, thus creating a monthly pseudo-menstruation. Over the years, some doctors have counseled women to take the pill continuously to avoid menstruation, both for convenience and for medical reasons. Seasonale®, the first product designed for longer uninterrupted use (for three months at a time) was undergoing final testing for FDA approval in 2003.

Beyond the pill, hormonal contraception has evolved to include the continuous use of a progestin alone by oral administration (the minipill), by injection, or by sub-dermal implants. New delivery systems for estrogen/progestin contraception have created a birth control skin patch and a vaginal ring contraceptive.

Contraceptive injections. Elsimar Coutinho, a Brazilian gynecologist, was the first to demonstrate that injections of 150 mg of the synthetic progestin medroxyprogesterone acetate (Depo-Provera®) can inhibit ovulation for three-month durations. After several decades of use for other gynecological purposes, Depo-Provera® was approved as a contraceptive in the United States in 1993. It offers a high level of effectiveness in preventing pregnancy (99.7%) and the ability to suppress menstruation. An injection every three months replaces the need to remember to take a pill every day. By not having a monthly period, women can avoid monthly cramps, and reduce their risk for endometriosis and uterine fibroids. Although it is as effective as surgical sterilization, the method is reversible; women who wish to become pregnant after stopping the drug usually do so within a year. Because it has no estrogen, this method does not maintain normal bone density, hence it could lead to the development of osteoporosis. An alternative system that addresses this problem combines Depo-Provera® with ethinylestradiol, the estrogen found in many oral contraceptives, taken as a monthly injection. With this system, a woman has a monthly menstruation, and maintains bone density.

Contraceptive implant. Another drug delivery system that provides acontinuous dose of progestin is the sub-dermal implant. The first contraceptive implant was NORPLANT®, developed by scientists at the Population Council in New York. It consists of six flexible tubes of Silastic® containing the progestin levonorgestrel. The contraceptive steroid is released at a slow and relatively constant rate for 5 years. This long-acting characteristic is the main advantage of this and other implant systems. In the case of NORPLANT®, one visit to a clinic for the simple insertion procedure replaces taking a pill daily for five years. Ovulation-suppression is the main mechanism of action. During the first two years of use 80 percent to 90 percent of cycles are clearly anovulatory (no eggs are released). By the fifth year about 50 percent of cycles are ovulatory. The high level of contraceptive protection (99.8%) covering the entire five-year span depends on an additional mechanism of action: the prevention of sperm from ascending into the female reproductive tract, so that fertilization cannot occur. This is achieved through an effect on the woman's cervical mucus. In a normal cycle, the mucus becomes less viscous and more abundant at about mid-cycle, facilitating sperm transport when ovulation is about to occur. In Norplant® users, the mucus remains scanty, thick, and impenetrable to sperm.

Other implant systems have been developed that last for one year or three years, and have the advantage of reducing the number of implants, thus simplifying the insertion and removal procedure. The first single implant method, a three-year system, is IMPLANON®, which contains the progestin etonorgestrel, a so-called third-generation progestin. Another three-year system, JADELLE®, contains the contraceptive hormone levonorgestrel. By 2002, JADELLE® had received FDA approval; IMPLANON® is used in many European countries.

Vaginal ring contraceptive. NuvaRing® is the first monthly vaginal ring for contraception. A woman using the vaginal ring inserts and removes it herself so that it is not a clinic-dependent method. This novel contraceptive was approved for marketing in the United States in 2001. It is based on the combined release of a low dose of progestin and estrogen over a 21-day period of use. The steady flow of hormones (etonorgestrel and ethinyl estradiol) prevents ovulation as its main mechanism of action. Women begin using NuvaRing® around the fifth day of their menstrual period, and leave it in place for three weeks. The ring is removed for a week so that a menstrual flow can occur, and a new ring in placed in the vagina for the next cycle. Since it is not a barrier method, the exact positioning of the ring is not important for its effectiveness (about 99%).

Birth control patch. The ORTHO EVRA™ birth control patch was approved by the FDA in 2001. This transdermal system delivers the combination of a progestin and estrogen (norelgestromin/ethinyl estradiol) in a one-time weekly dose. The system is 99 percent effective. The thin, beige patch delivers continuous levels of the two hormones through the skin into the bloodstream. A new patch is used weekly for three consecutive weeks. The fourth week is patch-free so that a menstrual-like bleeding can occur. Like other hormonal contraceptives, the primary mechanism of action is ovulation suppression. Other contraceptive patches are being developed. One of these employs a transparent material to make the patch less evident, particularly for women with darker skin.

Progestin-releasing intrauterine system. Late in 2000, the FDA approved a levonorgestrel-releasing intrauterine system that had been available in Europe for 10 years. Developed by Population Council scientists, MIRENA® is a long-acting contraceptive that lasts for five years, and is more than 99 percent effective. In addition to its ease of use for women, it has the advantage that menstrual periods tend to become shorter and lighter. Some women experience an absence of menstrual bleeding after one year. Studies suggest several mechanisms that prevent pregnancy: thickening of cervical mucus, which prevents the passage of sperm, inhibition of sperm motility, and suppression of endometrial growth. Approximately eight out of every ten women who want to become pregnant will establish a pregnancy in the first year after MIRENA® is removed. Insertion and removal of MIRENA® is a short procedure done by a trained health care professional.

Emergency Contraception

Post-coital contraception that could prevent a pregnancy from becoming established has been possible for several decades. During the 1960s, orally active estrogenic products were shown to initiate menstrual-like bleeding when taken within a few days of unprotected intercourse. Bleeding and sloughing of the uterine lining means that pregnancy cannot take place even if a fertilized egg is present. In the 1960s, the product used most frequently to cause this was diethylstilbestrol (DES). Subsequently, it was demonstrated that a high dose of the conventional pill, a combination of estrogen and progestin, when taken up to 72 hours after intercourse can prevent pregnancy from becoming established. Now referred to as "emergency contraception," several products have been sold in European countries for many years and two were introduced in the United States in 1999. Prevens® consists of four high-dose oral contraceptive pills all to be taken within 48 hours. A second product, marketed initially in Hungary, is a progestin-only product that causes far fewer of the transient side effects of the combination pill. It is distributed in the United States under the name Plan B®.

Emergency contraception does not work by terminating an early pregnancy. Its action is prior to implantation.

Nonhormonal Intrauterine Devices (IUDs)

Modern inert IUDs. The most widely used reversible contraceptive by global count in 2001 is not any of the hormonal methods but the intrauterine device. The IUD is little used in the United States, but has 120 million users in the developing countries. (It accounts for more than half of all couples using reversible contraception in China, Cuba, Turkey, and Vietnam.) The IUD is also commonly used in Europe: For example, it is used by 30 percent of contracepting women in Sweden and Norway. Its appeal lies in simplicity of use, ease of reversibility, absence of medical side effects, low cost, and high effectiveness.

Modern IUD research began at about the same time that the final stages of research on oral contraceptives were in progress. Despite intensive research, scientists do not fully understand why the presence of a foreign body in the uterus prevents pregnancy. The evidence clearly indicates that the IUD is a prefertilization method: The presence of fertilized eggs in IUD users cannot be demonstrated.

Copper-releasing IUDs. The Lippes loop and other plastic IUDs of the 1960s were highly effective compared to other contraceptive methods, but the real breakthrough in effectiveness occurred when copper-releasing IUDs were developed. This started as a small laboratory research project by Jaime Zipper in Santiago, Chile. It is not known why the release of copper in the uterus is so effective in preventing pregnancy. There is evidence from animal studies that the copper ions released from the copper wire attached to the plastic IUD act to stop most sperm before they reach the fallopian tube, but there are probably other mechanisms of action, as well, that account for the high level of effectiveness in preventing pregnancy. In a seven-year study, the World Health Organization found that the contraceptive effectiveness of the Copper T-380A is equal to that of surgical sterilization. The device maintains its effectiveness for 10 to 12 years. It can be realistically described as reversible sterilization.

Table 1 compares the contraceptive effectiveness of the major modern contraceptive methods in use in 2002, and updated from Hatcher (1998), for which there are adequate data based on a variety of studies.

TABLE 1

Pregnancy Rates Associated with Use of Birth Control Methods

Method	Rate of pregnancy with typical use (%)	Lowest expected rate of pregnancy (%)
Sterilization		
Male Sterilization	0.15	0.1
Female Sterilization	0.5	0.5
Hormonal Methods		
Implant (Norplant™)	0.05	0.05
Hormone Injection (Depo-Provera®)	0.3	0.3
Combined Pill (Estrogen/Progestin)	5	0.1
Minipill (Progestin only)	5	0.5
Interuterine Devices (IUDs)		
Copper T	0.8	0.6
Mirena®	0.1	0.1
Barrier Methods		
Male Latex Condom	14	3
Diaphragm	20	6
Vaginal Sponge (no previous births)	20	9
Cervical Cap (no previous births)	20	9
Female Condom	21	5
Spermicide (gel, foam, suppository, film)	26	6
Natural Methods		
Withdrawal	19	4
Natural Family Planning (calendar, temperature, cervical mucus)	25	1-9
No Method	85	85

Note: Estimates of the percent of women likely to become pregnant while using a particular contraceptive method for one year. "Typical Use" rates assume that the method either was not always used correctly or was not used with every act of sexual intercourse. "Lowest Expected" rates assume that the method was always used correctly with every act of sexual intercourse.

SOURCE: Hatcher, Robert A., et al., eds. (1998).

The fertility transition in less developed countries will have to be accomplished essentially using the present armamentarium of contraceptive devices in combination with other methods of birth control. New contraceptives will need to offer broader product profiles. Couples will be looking for non-contraceptive health benefits, particularly for the prevention of sexually transmitted diseases. High priority is being given to developing a vaginal gel that is microbicidal and spermicidal so that women, on their own initiative, can use a contraceptive that will protect them from sexually transmitted disease including HIV/AIDS. New products have been designed that emphasize menstruation suppression. This option provides health benefits and gives women control not only of when they will have a pregnancy, but if and when they will menstruate.

Contraceptives Used by Men

The development of methods of contraception that would be used by men is promising. The condom and the vasectomy operation are effective because they prevent sperm from entering the female without interfering with the male libido or potency. The development of a medical method that would stop sperm production would be easy; however, most approaches either inhibit the man's production of testosterone or elevate levels to an unsafe height. This problem can be overcome by the use of a testosterone-like compound, MENT®, that acts as a substitute for testosterone in many beneficial ways while suppressing sperm production and protecting the prostate gland against hyper-stimulation. MENT® is being studied in Europe for possible use as hormone replacement therapy in aging men but once on the market for that purpose, possibly in 2003, its use as a male contraceptive would be evident. There is also considerable basic research on approaches that would not inhibit sperm production but would interfere with the final maturation processes of the sperm once they leave the testis. This would make the sperm unable to fertilize eggs.

See also: *Birth Control, History of; Family Planning Programs; Reproductive Technologies.*

BIBLIOGRAPHY

Connell, Elizabeth B. 2002. *The Contraception Sourcebook.* New York: Contemporary Books.

Hatcher, R. A., et al. 1998. *Contraceptive Technology.* 17th edition. New York: Ardent Media.

United States Census Bureau. 1999. *World Population: 1998.* Appendix X. Washington, D.C.: Government Printing Office.

Sheldon J. Segal

CONTRACEPTIVE PREVALENCE

Contraceptive prevalence measures the extent to which contraception is being used in a population, in particular among women of reproductive age (conventionally, between 15 and 50). Prevalence is the proportion, expressed as a percentage, of women of reproductive age currently using a method of contraception.

This definition, however, presents several ambiguities regarding the base population, the reference period, and what constitutes a method of contraception, lending itself to variations in measurement. As to the base population, ideally prevalence should cover all sexually active partners—men and women—of reproductive age. In practice, however, information on contraceptive use is most often sought only from women, often only married women. (The "married" group usually includes those in consensual unions in countries where such unions are common.) In most countries, the vast majority of women of reproductive age is married or in an informal consensual union, so this restriction does not greatly affect estimates of contraceptive prevalence. However, in countries where large proportions of unmarried women are sexually active, prevalence estimates based solely on currently married women may not reflect the true level of overall contraceptive use. For example, in the developed countries around 1990, contraceptive prevalence among unmarried women ranged from 47 percent in the United States to 75 percent in Belgium.

Another problem in defining the base population concerns the extent to which all women of reproductive age are exposed to the risk of conception at a particular time, given that some women may be infecund or may not be sexually active while others may be seeking to become pregnant. It is for this reason that, in practice, contraceptive prevalence does not attain the theoretical maximum value of 100 percent.

The definition of contraceptive prevalence centers on current use, and the distinction between past and current contraceptive use can be problematic. Most surveys that have asked about the current use of a method of contraception have asked about use "now" or "within the last month"; sometimes other reference periods are specified. Moreover, there is usually no information collected about the regularity with which the method is employed or about the respondent's understanding of correct use. The fuzziness in the timeframe for measuring use and the difficulty of identifying exactly the women who are exposed to the risk of conception during the specified period undermine the status of prevalence as a *rate.* It can be recorded, rather, as a simple percentage.

What is considered as contraceptive use is also somewhat subjective, given the differing effectiveness of different methods and the varying motives for use. Contraceptive methods are usually grouped into two broad categories, modern and traditional. Modern methods are those that require clinical services or regular supply: they include female and male surgical contraception (sterilization), oral contraceptive pills, intrauterine devices (IUDs), condoms, injectible hormones, vaginal barrier methods (including diaphragms, cervical caps, and spermicidal foams, jellies, creams, and sponges), and, more recently, subdermal contraceptive implants. The traditional methods—also known as non-supply methods to distinguish them from modern supply methods—include the rhythm method, withdrawal (coitus interruptus), abstinence, douching, prolonged breastfeeding, and a variety of folk methods. Nonetheless, the labels "modern" or "traditional" are inexact: for example, both the condom and the rhythm method have a long history of use, yet the condom is considered modern and the rhythm method traditional.

Almost all surveys about contraceptive use have asked about rhythm and withdrawal, but there has been less consistency regarding other traditional methods. A particular difficulty arises with practices whose main motivation may not have been to prevent pregnancy but which may do so in fact—notably, abstinence and breastfeeding. Some surveys have explicitly excluded such practices from the definition of contraception.

In some African countries, there is a tradition of lengthy abstinence from sexual relations following a birth, but surveys often report prolonged abstinence as the method currently used by a substantial proportion of women. The distinction between contraceptive and noncontraceptive motives for this traditional practice is not clear-cut, and many women who practice lengthy postnatal abstinence evidently do not regard it as contraception. Most surveys do not include abstinence, or postnatal abstinence specifically, in the definition of contraception—including surveys conducted in sub-Saharan Africa. When women spontaneously report that they were practicing prolonged abstinence for contraceptive reasons, they may be recorded under the category of "other" methods.

Breastfeeding has fertility-inhibiting effects and in societies that practice prolonged breastfeeding, fertility is depressed. As in the case of abstinence, most surveys have not included breastfeeding in the list of contraceptive methods. In cases where it has been included, the number of women that identify breastfeeding as their contraceptive method is typically a small fraction of the number that are currently breastfeeding.

Depending on the society, folk methods of contraception may include a large number of herbal preparations, manipulation of the uterus, vigorous exercise, adoption of particular postures during or after intercourse, incantations, and the wearing of charms. The effectiveness of these methods has never been scientifically evaluated: some are wholly fanciful, others may be highly unreliable, and still others probably act as abortifacients rather than as contraceptives. Women often do not mention folk methods unless the survey inquires about them specifically, and most surveys do not include probing questions dealing with specific folk methods.

Sources of Information on Contraceptive Prevalence

Surveys are considered the best source of data on contraceptive practice, since they can record the prevalence of all methods, including those that require no supplies or medical services. Most surveys ask respondents broadly similar questions to measure contraceptive use. Women are first asked what methods they know about, and the interviewer then names or describes methods that were not mentioned by the respondent. Respondents are then asked about use of each method that was recognized. This procedure helps make clear to the respondent what methods are to be counted as contraceptive. When methods are not named by the interviewer, the level of use tends to be underreported. In particular, it does not occur to many persons to mention methods such as withdrawal and rhythm, which require no supplies or medical services.

Organized family planning programs keep records on their clients who come for contraceptive supplies or services. These records are another main source of information about contraceptive prevalence. However, data from this source have the serious drawback of excluding use of contraception obtained outside the program, including modern methods supplied through nonprogram sources as well as methods that do not require supplies or medical services. In addition, the process of deriving reasonably accurate prevalence estimates from the information in family planning program records is much less straightforward than the direct questions posed in representative sample surveys.

Contraceptive Prevalence

Prevalence levels range from 4 to 10 percent in pretransitional societies, where fertility is typically high, to 70 to 80 percent in posttransition, low-fertility countries. (As mentioned above, in practice, contraceptive prevalence never attains the maximum value of 100 percent.) In 1997 contraceptive prevalence for the world as a whole was estimated to be 62 percent—that is, 62 percent of currently married women between ages 15 and 50 were using a method of contraception. Regional average levels of prevalence range from 25 percent in Africa to over 65 percent in Asia and Latin America and the Caribbean. The average prevalence for developed countries was 70 percent.

The reported level of contraceptive use in pretransitional societies is very low for both modern methods and traditional methods. For example, contraceptive prevalence in Chad in 1996 was 4 percent (Chad's total fertility rate exceeded 6); in Uganda in 1995 it was 15 percent. The prevalence of modern method use was 1 percent in Chad and 8 percent in Uganda. A large proportion of married contraceptive users in Chad reported the use of traditional methods of contraception: rhythm and withdrawal. It is likely that many women in pretransitional societies use traditional methods that are not captured in the standard surveys.

In the low-fertility countries, the great majority of women not using contraception are pregnant, seeking to become pregnant, infecund, or sexually inactive. Because of the relatively high levels of prevalence already reached in these countries, there is little room for further increase. In developed countries, certain traditional methods—including withdrawal and various forms of the calendar rhythm method—are commonly used: together they account for 26 percent of total contraceptive use in the low-fertility developed countries, compared with just 8 percent in the less developed regions. However, recent trends indicate that the prevalence of modern methods is increasing at the expense of traditional methods. In France, for example, between

1978 and 1994 the use of modern methods increased from 48 to 69 percent, even as the use of all methods decreased by 4 percent. Contraceptive prevalence in the United States in 1995 was estimated to be 76 percent of women who were married or in a union. Female sterilization was the most popular method, with a prevalence of 24 percent, followed by the pill, at 16 percent.

Empirical Relationship between Prevalence and Fertility

There is a strong relationship between contraceptive prevalence and the overall level of childbearing as measured by the total fertility rate. (The total fertility rate indicates the average number of children that would be born per woman according to childbearing rates of the current period.) Cross-national data show that the total fertility rate decreases, on average, by 0.7 children for every 10 percentage-point rise in contraceptive prevalence. This translates into 1 child fewer for every 15 percentage-point increase in contraceptive prevalence. Contraception is the most important of the proximate determinants of cross-national differences in fertility. (Other major proximate determinants of these differences are patterns of marriage and sexual activity outside of marriage, the duration of breastfeeding, and the practice of induced abortion—none of them as strongly associated with fertility as contraceptive use.)

See also: *Family Planning Programs; Fecundity; Fertility, Proximate Determinants of.*

BIBLIOGRAPHY

Abma, Joyce, et al. 1997. "Fertility, Family Planning, and Women's Health: New Data from the 1995 National Survey of Family Growth." *Vital and Health Statistics* 23(19): 61.

United Nations. 2002. "Family Planning." In *World Population Monitoring 2002 Reproductive Rights and Reproductive Health: Selected Aspects.* New York: United Nations.

United Nations. 2000. *Levels and Trends of Contraceptive Use as Assessed in 1998.* New York: United Nations.

VASANTHA KANDIAH

COST OF CHILDREN

At least since 1800 there has been a growing awareness that children are a cost factor for the household. To raise children, parents, or the household at large, must undertake a variety of direct expenditures. Children also require a time investment by their parents, some of which might otherwise be used in gainful economic activity. The latter costs, measured not as money spent on children but in lost earnings, are termed the parents' opportunity costs of children.

Examining parents' decisions about having children in sheer economic terms is often undertaken only with reluctance. The rewards of having children tend to be primarily emotional, associated with a mixture of altruistic and self-serving impulses: to nurture, to continue the bloodline, to balance family life, to satisfy curiosity about one's offspring, and to create relationships based on love. At the same time, and most evident in traditional agricultural societies, children yield economic rewards (1) by supplying labor resources to the family enterprise, often from an early age; and (2) when grown, by providing a measure of physical and economic security to parents, especially in the latter's old age, for which no equivalent institutional means may be readily available. If only implicitly, parents are likely to balance the costs of raising children against expectations of children's material and immaterial utility. An example of the cost of child-rearing becoming the object of a cold economic calculus can be seen in the decisions made by slave-owners as described by the economic historians Robert Fogel and Stanley Engerman. For slave-owners, the cost of raising slaves was in economic terms analogous to cattle-breeding.

In the nineteenth century the cost of children became a prominent consideration in policies addressing poverty. In order to ensure welfare equality among poor families irrespective of their number of children, families with many children would have to be supported by a cost-of-children subsidy. Later on, assessment of child costs also became pertinent in establishing the levels of family allowances and tax rates.

The first and classical study bearing on the cost of children is by the statistician Ernst Engel, who in 1895 published a study for the Prussian government. His name is still known through Engel's Law, which states that the food share in the household budget falls with rising income. There was considerable interest in the cost of children through most of the twentieth century, but some waning of interest in the later years. The main reason seems to be that there is no generally accepted scientific solution to the problem of what the costs of children are and that it seems impossible that one will be found.

Socializing the Costs of Children

Nevertheless most modern societies accept the idea that families and especially poor families should be partly subsidised in order to mitigate the welfare differences that may be caused by differences in the number of children. There are two questions. (1) What subsidies would be needed to neutralize the differences in family size? (2) If those amounts can be identified, should the state's subsidy be set at the level needed for complete neutralization, or at a lower or even a higher level? (A subsidy higher than needed for neutralization might be adopted as a means to raise the birth rate.) The second question is clearly a political issue, which is not the subject of this article. The first question is the relevant one.

It was noted that there is no generally accepted scientific solution to the problem. The practical solution chosen is just to let politicians and/or civil servants make decisions on the basis of intuition and compromises among interest groups such as the parents of large families. This is the route taken in most countries and explains the diversity in child-friendly regulations among countries.

A distinction may be drawn between household subsidies delivered in kind and those provided as income supplements. In-kind subsidies are in the form of state provision of below-cost education, health facilities, childcare, and even school meals. The objective is not only welfare equalization. For instance, education and the removal of illiteracy not only benefits the child who gets the education but also has a large positive external effect for others. But even if those policies are in force, the household itself still incurs substantial child-related expenses for food, clothing, shelter, insurance, etc. These can be offset by family allowances or family-size-dependent tax deductions. Benchmark estimates are needed in order to establish welfare-neutral compensations. Whether the actual subsidies provided are under-, over-, or just compensating is a matter of political choice.

Methods of Estimating the Cost of Children

A naive, but still popular, approach is to determine expenditures for children by bookkeeping and budget surveys. However, this approach raises two problems.

(1) What expenditures are necessary and thus may be called costs and what expenditures should not be seen as necessary costs? This depends very much on the cultural environment (establishing expenditure norms) and on the level of wealth of the household (wealthier families spend more on their offspring than poorer families [can] do). If the normative cost of children that is to be established is to be used for taxation and social security purposes, it is felt by many that it is unacceptable to assign to richer families a higher cost of children and as a consequence a higher per-child tax deduction. This leads to the ethical presumption that the cost of children is to be set equal to the cost incurred by a normative household, which is typically chosen at the minimum income level.

(2) The second problem in the bookkeeping solution is that of joint costs. There are many items in household expenditures that cannot be assigned exclusively as benefiting one particular member. Examples are expenditures on housing, health, insurance, television, etc. Decisions on how to assign such expenditures between parents and children are partly arbitrary. Recognition of economies-of-scale effects (cheaper by the dozen) introduces further complexities. The best-known household expenditure scale is probably the so-called Oxford scale, which is adopted more or less as the official scale by the OECD and the EU. It sets the first adult at 1.0, other adults at 0.7, and children (below 16 years) at 0.5. This scale, although not based on firm research results, is frequently used in official statistics to compare household welfare.

More sophisticated methods of estimating costs of children are the so-called 'adult good' method and the 'food-share' method. The adult good method (developed by E. Rothbarth and Angus Deaton and John Muellbauer) is based on the idea that one may identify a specific part of expenditures in the household budget, e.g. cigarettes, alcohol, etc., as *adult* expenditures. Let the monthly household expenditures be $2000. Assume that the adult's expenditures amount to $800 before the birth of the first child and $400 after the child has been born. Then the cost of the first child would be $800 to $400. This method also involves arbitrary elements. What are 'adult goods' and is the consumption of adult goods representative for 'adult welfare'? It may be assumed that if the birth of a child is the result of a voluntary choice by the parents, parental well being is increased by having that child—that is, increased by more than the loss in adult welfare caused by the resulting reduction in adult expenditures.

The 'food-share' method, which is influential in social security policy in the United States, is based on seminal research by economist Mollie Orshansky. She assumed that the share of food in family expenditures is an index of the family's welfare. For example, suppose food makes up 33 percent of total family expenditures before the first child's birth in a household with a $2000 per month income, and increases to 40 percent after the child is born. Assume further that the one-child household would again spend 33 percent on food if its income increased to $2500. Then the cost of the child is considered to be $500. Notice that the food share in accord with Engel's Law falls with increasing income. The method assumes that food-share represents household's welfare, which is dubious, and that the cost of children varies with income level.

A third approach to estimating the cost of children is subjective. Individuals are asked how satisfied they are with their income. It is found that respondents are less satisfied with the same income, the more children they have to support from it. This method was proposed by Bernard van Praag and Arie Kapteyn, who worked at the time at Leyden University in the Netherlands and is known in the literature as the Leyden method. On the basis of these satisfaction surveys it can be estimated how much has to be given to a household to keep it at the same financial satisfaction level after the birth of an additional child.

Although this method is less arbitrary than the methods previously described, it too has problems. First, the cost of children thus defined again increases with income. Second, it is unclear whether financial satisfaction is a good proxy for the metaphysical concept of household well-being. It is quite probable that non-financial satisfaction with life increases with the birth of a child. Third, the cost of the child will differ between one- and two-earner families. However, it may be argued that the additional money spent on external childcare will be roughly equivalent to the income forgone by the mother, if she would stay at home to care for her own children.

Although there is no generally accepted definition of the cost of children or accepted method of assessment, the various methods have some common features. Generally each shows an economies-of-scale pattern. For the objective methods, costs per additional child seem to diminish with rising family size at an exponential power of about 0.50. For subjective methods, the corresponding profile is consistently flatter, at about 0.30. Subjective estimates, however, implicitly take existing family allowance systems and the price of education into account. So the estimated costs of children are in a sense complementary to the family allowance system. In countries with liberal family allowance systems, and education and health care costs covered by the state, the estimated subjective costs will be smaller than in countries where parents receive fewer or no such benefits. For instance, significant differences in estimated child costs have been found between the Netherlands and Germany on one hand and the United Kingdom and Russia on the other.

In most countries even at the minimum income family income levels there is not a complete state compensation for the costs of children. For higher income levels, this holds a fortiori. If the financial consequences are among the determining factors in a couple's decisions concerning numbers of children, then most countries have a system that is discouraging childbearing. A few countries—for example, France and Canada—have a much more liberal system with the explicit purpose of increasing numbers of births. However, the effects are modest.

A final question that should be asked is whether children not only impose costs but also offer benefits in terms of an addition to general well-being. It might be argued that parents decide on having a child by comparing the expected benefits and costs to their well-being. For the first child the benefit will be evaluated as being larger than the cost. As the marginal benefit falls with each new child, at some specific family size the additional cost will be assessed to be larger than the additional benefit. Then the optimum family size is reached. If this theory were true the cost of a child is still more difficult to define. An attempt in this direction has been made by van Praag and Erik Plug, who found that the optimum number of children increases with income. Hence children are a luxury good.

Almost all states utilize some cost-of-child concept for minimum income families but the operationalization is mainly based on political decisions, sometimes enriched by the ideas of experts and social workers. If most of the population supports that practice, it is clearly acceptable, although not founded on widely accepted economic science. For an extensive survey, refer to the article by van Praag and Marcel Warnaars in the *Handbook of Population and Family Economics.*

See also: *Family Allowances; Family Policy; Microeconomics of Demographic Behavior.*

BIBLIOGRAPHY

Deaton, Angus S., and John Muellbauer. 1986. "On Measuring Child Costs: With Applications to Poor Countries." *Journal of Political Economy* 94: 720–744.

Engel, Ernst. 1895. "Die Lebenskosten Belgischer Arbeiterfamilien früher und jetzt—ermittelt aus Familienhaushaltrechnungen." *Bulletin de l'Institut International de Statistique* 9:1–149.

Fogel, Robert W., and Stanley L. Engerman. 1974. *Time on the Cross: The Economics of American Negro Slavery.* Boston: Little Brown.

Orshansky, Mollie. 1965. "Counting the Poor: Another Look at the Poverty Profile." *Social Security Bulletin* 28: 3–29.

Rothbarth, E. 1943. "Note on a Method of Determining Equivalent Income for Families of Different Composition." In *War-time Patterns of Saving and Spending,* ed. Charles Madge. Cambridge, MA: Cambridge University Press.

van Praag, Bernard M. S., and Arie Kapteyn. 1973. "Further Evidence on the Individual Welfare Function of Income: An Empirical Investigation in the Netherlands." *European Economic Review* 4: 33–62.

van Praag, Bernard M. S, and Erik J. S. Plug. 1999. "The Cost and Benefits of Children." In *Fighting Poverty: Caring for Children, Parents, the Elderly and Health,* ed. Stein Ringen and Philip R. de-Jong. Aldershot: Ashgate.

van Praag, Bernard M. S., and Marcel F. Warnaar. 1997. "The Cost of Children and the Use of Demographic Variables in Consumer Demand." In *Handbook of Population and Family Economics,* Vol. 1A, ed. Mark R. Rosenzweig and Oded Stark. Amsterdam: Elsevier.

Bernard M.S. van Praag

CRIME, DEMOGRAPHY OF

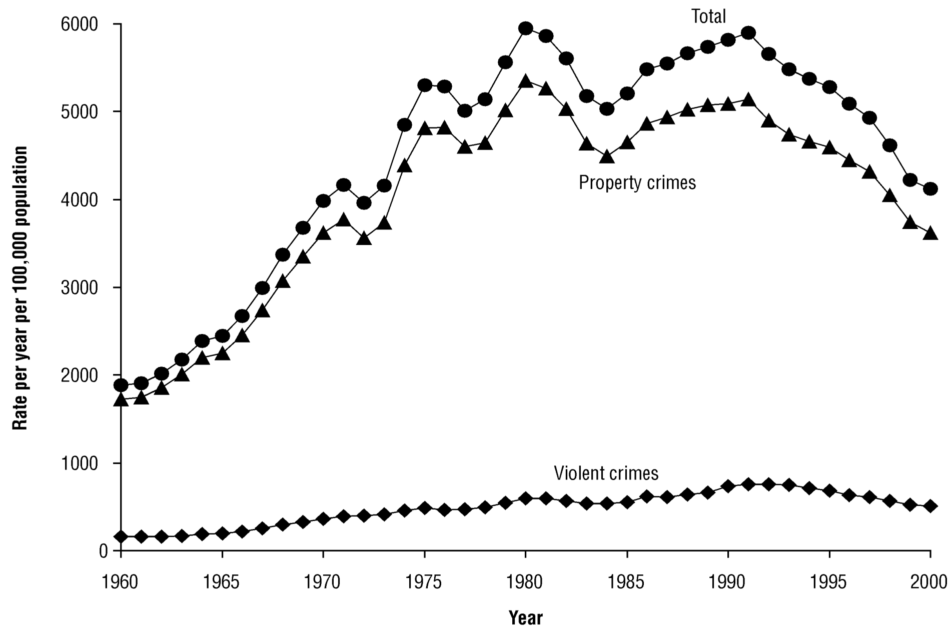
Crime is an act that violates criminal law and is punishable by the state. Such an act is considered juvenile delinquency if the person who commits it is not legally an adult in the jurisdiction where he or she engaged in the offense. Juvenile delinquency also includes status offenses such as underage drinking or truancy, which are only offenses because the perpetrator is under a legal adult age. Because of lack of uniformity in definitions and differences in accuracy and completeness of reporting, international comparisons of crime rates are exceedingly difficult and error-prone. This entry focuses on demographic aspects of crime in the United States.

Crime Data and Trends

There are three major sources of data on crime and delinquency in the United States. First is the Federal Bureau of Investigation's (FBI) Uniform Crime Reports (UCR). These data provide summary counts of crimes reported to police agencies. The UCR presents detailed data on seven categories of crime, called the index offenses (or Part I crimes). These include four violent offenses—murder and nonnegligent manslaughter, forcible rape, robbery, and aggravated assault—and three crimes against property—burglary, larceny-theft, and motor vehicle theft. Reported crime counts are also provided in the UCR for a set of twenty-one additional (Part II) crimes. The second major source of crime data is the National Crime Victimization Survey (NCVS), which collects information on crime victimization from household interviews. Because many crimes are not reported to the police, NCVS data show much higher rates of victimization than the UCR. However, both UCR and NCVS data tend to exhibit quite similar long-term crime trends. The third data source, collected through self-report surveys of youth (e.g., the National Youth Survey) or the general population, reflects crime and delinquency offending.

FIGURE 1

Reported Crime Rates in the United States by Major Category, 1960–2000



Note: Rates refer to FBI Uniform Crime Reports data for index offenses.

SOURCE: Maguire and Pastore, eds. (2001).

The most extensive time series of crime rates in the United States are available for the UCR index offenses. Annual rates for the years 1960 to 2000 of total, property, and violent index crimes per 100,000 population are presented in Figure 1. The United States experienced dramatic increases in rates of reported index crimes in the three decades following 1960, but these rates then dropped every year from 1991 to 2000. The rate of violent crime more than quadrupled between 1960 and 1991—from 161 to 758 per 100,000 population annually. By 2000 the violent crime rate had fallen to about 500 per 100,000, a rate not seen since the late 1970s. Within the category of violent crime, the number of murders (including non-negligent manslaughter) in the United States was 23,000 in 1980 and 15,500 in 2000; the corresponding rates per 100,000 population were 10.2 in 1980 and 5.5 in 2000. The rate of reported property crime has been somewhat more volatile over time, but still tripled between 1960 and 1991; its subsequent steady decline resulted in a 2000 rate similar to that experienced in the early 1970s. Figure 1 also clearly shows that property crimes comprise the vast majority of all index offenses. In 2000, for example, the four violent index crimes constituted just 12.3 percent of all index offenses.

Demographic Predictors of Crime

Demographic factors such as age, sex, and race play an important role in understanding variation in crime rates across time and place. Demographic features of the population effect crime rates in two distinct ways. First, characteristics of population structure have *compositional* effects: crime rates are higher when demographic groups that have greater levels of involvement in crime constitute a larger share of the population. Second, aspects of population structure may have *contextual* effects on crime when they exert causal influences on criminal motivations and opportunities for crime independent of individual level for criminal tendencies.

The incidence of crime by age group exhibits a consistent pattern: it increases sharply between early and late adolescence (around age 17), and then declines. The late-adolescent peak in offending rates—the "age-crime curve"—is one of the few established empirical regularities in the demography of crime, although debate over the nature of this relationship continues. Scholars such as Michael Gottfredson and Travis Hirschi argue that the age-crime curve is essentially invariant across subpopulations based on sex, race, income, and other characteristics, and cannot be explained by social processes that vary across age. Others argue that the relationship between age and crime varies by offense type and historical period. Contextual hypotheses regarding the effects of age structure have emphasized the negative impact of disproportionately youthful populations on the capacity for social control by societies and other collectivities.

The relationship between sex and crime is also well-established, with men exhibiting consistently higher rates of criminal activity, particularly for serious crimes such as the violent index offenses. The explanation for sex differences in criminal activity is also the subject of continued debate. The widespread view presented by John Hagan, John Gillis, and A. R. Simpson links gender inequality with variation in criminal activity. In this view, sex differences in crime rates should narrow as women achieve greater social equality with men. In contrast, other scholars such as Darrell J. Steffensmeier and Emilie Anderson Allan suggest that criminal activity by women is likely to be higher in contexts where gender inequality—and the corresponding level of crime-inducing disadvantage among women—is most pronounced. Contextual hypotheses regarding the effect of the population sex ratio (the ratio of the number of men to women) have drawn attention to the potential role of high sex ratios on the social valuation of women. Contexts in which there are relatively few women may result in greater protection of women from victimization.

Official statistics on reported crimes and arrests show that African Americans are over-represented as both offenders and victims in most types of serious crimes in the United States. The causes of the large black–white difference in criminal involvement are controversial. Some researchers have contended that distinct cultural orientations toward violence produce the racial differences in the crime rates. However, most recent research attributes the largest part of the race gap in violent crime to differences in the structural circumstances of African Americans and whites. African Americans have higher levels of disadvantages such as poverty than whites, and these disadvantages are associated with greater violent criminal offending and victimization. In addition, African Americans tend to live in more highly disadvantaged communities that produce social conditions that are more conducive to crime. When African Americans and whites live in comparable community settings, rates of violence are quite similar.

See also: *Homicide and Suicide.*

BIBLIOGRAPHY

Easterlin, Richard A. 1987. *Birth and Fortune: The Impact of Numbers on Personal Welfare.* Chicago: University of Chicago Press.

Gottfredson, Michael, and Travis Hirschi. 1990. *A General Theory of Crime.* Stanford, CA: Stanford University Press.

Hagan, John, John Simpson, and A. R. Gillis. 1987. "Class in the Household: A Power-Control Theory of Gender and Delinquency." *American Journal of Sociology* 92: 788–816.

Krivo, Lauren J., and Ruth D. Peterson. 1996. "Extremely Disadvantaged Neighborhoods and Urban Crime." *Social Forces* 75: 619–650.

———. 2000. "The Structural Context of Homicide: Accounting for Racial Differences in Process." *American Sociological Review* 65: 547–559.

Sampson, Robert J., and William Julius Wilson. 1995. "Toward a Theory of Race, Crime, and Urban Inequality." In *Crime and Inequality,* ed. John Hagan and Ruth D. Peterson. Stanford, CA: Stanford University Press.

South, Scott J., and Steven F. Messner. 1987. "The Sex Ratio and Women's Involvement in Crime: A Cross-National Analysis." *Sociological Quarterly* 28: 171–188.

Steffensmeier, Darrell J., and Emilie Andersen Allan. 1996. "Gender and Crime: Toward a Gendered Theory of Female Offending." *Annual Review of Sociology* 22: 45–87.

Steffensmeier, Darrell J., Emilie Andersen Allan, Miles David Harer, and Cathy Streifel. 1989. "Age and the Distribution of Crime." *American Journal of Sociology* 94: 803–831.

U.S. Department of Justice, Federal Bureau of Investigation, *Crime in the United States, 2000.*

INTERNET RESOURCE.

Maguire, Kathleen, and Ann L. Pastore, eds. 2001. *Sourcebook of Criminal Justice Statistics,* Table 3.120. <http://www.albany.edu/sourcebook/>.

Lauren J. Krivo
Christopher R. Browning

CULTURE AND POPULATION

Demographers have long suspected that understanding population processes requires an understanding of culture. The need to take account of culture is an empirical issue, growing from the recognition of otherwise unexplainable differences in such demographically relevant areas as fertility, marriage practices, and kinship systems.

Acknowledgment of a cultural dimension in population studies has an intellectual genealogy that includes those nineteenth- and early-twentieth-century British bureaucrats who administered an empire by pivoting their data collection strategies along observed markers of ethnic and other identities. It took a more sustained scholarly turn from this administrative past with the post-World War II debates over development programs and the rationality of widely differing fertility regimes across societies. Later developments—such as the inability of simple demographic transition theories to account for variations in the pattern of fertility change across Europe's cultural regions—clinched the importance of cultural factors beyond changing patterns of urbanization, literacy, infant and child mortality, and industrialization. Finally, John C. Caldwell's movement into micro-demography in the 1970s and 1980s encouraged highly localized studies of population processes involving intimate, long-term contact between researchers and the people being studied. These studies opened population research to its most recent engagement with cultural explanation.

This engagement has brought a usable theory of culture for demographic analysis within the reach of population researchers. A theory of culture for demography must necessarily enhance, rather than do away with, existing analytic approaches based on the social survey and multivariate models. Incorporating culture into demography may nevertheless demand revision of the longstanding assumptions underlying some population research. This demographically viable theory of culture emphasizes understanding concrete and highly local situations. For demography, a working theory of culture would lead to better-specified models through the definition of novel independent variables, a refined interpretation of existing standard variables, and the greater understanding of actor motivations.

A Theory of Culture

Contemporary cultural analysis allows researchers to incorporate local systems of meaning and motivation into demographic explanations while accounting for a dynamic relationship between individual actors and their institutional contexts. Earlier definitions of culture emphasized normative institutions and betrayed a legalistic concern with rules for social organization. Contemporary culture theorists have increasingly moved toward definitions that emphasize shared systems of symbolic meaning that both construct and are constructed by the active participation of their members. As scholar David Kertzer writes, from being the "cultural dopes" of earlier theories, people are recognized to actively negotiate and manipulate the cultural symbols available to them and, in so doing, create the possibilities for culture change. This trend toward emphasizing systems of meaning, along with the understanding that discrete cultural systems are themselves embedded within larger political worlds, challenges some of the assumptions in older demographic analyses. At the same time, these developments offer workable solutions that enhance the specificity and explanatory power of population research. They also offer more empirically satisfying understandings of how the shared and intersubjective nature of culture can be linked to variable individual experience and action.

Examples of cultural approaches, spawned in part by a welcoming openness among demographers themselves, abound in recent collections of demographic research by anthropologists. Although differing in emphasis, these approaches use definitions that share important characteristics for understanding meaning in cultural terms. In Clifford Geertz's classic phrasing, which captures the sense of meaning and motivation, cultural patterns may be taken as both models *of* and models *for* reality.

As models *of* reality, cultural patterns constitute the perceived worlds of human actors and define how behaviors receive their symbolic meaning within a field of relationships. The same behaviors may hold entirely different meanings across settings. Beginning with cultural models of reality allows demographers to discover what is significant from the point of view of the actors themselves. Both demographers like Caldwell and anthropologists like Eugene Hammel recommend attention to cultural models of reality as a starting place for analysis.

As a model *for* reality, culture offers a partial resolution to the problem of establishing motivation for actors operating within a common cultural context—the cultural logic of why people do what they do. Although the cultural emphasis on the localized nature of motivations requires a change from the assumptions of some approaches (specifically, that people act rationally to achieve universal goals), it does not by itself do away with the assumption of rational actors altogether.

While these two features of culture, as models of and for reality, promise enhanced demographic analyses, other characteristics make it difficult to use the culture concept in demography. Culture, whether as model of or model for reality, exists in the background understanding of its members. Cultural models are not necessarily consciously held, so that the actors themselves are unlikely to be able to provide a coherent account of their own key frames of meaning and motivation. The discovery of these models requires analysis beyond the face-value responses to questions posed by researchers in focus groups or surveys, and may require attention to domains that appear superficially remote from the proximate determinants of demographic phenomena.

Contemporary cultural theorists assert that a concern for meaning need not preclude using empirical data, although it may require quantitative analysts to broaden the criteria for what counts as a valid argument and to be more open to reformulation and reinterpretation. A truism for culture theory is that cultural systems are at some level coherently integrated. Those themes that have key cultural salience are likely to echo across markedly different domains such as oral traditions, ritual, and everyday practices. From this perspective, symbolic constructions, recurrent themes present in myths and legends, and even the layout of physical space may all be used as empirical indicators to support an interpretation of key cultural elements that have demographic significance.

Applications to Population Research

The most immediate outcome of demographic attention to culture may be the reinterpretation of existing standard variables. For cultural theorists, no behavior is devoid of cultural meaning. Kertzer argues that cultural explanations, coupled with attention to political economy, reintroduce the emotional and symbolic sides of human beings into demographic models, and thereby link apparently discrete behaviors to a whole system of meanings. Even the more proximate determinants of demographic events, such as the role of education in age at marriage, can be significantly reinterpreted through cultural understanding.

Few relationships, for example, are more consistent than the positive association between schooling and age at marriage: the higher the schooling level, the older the age at marriage. Demographic Transition Theory in its earlier, classic form took education at face value to be an indicator of modernization and argued that it correlated with secularization, increased rationality, and heightened individual autonomy. Such understandings ignore both the possibility that marriage may have implications for relationships involving family groups larger than the two individuals united by it, and the potential for symbolic, in addition to utilitarian, meanings for education.

An analysis from rural Pakistan by Tom Fricke and colleagues confirmed the positive association but included the puzzling finding that a substantial fraction of women who attended school only briefly, without completing a full year, also married at later ages than those who never attended school at all. Using local understandings and practices for reinterpreting the meaning of this variable, the authors suggested that education was part of a larger world of symbolic status indicators. The new cultural reading of education as a marker of family status placed the experience of schooling within a wider array of prestige markers that are at play in marriage negotiation in this specific context. In a setting where no woman chose her own husband, actual educational attainment and its implications for autonomy were secondary.

By attending to local systems of meaning and practice, researchers introduce novel variables beyond the immediately demographic into analysis. Thus, by noting the culture of sin, the institutional role of the Catholic Church, and changes in family and work within an existing kinship system, Kertzer integrates cultural and economic explanations in his study of the rising practice of infant abandonment in eighteenth- and nineteenth-century European societies. Susan Greenhalgh's reinterpretation of Chinese fertility transitions extends the focus on individual families to larger institutional contexts, such as the demise of pre-existing state systems of mobility. In his analyses of marriage change, Fricke introduces individual variations in culture-specific elements of the marriage process to show how symbols are redeployed by active agents who pursue their options within a common framework of meanings. All three of these studies suggest that these novel variables must be arrived at through an understanding of concrete empirical situations.

The use of cultural models also complicates the understanding of motivations. Even if general motivations such as improved social, economic, and political status may be said to characterize all people, the understanding of avenues for achieving these general goals is always conditioned by concrete local histories and circumstances. Moreover, the content and demographic implications of these general categories can vary considerably depending on the larger system of which they are a part. Examples of the value of considering the cultural aspects of motivation are found in the contrast between how patrilineal families influence fertility in Greenhalgh's studies of China and in Fricke's studies of Nepal. Where cultural models stress the autonomous responsibility of the patrilineal family for its own well being, security and mobility goals may encourage high fertility. Where cultural models stress cooperation between patrilineal units, high fertility may be a secondary consideration (since the responsibility for well being includes multiple lineages united by marriage). Similarly, Tim Dyson and Mick Moore's contrast of demographic regimes in north and south India turns on this difference and demonstrates how women's symbolic roles within two pre-transition settings can differ because of their different relationships to larger organizational features.

Implications for Population Research

In spite of increased academic interest, incorporating culture into demographic analysis remains problematic. Anthropology, the discipline of culture's greatest theoretical elaboration, has a different research orientation and style from demography. These differences are compounded by the difficulty of translating the new understandings of culture into terms that present population specialists with a demographically usable model. While population researchers have themselves recognized the need to include culture in their research, the apparent difficulties in using it, the need to rethink fundamentals, and demography's disciplinary orientation toward multivariate analyses of individual-level variations raise the constant temptation to ignore culture in favor of more easily gathered and analyzed measures.

Anthropologists point to two strains of demographic explanation that fail to make use of these revised theories. The first tends to leave out culture altogether by positing universally applicable goals to rational actors whatever the context. At the level of aggregate analysis, the inattention to cultural context replicates the failure of classic Demographic Transition Theory. At the level of individual analysis, the inattention leaves out the highly localized meanings of standard variables in favor of more universal and decontextualized interpretations. Even when these analyses incorporate subjective states through the measurement of values and attitudes, they are unlikely to achieve a fully realized cultural view of meaning because they undervalue its shared patterns in favor of individual variation.

The second strain in demographic explanation tends to focus on institutional contexts, but falls prey to the static treatment of culture widely adhered to within anthropology itself a half century ago. Individual actors are not acknowledged as thinking and emotion-laden participants and strategists in this approach. Here, culture exists in the form of ironclad rules followed by its unquestioning members. While these group measures have the advantage of easy use as independent variables in multivariate models, they have encouraged the use of such ill-considered cultural categories as "Muslim cultures" or "Confucian cultures" and the like. These categories leave out local histories and contexts, along with the possibility of demonstrating the mechanisms by which cultural variables may influence demographically relevant behaviors.

Although the precise mechanisms that connect culture and population processes may best be investigated through the kinds of long-term and intensive studies characteristic of micro-demography and anthropological fieldwork, the sensitive use of cultural understandings in demographic analysis is far less demanding. Cultural demography does not require that every researcher learn a field language and spend months in a single community. Many of the individual studies and collections cited here are, in fact, reliant on secondary data sets or involve historical materials. Culturally sensitive population studies require an assumption that people engage their worlds in terms of highly various and local systems of meaning, and a willingness to explore existing sources with an eye to relating those meanings to demographic outcomes.

See also: *Anthropological Demography; Caldwell, John C.; Mass Media and Demographic Behavior; Religions, Population Doctrines of; Values and Demographic Behavior.*

BIBLIOGRAPHY

Caldwell, John C. 1982. *Theory of Fertility Decline.* New York: Academic Press.

Coale, Ansley J., and Susan Cotts Watkins, eds. 1986. *The Decline of Fertility in Europe.* Princeton, NJ: Princeton University Press.

D'Andrade, Roy G., and Claudia Strauss, eds. 1992. *Human Motives and Cultural Models.* New York: Cambridge University Press.

Dyson, Tim, and Mick Moore. 1983. "On Kinship Structure, Female Autonomy, and Demographic Behavior in India." *Population and Development Review* 9: 35–60.

Fricke, Tom. 1997. "Marriage Change as Moral Change: Culture, Virtue, and Demographic Transition." In *The Continuing Demographic Transition,* ed. G. W. Jones, R. M. Douglas, J. C. Caldwell, and R. M. D'Souza. New York: Oxford University Press.

Fricke, Tom, Sabiha H. Syed, and Peter C. Smith. 1986. "Rural Punjabi Social Organization and Marriage Timing Strategies in Pakistan." *Demography* 23: 489–508.

Geertz, Clifford. 1973. *The Interpretation of Cultures.* New York: Basic Books.

Greenhalgh, Susan. 1988. "Fertility as Mobility: Sinic Transitions." *Population and Development Review* 14: 629–674.

———, ed. 1995. *Situating Fertility: Anthropology and Demographic Inquiry.* New York: Cambridge University Press.

Hammel, Eugene A. 1990. "A Theory of Culture for Demography." *Population and Development Review* 16: 455–485.

Kertzer, David I. 1997. "The Role of Culture in Demography." In *The Continuing Demographic Transition,* ed. G. W. Jones, R. M. Douglas, J. C. Caldwell, and R. M. D'Souza. New York: Oxford University Press.

Kertzer, David I., and Tom Fricke, eds. 1997. *Anthropological Demography: Toward a New Synthesis.* Chicago: University of Chicago Press.

Lorimer, Frank, ed. 1954. *Culture and Human Fertility.* Paris: UNESCO.

Wuthnow, Robert. 1987. *Meaning and Moral Order: Explorations in Cultural Analysis.* Berkeley: University of California Press.

Tom Fricke

CYCLES, POPULATION

A population cycle occurs when the growth rate of population varies over time in some fairly recognizable fashion. This might be due to changes in patterns of migration, or fluctuations in birth and death rates. Although it is generally accepted that there are cycles of varying length in economic activity, there is less agreement on the topic of population cycles.

T. R. Malthus was the first to posit the existence of population cycles, which he argued were the result of a pattern of economic and demographic feedback. An abundant harvest might temporarily raise wages, but the higher wages would cause an increase in birth rates, leading in turn to an increase in the number of laborers and hence to a decline in real wages. This decline in real wages would be met either by reduced birth rates (the "preventive check") or by an increase in mortality rates (the "positive check"). In either event, Malthus suggested that these fluctuations would cause population growth rates—and real wages—to cycle about some fairly constant level.

Later theorists thought that Malthus's theory was rendered obsolete by technological innovation, as the industrial revolution produced steady increases in both population and real wages. But the theory of population cycles was revived by the economist Simon Kuznets (1901–1985), who studied patterns of growth in the nineteenth and early twentieth centuries in the United States and identified what have come to be known as "Kuznets cycles": pronounced fluctuations of 15 to 25 years' duration in the growth of population, labor force, households, output, and capital stock. He suggested that an increase in the demand for labor, spurred perhaps by technological innovation, might generate increased immigration rates, and the new immigrants would further increase the demand for labor because of increased demand for housing and other goods and services. This feedback effect would gradually die away, returning population growth to its pre-immigration level. Such cycles were not thought to be self-generating, but rather were the result of an exogenous change in the demand for labor.

Richard Easterlin suggested that these Kuznets cycles changed significantly in the second half of the twentieth century because of changes in immigration policy. With tighter restrictions on immigration, any exogenous growth in the demand for labor could not be met through increased immigration, and would instead produce higher wages for the indigenous labor force, especially for younger workers. These improved wages would then result in an earlier age at marriage and higher birth rates, generating an urban economic boom and thus further increasing the demand for labor.

Easterlin's emphasis on younger workers, and on their wages relative to those of older workers, was a significant extension of Kuznets's original theory, since it introduced for the first time a credible mechanism for creating self-generating population (and economic) cycles. Easterlin developed this concept more fully in his later work, where he hypothesized that the small Depression-era birth cohorts of the 1930s had experienced a significant increase in their relative wages because of imperfect substitutability between older and younger workers: the younger workers were in short supply relative to older workers, and thus benefited most from the post–World War II economic boom. They married earlier and at higher rates, and exhibited a sharp increase in fertility rates that produced the 1946–1964 baby boom. When the large baby-boom birth cohort entered the labor market in the 1970s, however, they had the opposite experience: they were in excess supply relative to older workers. Their reduced relative wages caused them to postpone or forgo marriage and childbearing, producing the low birth rates of the post-1960s "baby bust."

Easterlin's model failed to predict actual events in the 1980s, however, when it was expected that smaller birth cohorts would begin to experience improved labor market conditions. Diane Macunovich (1999) has suggested that the effects of birth cohort size may produce asymmetric population cycles. When the size of birth cohorts entering the labor market is increasing, young workers not only supply labor for the economy, they also add to demand for goods and services as they set up their own households—an effect similar to that observed by Kuznets. Thus, when the size of the cohort entering the labor market is increasing, the negative effect of their oversupply of labor is offset to some extent by a stimulative effect on the economy, as producers expand production capacity to meet demand. The opposite would occur when the size of entry-level cohorts begins to decline and producers find themselves with excess production capacity. This latter effect would have been masked for the small birth cohorts entering the labor market in the 1950s because of the pent-up demand from the war years, but it was experienced fully by the cohorts entering the labor market in the 1980s. This suggests that if self-generating population cycles do occur, they cannot be expected to have a regular period or amplitude.

Several researchers have focused on determining whether population cycles are theoretically possible—that is, whether they can be represented by a formal mathematical model—and whether the observed U.S. cycles conform to an acceptable theoretical model. Ronald Lee (1974) defined a family of models that might encompass an Easterlinian feedback mechanism, identifying two types of cycle that could be generated: short-term or transient cycles, and longer-term sustained cycles. Lee concluded that parameter values for what he termed a cohort model estimated from the U.S. experience between 1917 and 1982 could not sustain longer-term cycles. However, he suggested that longer term cycles could be generated by what he called a period model, in which period fertility depends on total labor force size.

In parallel with this work, Paul Samuelson (1976) developed what he termed "an oversimplified version of the Easterlin theory" using a two-generation overlapping generations model—a model that Gustav Feichtinger and Gerhard Sorger (1989) later extended to a continuous-time model. Using nonlinear differential equations, Feichtinger and Sorger were able to generate an Easterlin cycle with a period of about 43 years. They pointed out that a discrete-time framework, although more appropriate for describing population dynamics, does not yield the period length of the Easterlin cycle.

Frank Denton and Byron Spencer (1975) and Joseph Anderson (1982) presented simulation models examining the cyclical implications of an Easterlinian model, demonstrating that demoeconomic behavior is predominantly nonperiodic, hence essentially unpredictable.

Kenneth Wachter attempted to determine the characteristics of a "viable feedback model" for sustained fertility cycles, and concluded that "there *are* viable feedback models for U.S. births, but very few, and they are very special." He demonstrated that an Easterlin type of relative cohort size model can be one of these "special" cases—especially if the timing as well as the level of the younger cohort's fertility is affected by relative cohort size. Alternatively, the Easterlin model can produce sustained cycles if a "bandwagon" effect causes the fertility of other age groups to follow that of the younger cohorts. However, Wachter emphasized that institutional factors and period effects make it very difficult to test for population cycles given the relatively short time period of available data (p. 124).

C. T. Cyrus Chu and Huei-Chung Lu (1995) again took up the models specified by Lee and Wachter. They tested a version that incorporated both Lee's period and cohort models, and found that "there indeed exists a limit cycle solution for the U.S. fertility data; however, this limit cycle solution is not stable, and therefore the population trajectory will not converge to that limit cycle" (p. 54). However, their model made no allowance for specific period effects that might have influenced the observed pattern of fertility in the second half of the twentieth century. Thus, as Chu and Lu emphasize the existence and nature of population cycles remains an area for further research.

See also: *Baby Boom; Easterlin, Richard A.; Economic-Demographic Models; Kuznets, Simon.*

BIBLIOGRAPHY

Anderson, Joseph M. 1982. "An Economic-Demographic Model of the U.S. Labor Market." In *Research in Population Economics,* Vol. 4, ed. J. Simon and P. Lindert. Greenwich, CT: JAI Press.

Chu, C.T. Cyrus, and Huei-Chung Lu. 1995. "Toward a General Analysis of Endogenous Easterlin Cycles." *Journal of Population Economics* 8: 35–57.

Denton, Frank T., and Byron G. Spencer. 1975. *Population and the Economy.* Lexington, MA: Lexington Books.

Easterlin, Richard A. 1968. *Population, Labor Force, and Long Swings in Economic Growth: The American Experience.* New York: National Bureau of Economic Research.

Feichtinger, Gustav, and Gerhard Sorger. 1989. "Self-Generated Fertility Waves in a Non-Linear Continuous Overlapping Generations Model." *Journal of Population Economics* 2: 267–280.

Lee, Ronald Demos. 1974. "The Formal Dynamics of Controlled Populations and the Echo, the Boom and the Bust." *Demography* 11: 563–585.

———. 1976. "Demographic Forecasting and the Easterlin Hypothesis." *Population and Development Review* 2: 459–72.

Macunovich, Diane J. 1999. "The Fortunes of One's Birth: Relative Cohort Size and the Youth Labor Market in the U.S." *Journal of Population Economics* 12: 215–272.

Samuelson, Paul A. 1976. "An Economist's Non-Linear Model of Self-Generated Fertility Waves." *Population Studies* 30: 243–248.

Wachter, Kenneth W. 1991. "Elusive Cycles: Are There Dynamically Possible Lee-Easterlin Models for U.S. Births?" *Population Studies* 45: 109–135.

Wachter, Kenneth W., and Ronald Demos Lee. 1989. "U.S. Births and Limit Cycle Models." *Demography* 26(1): 99–115.

Diane J. Macunovich

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DARWIN, CHARLES

(1809–1882)

The naturalist Charles Robert Darwin expounded the first successful theory of evolution based on the processes of natural selection in botanical and animal populations. The son of a physician and the grandson of a well-known polymath, Erasmus Darwin, Charles Darwin drifted from medicine at Edinburgh to preparation for a career in the Church of England at Cambridge while enjoying country pursuits such as hunting, shooting, and specimen collection throughout his young adulthood. Recognition of his skills as a naturalist first came in the form of an offer to undertake the geological, zoological, and botanical side of the official naval survey of the South American coast carried out by the HMS *Beagle* from 1831 to 1836. Upon his return, private wealth enabled Darwin to remain an independent scientist for the rest of his life.

In the course of trying to make sense of his observations, Darwin hit upon the main ideas that were later to constitute the theory of natural selection. Reading the economist T. R. Malthus's *Essay on Population* in 1838 provided an essential step in that process. Darwin was familiar with competition for survival in the animal kingdom, but the quasi-mathematical form of Malthus's theory of the potential force exerted by population growth on resources in unchecked populations proved fruitful. It revealed that there was a persistent process at work by which individual members of any species that possessed slight advantages in the struggle for survival would succeed while others either failed to breed or went extinct. Lack of room and nourishment sets up a competition in which the better adapted have a greater chance of breeding and thus of passing on the original variation. Publication of Darwin's findings was much delayed: *The Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* was not published until 1859 after Darwin learned that the scientist Alfred Russel Wallace (1823–1913), who had also been influenced by reading Malthus, was about to publish a similar theory.

The study of animal populations in terms of why they fail to show the exponential properties suggested by Malthus's geometric ratio, the interaction between birth rates and death rates, and the effect of density and territoriality in constraining fluctuations in population size followed in the wake of the interest shown in human populations. For Darwin and Wallace that interest centered on positive checks and their implications for natural selection.

Detailed studies of the principles of population interaction and competition were delayed until the twentieth century. David Lack, for example, showed that birds exercise reproductive control through natural selection. Clutch size converges on the "efficient" solution: It corresponds to the largest number of young for which the parents can on average find sufficient food.

Malthus, who was attacked for stressing the aspects of behavior that humankind shares with animals, became important to biology precisely because of this fact. Malthus's habits as an observer, balancing speculation with detailed observation, are similar to those involved in natural history. Any reader with the experience of Darwin and Wallace would recognize the same mentality, procedures, and need to fill the gaps in knowledge created by the absence of scope for controlled experimentation with natural populations. Ultimate and proximate causes need to be separated, but that can be done only with great difficulty. Migration to other regions also causes similar problems when one tries to draw inferences. This led to Darwin's problem in proving that what could be observed as a result of artificial selection was also true of natural selection. Because of the current availability of accurate human population statistics, Darwin's observations continue to offer a benchmark for noting differences in animal population behavior.

Darwin's theory, having acknowledged its debts to the human or social sciences, exerted a reciprocal influence on the study of human populations. It did this not so much through questions involving quantities, Malthus's sole concern, but through questions affecting qualitative changes in human populations as judged by intelligence or other properties deemed to be heritable. This question was first addressed by Darwin's cousin, Francis Galton (1822–1911), whose studies of the inheritance of intelligence, though first undertaken without a knowledge of genetic transmission mechanisms, launched the field known as eugenics. Darwin appropriated Galton's ideas on the effect of inheritance in his *Descent of Man* (1871), giving his personal blessing to one version of a doctrine already in circulation, social Darwinism, or what would later be called sociobiology.

See also: *Animal Ecology; Biology, Population; Eugenics; Evolutionary Demography; Galton, Francis; Malthus, Thomas Robert; Sociobiology.*

BIBLIOGRAPHY

Barlow, Nora, ed. 1969. *The Autobiography of Charles Darwin, 1809–1882.* New York: Norton Library.

Bowler, Peter J. 1976. "Malthus, Darwin, and the Concept of Struggle." *Journal of the History of Ideas* 37: 631–650.

Browne, Janet. 1995. *Charles Darwin; Voyaging.* London: Jonathan Cape.

Darwin, Charles. 1985 (1859). *The Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. London: Penguin.

———. 1998 (1871). *The Descent of Man and Selection in Relation to Sex*. Great Minds Series. Amherst, NY: Prometheus Books.

Galton, Francis. 1972 (1869). *Hereditary Genius; An Inquiry into its Laws and Consequences*. Gloucester, MA: Peter Smith.

Lack, David. 1952. *The Natural Regulation of Animal Numbers.* Oxford: Oxford University Press.

DONALD WINCH

DATA ASSESSMENT

In a perfect world, data would always be complete, accurate, current, pertinent, and unambiguous. In the real world, data is generally flawed on some or all of these dimensions. Data assessment in practice has tended to focus on completeness and accuracy, and that is the focus of these notes. Currency, pertinence and clarity deserve more attention than they receive, perhaps, but their assessment requires very different methods.

Assessment is sometimes thought of as a preliminary to analysis proper. This is a useful distinction in some circumstances, but in general the assessment of error and the drawing of substantive conclusions are two sides of the same coin. This is suggested by the symbolic equation "Data = Reality + Error", in which "Reality" represents conclusions drawn from the data that are valid despite the error and "Error" represents spurious conclusions suggested by the data as a result of error. Since all conclusions fall into one or the other of these two categories, conclusions about error are at the same time conclusions about reality, and conversely.

Data may be defined as systematic information about the members of some statistical aggregate. *Systematic* means that the same information is available for every entity, with exceptions only for missing values and inapplicable cases (e.g., age at first marriage for a never married woman). *Statistical aggregate* refers to a collection of entities (e.g., persons, births, deaths, households) defined by explicitly stated rules for inclusion. Data consist concretely of (1) a collection of *records,* one for each entity in the statistical aggregate, each record containing information about the entity it represents, and (2) one or more texts describing the statistical aggregate and the content of the records. The records and associated documentation are often referred to as a *data set.* *Statistics* are indicators, usually but not necessarily numerical, derived from one or more data sets.

The term *data* in common usage may refer either to data or to statistics. Census data, for example, may refer either to census information on individual persons and households or to the tabular data contained in census publications, such as total population size and the distribution of population by age and sex.

Direct Assessment

There are two general approaches to the assessment of data, direct and indirect. Direct assessment consists of evaluating the coverage and content of a data set. *Coverage* refers to the faithfulness of the correspondence between the records that constitute the data set and the statistical aggregate the data set represents. Data sets may omit records for some entities that should be represented and include records that should not be included. Improper inclusions occur when a data set includes more than one record for the same entity, includes records for entities not in the statistical aggregate, or includes fictitious records. *Content* refers to the completeness and accuracy of the information contained on the records in the data set.

Direct assessment requires a record-matching study, in which two data sets are compared. The records in each data set are divided into two groups: matched records, which represent entities represented by records in the other data set, and unmatched records, the remainder. Numbers of matched and unmatched records provide a basis for assessing coverage. Comparison of corresponding values on matched records provides a basis for assessing content.

The value of information on coverage provided by a record-matching study is limited by *response correlation bias,* which exists whenever the inclusion of an entity in one data set is not independent of its inclusion in the other data set. In the extreme case of perfect correlation, both data sets would consist entirely of records representing the same entities, and matching would provide no information on coverage. Strict independence is unattainable in practice, but a modicum of independence is necessary for a record-matching study to yield useful information on coverage.

In a 1974 publication, Eli S. Marks, William Seltzer, and Karol J. Krotki provided a useful general discussion of record-matching studies. John G. C. Blacker wrote a 1977 article containing a critical assessment of record-matching studies in demography.

Record-matching studies for population censuses require a post-enumeration survey, a survey taken after the census for the purpose of evaluating its quality. Matching studies for civil registration data may involve special surveys or draw on other sources of data, such as newspaper reports of births and deaths.

Record-matching studies may be used to assess content error in population surveys. Coverage is less important for survey data than for population census or civil registration data because information is obtained only for a sample. Assessment of coverage for survey data generally focuses on the percentage of households or persons in the sample for whom it was possible to obtain data and on any selection biases that might arise from the exclusions.

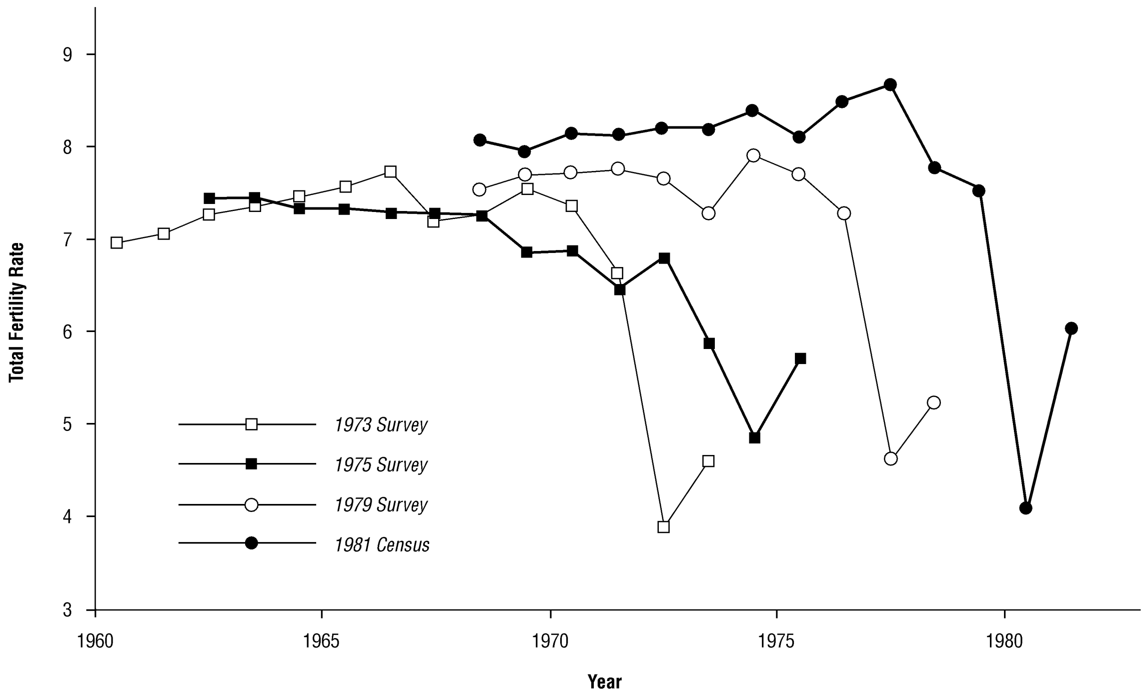
Indirect Assessment

Direct assessment of data sets is expensive, both because a second data set is required for comparison and because matching is often a complex and difficult process. The results of direct assessment are, moreover, limited by response correlation bias and by the tendency of data sets collected at the same or nearly the same time to have similar content error. The indirect approach, by which data sets are assessed by analyzing the accuracy of statistics derived from them, is generally far less expensive and will often give results as good as or better than direct assessment.

Assessment of a statistic is concerned with its accuracy, that is, with how close it is to the true value it represents. The principle means for assessing the accuracy of a statistic is comparison with other statistics. Comparison may take many forms. In some cases it may rely on general knowledge rather than on specific comparison statistics. Sex ratios at birth in national populations, for example, tend to be about 105 male births per 100 female births. Should survey data indicate a much higher value, it might be concluded that the completeness of reporting of female births was deficient. Such conclusions must always take due account of context, however. A sex ratio at birth of 130, for example, might indicate sex-selective abortion rather than defective data.

FIGURE 1

Total Fertility Rates for Pakistan, Estimated from Four Data Sources



Note: Estimates for more than five years prior to each data-collection operation are smoothed.

SOURCE: Retherford, Mirza, Irfan, and Alam (1987).

Direct comparisons with other statistics generally provide the strongest conclusions about data quality. Consider for example Figure 1, which shows retrospective estimates of total fertility rates for Pakistan from four successive data sets. Taken in isolation, each retrospective series of estimates shows a sharp decline in fertility followed by a rise at the end of the series. Comparison of the four series, however, shows that these declines are spurious, for none of the declines indicated by the first three data sets is confirmed by any of the following data sets. The four series taken together suggest not only that there was no fertility decline but that fertility rose slightly between 1960 and the late 1970s.

This example illustrates how error patterns in statistics derived from data sets can be used to draw conclusions about data quality. In each of the four data sets there is a tendency for too few births to be reported during the second and third years prior to the year of data collection. Direct assessment is unlikely to reveal these errors because they tend to affect all data collection operations. The errors are revealed by the comparison of retrospective series of estimates derived from data sets collected in different years. Because many demographic estimation procedures provide such retrospective series of estimates, such comparisons are often possible.

Statistics derived from higher quality data sets will generally be more accurate than statistics derived from lower quality data sets, but there is no simple, general relation between the quality of a data set and the accuracy of statistics derived from it. A population census with perfect coverage would yield a perfectly accurate total population, for example, but a census that omitted some persons who should have been included and included the same number of persons who should have been omitted would also yield a perfectly accurate total. The latter scenario is unlikely, as omissions nearly always exceed improper inclusions, but the example illustrates the indeterminacy of the relation between data quality and the accuracy of statistics.

See also: *Age Measurement; Census; Estimation Methods, Demographic.*

BIBLIOGRAPHY

Blacker, John G. C. 1977. "Dual Record Demographic Surveys: A Re-assessment." *Population Studies* 31: 585–597.

Marks, Eli S., William Seltzer, and Karol J. Krotki. 1974. *Population Growth Estimation: A Handbook of Vital Statistics Estimation.* New York: Population Council.

Retherford, Robert D., G. Mujtaba Mirza, Mohammad Irfan, and Iqbal Alam. 1987. "Fertility Trends in Pakistan: The Decline That Wasn't." *Asian and Pacific Population Forum* 1(2): 1, 3–10.

Griffith Feeney

DATABASES, DEMOGRAPHIC

Demographic databases are systematic listings or files of statistical information on the characteristics of the members of a population, typically at the level of individuals, families, or households. A database of the population of the United States has been compiled every ten years since the first census was conducted in 1790. This was initially limited to such basic demographic information as age, sex, and race. It has grown to include much fuller demographic profiles of people, including education, employment and occupation, marital status, and income, along with characteristics of both the household and the housing unit.

Early Uses of Demographic Databases

Demographic databases, first as paper reports and then, with the advent of the computer, as electronic files, have become widely used in both the public and private sectors. In the case of the decennial U.S. census, before 1970 very little demographic information in the form of cross-tabulations was available in any format other than paper volumes. Demographic and social statistics for geographic areas ranging from states to cities to neighborhoods had to be sought in hundreds of separate volumes. Any attempt to aggregate this information required transforming it into a machine-readable form. Maps associated with the data were supplied separately; no geographic information systems were available.

Since 1970 the Census Bureau has increased the amount of information available in machine-readable form and at the same time has reduced the amount available on paper. For example, about 450,000 pages were published from the 1990 census; the total from the 2000 census is expected to be about 100,000 pages.

Problems and Opportunities Associated with Electronic Files

The shift to electronic files poses some potential problems. There is the risk that computers of the future will not be capable of reading information produced in the recent past. Moreover, federal statistical agencies in the United States, to save funds and speed delivery, have used the Internet both as an archive and as a means of data retrieval; there is no assurance that future users of the data will have easy access.

As a result of the use of computers, data users are no longer limited to data aggregated into geographic areas. Databases composed of information on individuals, commonly known as public use microdata samples, are also commonly available in machine-readable form. (They are carefully screened to ensure that information about specific individuals cannot be determined.) For the U.S. census, these samples, extracted from the full set of census returns, enable researchers to develop cross-tabulations not found in the summary files produced by the Census Bureau. Another enhancement to basic demographic databases is the ability to map aggregate information by using geographic line files that can be interpreted by computer mapping software.

The Internet and Electronic Linkage

The Internet, along with high-speed computers, has enabled researchers to move beyond the analysis of just a single database. Linkage of demographic information from disparate sources is readily attainable. For example, health records from hospitals can be linked with social security information and further linked to educational attainment data. This ability to link files, even with personal identifiers eliminated from the records, raises the possibility that individuals could be identified and their demographic and socioeconomic information disclosed. This potential for disclosure is an issue for both governmental statistical agencies and the private sector.

The Private Sector

Demographic databases are important tools in the private sector. Deciding where to build a plant or open a store and gauging whether a sufficient market exists for a proposed product require the use of demographic databases, if necessary created by the private sector. The first major private sector database, the "Survey of Buying Power," was published in 1929. It consisted of demographic and socioeconomic data for all counties and cities in the United States. Like the census, the survey eventually was produced in machine-readable form.

Private sector producers of demographic databases have moved beyond basic demographic and geographic tabulations. Through the use of statistical techniques such as factor analysis and cluster analysis, techniques that enable researchers to combine demographic variables into clusters composed of similar lifestyle characteristics, specialized databases have been generated for geographies such as postal codes and company trading areas. Information from warranty cards submitted by purchasers of products, subscription lists, telephone directories, and other sources is linked to create databases that can be used for direct marketing purposes. Although these linked files are nongovernmental, questions of privacy and confidentiality are still relevant.

A Public Good

In the United States demographic databases compiled by the federal statistical agencies are considered a public good. These agencies have no copyright protection and are permitted to charge for their data only to the extent that the charges cover the cost of dissemination. It is assumed that the cost of collection has already been paid by the taxpayers, and the agencies are supported through the federal budget. The United States is nearly alone in following this policy. In most other countries national statistical offices are expected to pay their own way, charging users for their data. At the same time these offices are pressured to make their information available electronically on the Internet or through other means so that as many people as possible have access to it.

Databases in the Future

The integration of demographic databases through the use of advanced computer capabilities may eventually give researchers the capability of one-stop shopping, with databases linked not only nationally but internationally. The United Nations and other international organizations, through their publications and the Internet, already produce and publish some databases of international demographic statistics. In the future researchers may be able to retrieve data on characteristics such as race, education, and income, taking account of all the different definitions, based on comprehensive metadata, in the form of one international file.

See also: *Bibliographic and Online Resources; Business Demography; Census; Data Collection, Ethical Issues in; Demographic Surveys, History and Methodology of; Longitudinal Demographic Surveys; State and Local Government Demography.*

BIBLIOGRAPHY

Anderson, Margo J. 1988. *The American Census: A Social History.* New Haven, CT: Yale University Press.

Doyle, Lane, and Zayatz Theeuwes. 2001. *Confidentiality, Disclosure, and Data Access.* Washington, D.C.: Elsevier.

Russell, Cheryl. 1984. *The Business of Demographics.* Washington, D.C.: Population Reference Bureau, *Population Bulletin,* Vol. 39.

Spar, Edward J. 2000. "The Private Sector." In *Encyclopedia of the U.S. Census.* Washington, D.C.: CQ Press.

"Survey of Buying Power." *Sales and Marketing Management,* annual publication. New York: Sales and Marketing Management Magazine.

United Nations. *Statistical Yearbook,* annual publication. New York: United Nations.

U.S. Department of Commerce, U.S. Census Bureau. 2001. *Introduction to Census 2000 Data Products.* Washington, D.C.: U.S. Government Printing Office.

U.S. Office of Management and Budget. 2002. *Statistical Programs of the United States Government.* Washington, D.C.: U.S. Government Printing Office.

Weiss, Michael. 1988. *The Clustering of America.* New York: Harper & Row.

Edward J. Spar

DATA COLLECTION, ETHICAL ISSUES IN

Ethics in demographic data collection, or in demographic research more generally, has received little explicit attention in the population field and no formal guidance from the principal professional associations. This is in contrast with the treatment of ethics in anthropology, sociology, statistics, and medical research. Ethical discussions in the population field have focused almost exclusively on the ethical dimensions of population policies and programs.

As a result, available ethical guidance comes primarily from national and international professional associations in allied fields. The major concerns of professional associations are proper behavior among members of the profession and by members of the profession toward others—students, employers and donors of research funds, research subjects or respondents, and the general public or society at large.

Applied to demographic data collection, the most relevant topics are (1) promoting the neutrality and objectivity of the data collection operations and outputs, including issues of professional competence and integrity, and (2) safeguarding the autonomy of research subjects or respondents, including the protection of respondents and the entire study population from potential harm.

Since the official statistics generated by governmental sources, such as population censuses or birth and death registration systems, are a major source of demographic data, national and international norms relating to official statistics are also a relevant source of ethical guidance. However, these norms are primarily directed toward the behavior of governments and institutions rather than the actions of individual practitioners.

Professional and Scientific Integrity

The code of ethics of the American Sociological Association advises sociologists to "adhere to the highest possible technical standards that are reasonable and responsible in their research. . .act with honesty and integrity; and avoid untrue, deceptive, or undocumented statements. . .and avoid conflicts of interest and the appearance of conflict." The United Nations Fundamental Principles of Official Statistics, the International Statistical Institute's Declaration on Professional Ethics, and the American Statistical Association's Ethical Guidelines for Statistical Practice provide similar guidance.

Protecting Respondents and Other Research Subjects

Norms relating to confidentiality and the protection of human research subjects include the succinct statement in the Fundamental Principles of Official Statistics: "individual data collected by statistical agencies for statistical compilation. . .are to be strictly confidential and used exclusively for statistical purposes." The Code of Ethics of the American Sociological Association states that sociologists "have an obligation to ensure that confidential information is protected" so as to shield sensitive information obtained in research. Sociologists are also to "inform themselves fully about all laws and rules which may limit or alter guarantees of confidentiality. They determine their ability to guarantee absolute confidentiality and, as appropriate, inform research participants. . . of any limitations to this guarantee at the outset." The International Statistical Institute's Declaration on Professional Ethics and the American Statistical Association's Ethical Guidelines for Statistical Practice set out similar ethical obligations.

Also of relevance are the requirements that governments and other funding agencies impose on their grantees. Laws and other regulatory efforts are often designed to achieve many of the same ends as ethical norms; however, they are distinct approaches to misconduct and, in specific instances, they may be at variance with one another. Accordingly, researchers need to be aware of both the ethical and legal constraints relevant to their planned research and data collection efforts.

Current norms and regulations designed to protect human research subjects were initially developed as a reaction to the Nazi medical experiments carried out on concentration camp inmates during World War II. Over the years, by simple extension, the area of concern has broadened to include both

TABLE 1

Factors Contributing to Higher-Risk Demographic Data Collection and Research Based on Potential for Respondent or Group Harm

A. Critical factors

1. Population studied is weak or otherwise vulnerable.
2. Data gathering or research involves variables that are on "sensitive" topics, typically topics that are or can be used to identify or stigmatize one or more vulverable groups, or use classifications that permit the identification or stigmatization of such groups.

B. Aggravating factors

1. All or substantially all of population is covered (i.e., sampling is not used).
2. Longitudinal data gathering is involved, or the activity can be linked to a longitudinal system.
3. Participation is mandatory or is effectively coerced.
4. Little or no input from the subject population in planning the data gathering or research activities. (The risk potential is further enhanced if there are substantial inputs in terms of expertise, staff, or funds from foreign persons or institutions.)
5. The data gathering or research is carried out in a war, a period of civil disruption, or during or shortly after a similar emergency.
6. Little or no attention given to organizational, operational, methodological, and technological safeguards against the misuse of information obtained for non-statistical purposes.
7. Confidentiality assurances provided to respondents have limited or no legal basis.
8. Ethical reviews are not carried out, are perfunctory, or are heavily influenced by utilitarian consideration.

Note: The presence of either or both critical factors gives rise to a presumption of risk and each additional aggravating factor present further augments such risk. On the other hand, it should be emphasized that the presence of crititcal and aggravating factors does not mean that actual harm has occurred.

SOURCE: Compiled by author.

experimental and non-experimental threats and has been adopted, without substantial modification, by social science researchers more generally. Thus, the related protections focus on safeguarding against invasive acts on the body or mind of the research subject, particularly through biomedical and psychological experiments, that threaten the physical or mental well-being of that subject. A key element of such protections is the general requirement that the voluntary, informed consent of each individual research subject must be obtained before any research is begun.

Besides the areas of experimental psychology and the work of some cultural anthropologists, virtually all demographic and related social science research and data gathering is minimally intrusive in terms of the original biomedical model and its extensions. Certainly the primary purpose and mode of the bulk of such data collection is simply the gathering of minimally sensitive information with the intent of characterizing populations rather than any individual respondent. Indeed, under the traditional informed consent paradigm many demographic data collection activities would be categorized as "minimally invasive." However, the need to protect respondents from harm arising from the information they provide imposes a responsibility on researchers to keep such information confidential. The inclusion of more sensitive health information and various biomarkers and anthropometric data (such as HIV status) in some demographic surveys calls for a higher level of respondent protection.

Under certain circumstances, information itself may pose real risks to human research subjects and their families, or to other members of the group to which these respondents belong. For example, as William Seltzer and Margo Anderson demonstrated, information on individuals and their group membership obtained through population registration and other routine data collection activities has been associated with major human rights abuses including genocide, forced migration, and internment. Historically, the risks have had particularly serious consequences for those in small, politically weak groups or in groups that were otherwise the object of attack. In the case of DNA testing, the risks lie primarily in the sensitivity of information obtained rather than in the degree of invasiveness of the procedure, and that those potentially at risk are not only the individual research subjects but also others with similar genetic characteristics.

The degree of risk associated with any demographic data collection effort or program is a function of many factors, including: the method of data collection, study design, the population being studied, the variables employed, and the level and methods of analysis. Table 1 summarizes those factors that seem to have contributed to elevated risks of misuse in the past.

As important as ethical considerations may be in promoting responsible demographic data collection, other kinds of safeguards can also play a role in protecting against possible misuse. These include substantive safeguards, methodological and technological safeguards, organizational and operational safeguards, and legal safeguards. Indeed, the use of multiple safeguards is perhaps the best defense against the misuse of demographic data and population data systems, and one goal of ethical awareness is to ensure that adequate attention has been devoted to these other safeguards.

Ethical norms also help temper the zeal of those promoting and implementing action and research programs and related demographic data gathering activities. These advocates or researchers are often so convinced of the importance and beneficence of research and data gathering that the resulting risks to others are minimized or ignored. Indeed, some of the most serious ethical lapses in research can be attributed to a lack of awareness that the particular activity presented any ethical issue at all.

See also: *Anthropometry; Census; Population Registers.*

BIBLIOGRAPHY

Annas, George J., and Grodin, Michael eds. (1992) *The Nazi Doctors and the Nuremberg Code: Human Rights in Human Experimentation.* New York: Oxford University Press.

Kultgen, John. 1988. *Ethics and Professionalism.* Philadelphia: University of Pennsylvania Press.

Murphy, Timothy F. and Marc A. Lappe, eds. 1994. *Justice and the Human Genome Project.* Berkeley: University of California Press.

Reich, Warren T., ed. 1995. *Encyclopedia of Bioethics,* revised edition. New York: Macmillan-Simon.

Seltzer, William and Margo Anderson. 2001. "The Dark Side of Numbers: The Role of Population Data Systems in Human Rights Abuses." *Social Research* 68: 2 (Summer): 481–513.

Vanderpool, Harold Y., ed. 1996. *The Ethics of Research Involving Human Subjects: Facing the 21st Century.* Frederick, MD: University Publishing Group.

INTERNET RESOURCES.

American Sociological Association. 1997. "Code of Ethics." <http://www.asanet.org/members/ecoderev.html>.

American Statistical Association. 1999. "Ethical Guidelines for Statistical Practice." <http://www.amstat.org/profession/ethicalstatistics.html>.

International Statistical Institute. 1986. "Declaration of Professional Ethics for Statisticians." <http://www.cbs.nl/isi/ethics.htm>.

William Seltzer

DAVIS, KINGSLEY

(1908–1997)

One of the foremost demographers of his time and one of the most eminent and influential figures in twentieth-century American social science, Kingsley Davis made major contributions to demographic theory, the sociology of the family, and especially the understanding of the world demographic transition.

In 1930 Davis received a bachelor's degree in English from the University of Texas, where he was editor of the literary magazine. In 1932 he enrolled as a graduate student in Harvard's sociology department, receiving a doctorate in 1936. At Harvard he studied under Talcott Parsons, Pitrim Sorokin, W. Lloyd Warner, and Carle Zimmerman but did not take the one course in population offered by E. B. Wilson. He received no training in formal demography until 1940–1941, when as a postdoctoral fellow at the Social Science Research Council he studied under Samuel Stouffer at the University of Chicago and at the U.S. Bureau of the Census.

Davis held academic appointments at Clark University (1936–1937), Pennsylvania State University (1937–1944), Princeton University (1942–1948), Columbia University (1948–1955), the University of California at Berkeley (1955–1977), the University of Southern California (1977–1990), and the Hoover Institution (1981–1992). He was president of the American Sociological Association in 1959 and president of the Population Association of America in 1962–1963 and received the Population Association of America's Irene B. Taueber Award for Outstanding Research in Demography in 1978. In 1965 he was the first sociologist to be elected to the U.S. National Academy of Sciences.

Davis first achieved a considerable reputation for his research on the family, but his interest in population dynamics and related policy matters was evident in his earliest writings. An article, "Reproductive Institutions and the Pressure for Population," published when Davis was 28, offered an incisive analysis of the decline of the birthrate in modern industrial societies, locating the cause in the "ripening incongruity between our reproductive system (the family) and the rest of modern social organization" (1937, p. 290; 1997, p. 612). Davis rounded out the analysis with an original and provocative discussion of the policies, actual and potential, that can be used in an attempt to resolve that incongruity. The article foreshadowed not only the main topics Davis pursued throughout his long scientific career but also the distinctive and often combative style with which he explored important social phenomena.

Davis's preoccupation with demographic research proper began, however, with his appointment at Princeton University in 1942. At that university he wrote an influential article, "The World Demographic Transition" (1945), and did the major work on his opus, *The Population of India and Pakistan* (1951). In 1956, with Judith Blake, then his wife, he coauthored a path-breaking article on social structure and fertility, identifying the variables through which social factors can affect human reproduction. His 1963 presidential address to the Population Association of America, "The Theory of Change and Response in Modern Demographic History," was an important contribution to demographic transition theory. Influential works on world urbanization and international migration followed.

Davis was an engaged scholar, often writing on demographic topics and policy issues for a wide audience. His arresting and forceful critique of the inability of family planning programs to achieve population stabilization that appeared in *Science* in 1967 spawned many heated debates in academia and in Washington policy circles. Davis contended that in implying that the only requirement for fertility reduction was a perfect contraceptive device, family planners avoided discussion of the possibility that fundamental changes in social organization were necessary prerequisites.

In the last stage of his scientific career Davis continued to explore changes in the family and in sex roles and their effect on fertility. He also organized influential conferences that focused attention on the causes and consequences of below-replacement fertility levels and the relationship between resources, the environment, and population change.

Davis was a compelling teacher, and many prominent demographers trained under his stewardship. He wrote with exceptional clarity. His linguistic innovations include the terms *population explosion* and *zero population growth.* Moreover, along with his colleague Frank Notestein, he was the first to popularize the term *demographic transition.*

See also: *Blake, Judith; Demographic Transition; Demography, History of; Fertility, Proximate Determinants of; Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY KINGSLEY DAVIS.

Davis, Kingsley. 1937. "Reproductive Institutions and the Pressure for Population." *Sociological Review,* July, pp. 289–366. Reprinted in *Population and Development Review* 23: 611–624 (1997).

———. 1945. "The World Demographic Transition." *Annals of the American Academy of Political and Social Science* 237: 1–11.

———. 1949. *Human Society.* New York: Macmillan.

———. 1951. *The Population of India and Pakistan.* Princeton, NJ: Princeton University Press.

———. 1963. "The Theory of Change and Response in Modern Demographic History." *Population Index* 29: 345–366.

———. 1967. "Population Policy: Will Current Programs Succeed?" *Science* 158: 730–739.

———. 1969/1972. *World Urbanization 1950–1970.* Berkeley, CA: Institute of International Studies.

———. 1973. *Cities: Their Origin, Growth and Human Impact.* San Francisco: W. H. Freeman.

———. 1984. "Wives and Work: The Sex Role Revolution and Its Consequences." *Population and Development Review* 10(3): 397–417.

Davis, Kingsley, and Judith Blake. 1956. "Social Structure and Fertility: An Analytic Framework." *Economic Development and Cultural Change* 4: 211–235.

Davis, Kingsley, ed., with M. S. Bernstam. 1991. *Resources, Environment, and Population: Present Knowledge, Future Options.* New York: Oxford University Press. Supplement to Vol. 16 of *Population and Development Review.*

Davis, Kingsley, ed., with M. S. Bernstam and R. R. Campbell. 1987. *Below-Replacement Fertility in Industrial Societies: Causes, Consequences, Policies.* New York: Cambridge University Press. Supplement to Vol. 12 of *Population and Development Review.*

SELECTED WORKS ABOUT KINGSLEY DAVIS.

Petersen, William. 1979. "Davis, Kingsley." In *International Encyclopedia of the Social Sciences,* ed. David L. Sills. Vol. 18: *Biographical Supplement.* New York: Free Press.

DAVID M. HEER

DEATH RATE

See *Mortality Measurement*

DEFORESTATION

Unlike the mere harvesting of trees for timber, deforestation changes a forest of growing trees into a different type of land cover. In France from 800 to 1300 C.E., the forests shrank by half, and in the United States from 1800 to 1920, the forests shrank by fully one-third. The replacement of forests, which ancient people might have seen as removing the lair of bandits and supernatural evil, in the twenty-first century seems a major transformation of the earth for the worse and hence an environmental threat.

Current Deforestation

During the 1990s the Food and Agriculture Organization (FAO) of the United Nations mounted a global survey to monitor changing forest areas. For the period from 1990 to 2000 FAO estimated that global deforestation was occurring at the average rate of 0.22 percent per year. Global forests shrank about 9 million hectares (ha) during the decade, an area roughly the size of Portugal or Hungary, or the state of Indiana. The global rates, however, cloak large regional differences, from 0.78 percent per year for deforestation in Africa, to its opposite, 0.08 percent per year afforestation in Europe. Among nations with more than one million ha of forest, the rates ranged widely—from deforestation at 3 percent or more per year in Niger, Ivory Coast, and Nicaragua to afforestation at 1 percent or more per year in seven nations as diverse as Belarus, China, Cuba, and Portugal.

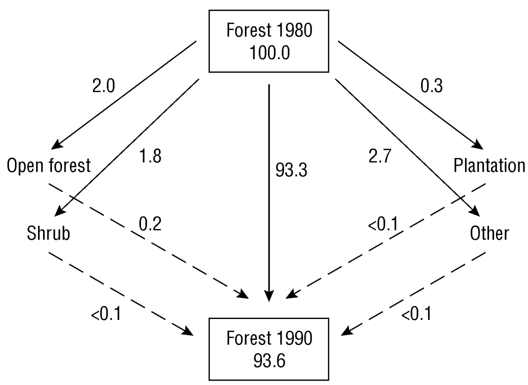
Changes in land cover, including deforestation, are dynamic. The shrinkage of the earth's tropical forests from 1980 to 1990 was studied in a 1997 FAO survey of 3 billion ha of land (an area the size of Africa, or more than three times the land area of the United States) with several types of land cover. The forest with closed canopy in 1980 covered roughly half the surveyed area and is represented in Figure 1 as 100 percent. A decade later 93.3 percent of the 1980 forest was still closed; two percent of the 1980 forest had become open (i.e., open and fragmented forest plus long fallow); 1.8 percent had become shrub and short fallow; and 0.3 percent had been converted to plantations of trees. The largest conversion, 2.7 percent, was to other land cover, a category that includes permanent agriculture, cattle ranching, and water reservoirs, among others. Small conversions from open-canopied forest, and even smaller ones from the other classes of cover, to closed-canopy forest added a fraction of one percent to the 1990 closed forest. The small conversions to closed forest leave the impression that deforestation tends to be permanent.

Figure 2 describes forest change over almost the same decade (1982 to 1992) for a developed nation (the United States) that had earlier lost one-third of its forest. Fully 96.4 percent of non-federally-owned forest remained and conversions from other covers to forest slightly more than offset the lost 3.6 percent, expanding forest cover a little during the decade. Figures 1 and 2 exemplify the dynamic nature of changing land use, regional differences, and, instead of only deforestation, the possibility of afforestation.

The complexity of land cover change and differences in the definition of what a forest is make for uncertain estimates of the rate of deforestation. For example, the 0.5 percent change of forest to federal ownership shown in Figure 2 does not necessarily entail deforestation. Nor does the change from closed to plantation forest seen in Figure 1. FAO is attempting to generate consistent estimates of change using a uniform definition of forest area and applying remote-sensing techniques. In the end, while there is no doubt that deforestation is proceed-

FIGURE 1

Changing Land Cover in Tropical Countries, 1980–1990



Note: The figure shows percentage reduction in the inital closed-canopy forest area (1980 = 100; estimated to be 1.368 million ha), by conversion to other land covers. *Open forest* includes open and fragmented forest plus long fallow; *Shrub* is shrubs and short fallow, and *Other* is permanent agriculture, cattle ranching, water reservoirs, etc.

SOURCE: Food and Agriculture Organization (1997).

ing in the tropics and afforestation is occurring in developed nations, some arbitrariness in estimated rates is inevitable.

Causes

Harvesting trees for lumber and pulp, even clear cutting the forest and allowing it to grow anew, does not qualify as deforestation. In developed nations, exemplified by the United States, lumber and pulp products have a declining role in the economy, so the overall impact of harvesting is diminishing over time. Authentic changes from forest to other cover occur when all the forest is removed for its products or the land is put to other use. Continually removing fuel wood can denude the land. In southern Africa, fuel wood accounts for about three-quarters of all energy use, and about 95 percent of all wood products were consumed for fuel. In the three rapidly deforesting countries cited above, Niger, Ivory Coast, and Nicaragua, two-thirds or more of the energy in each country came from wood in 1995. In the four countries that were mentioned above as having afforestation—Belarus, China, Cuba, and Portugal—wood represented less than one-twentieth of the energy source. In the first three countries population was rising faster than 2.4 percent per year during the period, while in the latter four the rate rose at less than 1 percent per year.

In 1803 economist T. R. Malthus wrote, "When acre has been added to acre till all the fertile land is occupied, the yearly increase of food must depend upon the amelioration of the land already in possession. This is a stream which, from the nature of all soils, instead of increasing, must be gradually diminishing" (Malthus 1992, p.17). Since Malthus wrote, the shrinkage of forests has often been attributed to expansion of cropland to supply an inexorably multiplying population. As countries have developed, however, they modified the connection between population size and cropland. Wealth increases expenditure on food but not in proportion to rising income. Eating more animal products can increase the need for feed, but the rise in protein intake per person tapers off in wealthy nations. Increasing yields per ha lower the need for cropland. In many countries, the events of the twentieth century produced an outcome that Malthus could not have envisioned: More and richer people were able to eat better while cropland scarcely changed or even shrank. In the 1990s in developed nations, the per capita supply of calories and protein and the total cropland declined by a fraction of 1 percent per year; in the developing world, calorie consumption rose by 0.7 percent per year and protein consumption by 1.2 percent, while cropland rose only by 0.3 percent per year.

Worldwide during the 1990s, a period during which the population was increasing by 80 million per year, forests shrank by nearly 1 million ha per year. But over the same period, cropland shrank—by 100,000 ha per year. Maintaining the Malthusian view that an increasing population requires more cropland, causing deforestation, thus becomes difficult. The role of grazing in deforestation is less clear because of the blurred distinction between pasture and woodland. (For this reason FAO abandoned reporting pasture area, although it did report that cattle numbers fell 2 percent per year in developed countries and rose 1.3 percent in developing countries during the period from 1990 to 1999.)

Geographers Alexander Mather and Coby L. Needle reasonably concluded from these estimates: "Outright rejection of the notion that forest trends are related to population trends is no more justifiable than an unqualified assertion that population growth is *the* driver of deforestation" (p.10).

Why Deforestation Matters

Why do some people see deforestation as an evil? An immediate reason is that eliminating forests may lead to a timber shortage. Traveling through New York and New England two centuries ago, President Timothy Dwight of Yale University worried that the voracious demand for fuel would deforest that region; yet at the beginning of the twenty-first century those areas again grow wide forests. The fear of timber shortage, of course, may be well justified in nations that continue to depend on fuel wood and are suffering deforestation.

Environmental consequences are another reason for concern about deforestation. Denuding land decreases evaporation from foliage and encourages rapid runoff and erosion. The loss of forest habitat can lead to the extinction of certain species. And, through diminished absorption of carbon dioxide in forest biomass, deforestation adds perhaps 20 percent to the carbon dioxide released from other anthropogenic sources, contributing to possible global warming.

Finally, the esthetic and emotional effects of deforestation, even if unmeasurable, cannot be ignored. Supported by myth, art, and literature, a veneration for forests persists.

Transition

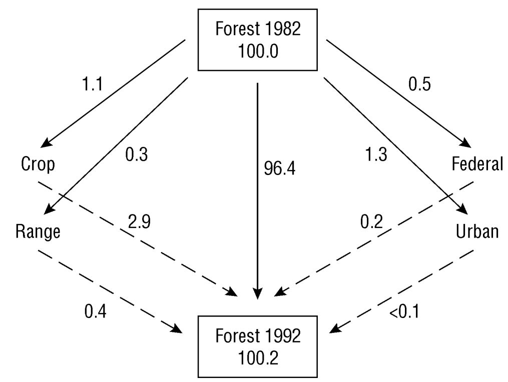
An era of rising population and deforestation that has evolved into an era of afforestation in some nations despite rising population has been labeled the forest transition by Mather and Needle. If deforestation is feared and since the global population is certain to grow in the first part of the twenty-first century, this transition must continue to be the goal.

Planting trees directly expands forests. By the end of the twentieth century, forest plantations comprised 5 percent of global forest cover and were expanding at 2.4 percent per year. Plantations, which can sometimes produce timber faster than natural forests, can spare natural ones from harvest. Maintaining existing cropland in usable condition and raising crop yields spare forests from agricultural encroachment. Developing other types of fuel lessens the need to cut forests for fuel wood. These processes are contributing to the forest transition that is evident in an increasing number of countries in the first years of the twenty-first century.

See also: *Land Use; Natural Resources and Population; Sustainable Development.*

FIGURE 2

Changing Land Cover in the United States, 1982–1992



Note: Percentage reduction in forests on non-federal land (1982=100; estimated to be 766 million ha), by conversion to other categories. *Forest 1982 100.0* is on non-federal land, *Crop* is cropland plus pasture, *Federal* is government land, and *Urban* is urban and built-up. (A small residual category is omitted.)

SOURCE: U.S. Department of Agriculture (1997).

BIBLIOGRAPHY

Clawson, Marion. 1979. "Forests in the Long Sweep of American History." *Science* 204: 1168–1174.

Dwight, Timothy. 1969. *Travels in New England and New York,* Volume 4. Cambridge, MA: Belknap Press of Harvard University Press.

Food and Agriculture Organization. 1997. *State of the World's Forests.* Rome: Food and Agriculture Organization.

Food and Agriculture Organization. 2001. *FRA 2000 Global Tables.* Rome: Food and Agriculture Organization.

Malthus, T. R. 1992 (1803). *An Essay on the Principle of Population.* Cambridge, Eng.: Cambridge University Press.

Mather, Alexander S., and Coby L. Needle. 2000. "The Relationship of Population and Forest Trends." *The Geographical Journal* 166: 2–13.

Palo, Matti, and Jussi Uusivuori. 1999. *World Forests, Society and Environment.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

Schama, Simon. 1995. *Landscape and Memory.* New York: Knopf.

U.S. Department of Agriculture. 1997. "Agricultural Resources and Environmental Indicators, 1996–

97." *Agricultural Handbook,* No. 712. Washington, D.C.: U.S. Department of Agriculture.

Waggoner, Paul E., and Jesse H. Ausubel. 2001. "How Much Will Feeding More and Wealthier People Encroach on Forests?" *Population and Development Review* 27: 239–257.

Wernick, Iddo K., Paul E. Waggoner, and Jesse H. Ausubel. 1998. "Searching for Leverage to Conserve Forests." *Journal of Industrial Ecology* 1: 125–145.

INTERNET RESOURCES.

Food and Agriculture Organization. <http://www.fao.org/>.

U.S. Energy Information Agency.<http://www.eia.doe.gov/>.

PAUL E. WAGGONER

DEMOGRAPHIC AND HEALTH SURVEYS

The Demographic and Health Surveys (DHS) project is designed to produce accurate and timely information on population, health, and nutrition in developing countries. DHS surveys are national sample surveys that provide key data for planning, monitoring, and evaluating programs in these areas. DHS data also play a major role in furthering international understanding of global population and health trends. The surveys provide an unparalleled body of comparable data on demographic, health, and nutrition indicators and are a primary source of reproductive and health information for Africa, Asia, Latin America, and the Caribbean.

Program Inception

The DHS program started in 1984 as a follow-up to the World Fertility Survey and the earlier Contraceptive Prevalence Surveys. Through the end of 2002, 145 DHS surveys of reproductive-age women had been conducted in 68 countries. In addition, 74 surveys of men had been conducted in 44 countries. Most DHS surveys have a sample size of 4,000 to 8,000 women, but several have had substantially larger samples. The 1998–1999 National Family Health Survey in India included interviews with 90,303 ever-married women.

Funding

The DHS program is funded by the United States Agency for International Development as part of the MEASURE Program, which is comprised of five related projects focusing on data collection, analysis, and dissemination. Additional funding for surveys in individual countries often is obtained from the United Nations Children's Fund (UNICEF), the United Nations Population Fund, the World Bank, the United Kingdom's Department for International Development, and other organizations. ORC Macro, based in Calverton, Maryland, provides technical and administrative support for the DHS program. Surveys are implemented by agencies in participating countries, under contract with ORC Macro.

The principal objectives of the DHS program are as follows:

- To improve the information base for policy development, economic and social planning, and the management of population and health programs;
- To promote the widespread dissemination and use of DHS data by policymakers and planners;
- To expand institutional capabilities in participating countries to collect and analyze survey data;
- To improve methodologies and procedures for conducting and analyzing demographic and health surveys.

The content of the surveys has varied over time, depending on emerging problems and the needs of data users, including participating governments, nongovernmental organizations, international agencies, and funding agencies. The surveys are based on a standard set of core questionnaires. Additional questionnaire modules on topics of interest, as well as country-specific questions, may be added to the core questionnaires in each country. This ensures that the questionnaires will be most relevant to the needs of each country while allowing for cross-country comparisons of findings on the core topics.

The current content of the core questionnaires covers topics such as fertility, fertility preferences, family planning, marriage, women's empowerment, sexual activity, reproductive health, child health, environmental health, nutrition, AIDS and other sexually transmitted diseases, and socioeconomic conditions. The questionnaire modules on HIV/AIDS, maternal mortality, and female genital mutilation have been used the most frequently. In addition, some recent surveys include biomarker tests for anemia, HIV, syphilis, lead levels, cholesterol, vitamin A, and hepatitis B.

Findings

The vast array of findings from the DHS surveys have been detailed in hundreds of reports and research papers. Among their findings, DHS surveys have documented a decline in fertility in most parts of the developing world, high discontinuation rates for specific contraceptive methods in many countries, relatively high percentages of female-headed households in sub-Saharan Africa and the Caribbean, a strong preference for sons in many countries, the adverse effect of short intervals between births on the survival prospects of infants, and a substantial level of unmet need for family planning in most countries.

DHS surveys have also found high levels of anemia among children and women in India and the Central Asian republics, a high prevalence of chronic energy deficiency among women in sub-Saharan Africa, relatively high levels of obesity among women in the Middle East and North Africa, and a strong effect of poor feeding practices on the nutritional status of young children. Additional findings include substantial advances in public knowledge about AIDS and an increase in condom use during high-risk sexual encounters in AIDS-affected countries, the importance of the empowerment of women in promoting improvements in the health of both women and children, and inadequate vaccination coverage for vaccine-preventable diseases among young children in almost all the developing countries covered.

Advantages and Disadvantages

No single type of survey or data collection instrument can provide all the information necessary to inform policymaking decisions and monitor and evaluate population, health, and nutrition programs. However, the DHS surveys provide a rich and varied base of information in these areas. Some of the specific advantages of the DHS surveys are the following:

- Data are collected in a standard fashion to facilitate comparisons across countries and over time;
- DHS surveys produce generalizable data from nationally representative samples;
- The DHS program produces detailed manuals for interviewers, supervisors, household listers, and sampling statisticians to promote uniformity in procedures;
- DHS surveys incorporate extensive quality controls, including the production of field quality tables throughout the fieldwork and multiple levels of supervision and monitoring to detect and correct errors at an early stage;
- DHS data sets are made widely available over the Internet at no cost to the user;
- The collection of information on a wide variety of topics in a single survey allows in-depth study of the relationships among population, health, and nutrition variables;
- DHS surveys provide an important vehicle for the collection of biological specimens and the measurement of biological markers of health status in a cost-effective manner;
- Recent DHS data sets are geo-coded to allow linking of DHS data and other data in geographic information systems.

Among the limitations are the following:

- DHS samples are generally not large enough to provide estimates for small geographic areas, which often are needed for monitoring and evaluating decentralized programs;
- DHS surveys in a specific country are typically conducted every three to six years so that annual estimates of key indicators are not available from the surveys;
- Like any large-scale national sample survey, DHS surveys are fairly costly;
- DHS samples are not large enough to produce reliable estimates of the levels or trends of some relatively rare phenomena, such as maternal mortality.

More details about the Demographic and Health Surveys are available on the DHS website, which includes information about all DHS surveys, directions for obtaining data sets, and instructions for ordering or downloading DHS publications. In addition, the website contains an online database tool, the STATcompiler, that allows users to build customized tables for hundreds of indicators based on DHS surveys in more than 60 countries.

See also: *Anthropometry; Data Assessment; Demographic Surveys, History and Methodology of; World Fertility Survey.*

INTERNET RESOURCE

Demographic and Health Surveys. 2003. <http://www.measuredhs.com>.

Fred Arnold

DEMOGRAPHIC SURVEILLANCE SYSTEMS

Collecting information on population dynamics in a defined geographic area is a practice that is as old as demography itself. Parish records and civil registers provided information that was used in the earliest attempts to characterize mortality and population dynamics. The earliest known calculations of mortality rates were based on civil registers for a segment of London.

Fertility models have been based on archival registers that are similar to contemporary surveillance systems. The first model life tables were based on population register mortality regimes.

In the twentieth century the role of population observatories expanded from description to investigation. Early studies focused on epidemiological questions (e.g., Goldberger et al. 1920). After World War II, controlled trials were used for the demographic evaluation of health experiments (e.g., Ferebee and Mount 1962) and research stations were created where vital registration in defined geographic areas was applied to estimate demographic characteristics and carry out an expanding range of epidemiological, social policy, and demographic studies. By the 1960s the health and population research role of those research stations and population laboratories was recognized as an area of scientific specialization within the field of demography. The term *demographic surveillance system* (DSS) came to be used to connote the technologies associated with the continuous monitoring of births, deaths, and migration in a defined population over time.

Descriptive Demography and Health Interventions

At the beginning of the twenty-first century approximately 50 DSS health and population research centers were in operation around the world. Although some surveillance systems were established for the purpose of descriptive demography, the aim of most contemporary applications is to evaluate the impact of health interventions. Well-established demographic surveillance systems can provide concomitant support for multiple social, demographic, and economic investigations. Some are sites for pharmaceutical trials. In the year 2002, 28 DSS research centers were participants in the INDEPTH Network, an international organization that disseminates DSS information.

Survey Designs

The early era of population registration occurred in settings that were closed to migration. Such settings no longer exist. Surveillance systems in modern populations have to deal with migration. Establishing surveillance requires a baseline census to describe the initial population of a site by age and sex and selected other characteristics. Two contrasting strategies then are employed to update the baseline census data:

1. The *individual observation approach* records the timing and incidence of all births, deaths, and migration in and out of study areas so that the risk of events at the individual level can be defined precisely at any point in time. Migration is defined in terms of an individual's arrival at or departure from a surveillance observation unit such as the extended family, a nuclear household, or a dwelling unit over a specified period of time. Definitions of migration specify the length of time that must elapse before migration is registered as an event. Recording and managing such information represent most of the task load of individual observation systems. Most continuous demographic surveillance systems incorporate procedures for recording marital events, causes of death, and status in a household structure defined by headship or

by spousal, parental, and familial relationships.

2. The *population observation model* registers births and deaths and employs repeat censuses to estimate populations at risk of these events over time. Studies conducted by the British Medical Research Council in Gambia and in eastern and southern Africa used this approach (e.g., Greenwood et al. 1990). Dual registration systems were used to adjust coverage errors in population laboratories. This approach has been useful in descriptive demography and studies that employ area units of analysis. Health interventions consigned to clusters of households, for example, can be evaluated by monitoring births and deaths over time, enumerating cluster populations at the baseline and at the end of the project period, and estimating cluster populations over the study period. This approach obviates the need to monitor individual migration continuously or to link event data with individual census registers, thus simplifying data management processes and reducing the complexity of field operations in comparison to individual surveillance approaches.

Despite the advantages of the aggregate population observation approach, most demographic surveillance systems that have been established since the 1990s have utilized continuous individual registration designs. This practice can be explained in part by the advent of low-cost computer technologies that overcome many of the limitations of the individual surveillance approach (e.g., MacLeod et al. 1996) and the emergence of health technologies that require individual-level trials.

Individual observation expands the range of social, demographic, and health research that can be conducted in conjunction with surveillance. In the individual continuous observation approach, any cross-sectional study that records demographic surveillance identification numbers eventually permits a longitudinal study of demographic processes. A few well-designed surveillance sites have produced several thousand scientific publications (e.g., Behar et al. 1968; Scrimshaw et al. 1968; D'Sousa 1984; Menken and Phillips 1990). The longest-running and best-known DSS is Matlab, in Bangladesh.

Cohort and Panel Studies

Cohort and panel studies are alternatives to the DSS approach for longitudinal health research. Cohort studies observe a specified subgroup in a population over time and are closed to the addition of study individuals as time progresses. Panel research involves interviewing an open cohort of individuals over time. Cohort and panel designs are appropriate when a single longitudinal study is designed to answer a specific research question about a segment of a population. However, launching a succession of cohort and panel studies in a specific population is more costly than DSS approaches because each new panel or cohort study requires a new enumeration, new field procedures, and the repeated development of specialized computer systems.

Limitations

The comprehensiveness of a DSS's demographic coverage represents the principal limitation. The required scale of the data collection imposes limits on the range of information that can be compiled about other topics. Sample cohort and survey studies sometimes are conducted in conjunction with DSS operations to expand the range of information available for longitudinal research. Cluster-sampling techniques are sometimes used to reduce the quantity of data collected and lower the costs. Surveillance is costly if field management and computing procedures are not well developed because errors can multiply over time and constrain analyses. The representativeness of DSS data sometimes is questioned both because the localities chosen for surveillance operations are likely to be unrepresentative of wider populations and because the presence of researchers and associated program activities may influence the behaviors that are observed.

See also: *Demographic Surveys, History and Methodology of; Longitudinal Demographic Surveys; Population Registers.*

BIBLIOGRAPHY

Behar, M., Nevin S. Scrimshaw, Miguel A. Guzman, and John E. Gordon. 1968. "Nutrition and Infection Field Study in Guatemalan Villages, 1959–1964. VIII: An Epidemiological Appraisal of Its Wisdom and Errors." *Archives of Environmental Health* 17: 814–827.

D'Souza, S. 1984. "Population Laboratories for Studying Disease Processes and Mortality: The

Demographic Surveillance System, Matlab." In *Methodologies for the Collection and Analysis of Mortality Data,* ed. Jacques Vallin, John H. Pollard, and Larry Heligman. Proceedings of a Seminar at Dakar, Senegal, July 17–10. Liège, Belgium: Ordina Editions.

Ferebee, S. H., and F. W. Mount. 1962. "Tuberculosis Morbidity in a Controlled Trial of the Prophylactic Use of Isoniazid among Household Contacts." *American Review of Respiratory Diseases* 85: 495–521.

Goldberger, Joseph, G. A. Wheeler, and E. Sydenstricker. 1920. "A Study of the Relation of Diet to Pellagra Incidence in Seven Textile Mill Communities of South Carolina in 1916." *Public Health Reports* 35: 648–713.

Greenwood, B. M., et al. 1990. "Evaluation of a Primary Health Care Programme in the Gambia and Its Impact on Mortality and Morbidity in Young Children." *Journal of Tropical Medicine and Hygiene* 93: 87–97.

INDEPTH Network. 2002. *Population, Health, and Survival at INDEPTH Sites.* Ottawa, Canada: International Development Research Centre.

Kasprzyk, Daniel, et al. 1989. *Panel Surveys.* New York: Wiley.

Linder, F. E. 1971. "The Concept and the Program of the Laboratories for Population Statistics." Laboratories for Population Statistics Scientific Series No. 1, March.

MacLeod, B. B., J. Phillips, and F. Binka. 1996. "Sustainable Software Technology Transfer: The Household Registration System." In *Encyclopedia of Library and Information Science,* Vol. 58, Supplement 21, ed. K. Allen. New York: Marcel Dekker.

Menken, J., and J. F. Phillips. 1990. "Population Change in a Rural Area of Bangladesh: 1967–1987." *Annals of the American Academy of Political and Social Science* 510: 87–101.

Mozumder, K. A., et al. 1990. "The Sample Registration System: An Innovative System for Monitoring Demographic Dynamics." *Asia-Pacific Journal* 5: 63–72.

Scrimshaw, N. S., et al. 1968. "Nutrition and Infection Field Study in Guatemalan Villages, 1959–1964. V: Disease Incidence among Preschool Children under Natural Village Conditions with Improved Diet and with Medical and Public Health Services." *Archives of Environmental Health* 16: 233–234.

James F. Phillips

DEMOGRAPHIC SURVEYS, HISTORY AND METHODOLOGY OF

Demographic surveys are surveys that wholly or primarily collect information on population characteristics and on the causes and consequences of population change. In addition, demographic surveys can be a name given to surveys that contain mostly demographic information although they also contain information of a non-demographic nature.

Historical Overview of Population Surveys

Population censuses attempt to measure characteristics of the total population of a country or territory through the *full* enumeration of all persons and relevant events. Surveys have emerged as alternatives to census taking with the development of statistical sampling techniques that permit interviewing only a part of the population of interest to obtain estimates that are valid for the population as a whole.

Population surveys have a long history, including the 1086 Domesday survey in England. This survey, as well as most other early surveys, was a social survey dealing with living conditions and poverty. Many of these studies were carried out in the eighteenth and nineteenth centuries, but none was based on true probability sampling methods. The first study that employed probabilistic sampling was a 1913 study by A. L. Bowley on the living conditions of the working classes in five English cities. Survey research in the demographic field only came into wide usage in the mid-1900s.

Demographic surveys are often taken in conjunction with a census. This was done for the first time in 1940, in the United States. The items covered in the census were significantly increased for 5 percent of the census population, making it possible to collect extensive additional information without increasing the burden on all census respondents and at relatively small additional cost.

One of the first demographic surveys was conducted by Raymond Pearl in 1939, covering 31,000 women in American hospitals. Other early U.S. demographic surveys include the Current Population Survey (CPS) carried out monthly by the Bureau of the Census since 1940; the 1941 Indianapolis study by Pascal Whelpton and Clyde Kiser; the 1960 Growth of American Families Study by Whelpton, Arthur Campbell, and John Patterson; and the 1965 and 1970 National Fertility Surveys carried out by Charles F. Westoff and Norman B. Ryder of Princeton University. The National Center for Health Statistics (NCHS) carried out six rounds of the National Survey of Family Growth (NSFG) between 1973 and 2002.

The CPS is focused on employment and unemployment and economic activity but additional questions are added from time to time to obtain information on other population characteristics. One of its advantages is its large sample size: 50,000 households. The data from the CPS serve to update information on the U.S. population between the decennial censuses. Annual demographic data files are available from this source. The other early surveys mentioned above were designed to provide information specifically related to fertility, family planning, and family formation. They sampled women in the fertile age group, with sample sizes below 10,000.

The NCHS undertakes a number of health related survey activities that provide significant demographic information, such as the National Health and Nutrition Examination Survey, which has been carried out eight times since 1960. The round that began in 1999 has been converted into a continuous survey in which 5000 people are surveyed annually in 15 locations in the United States.

Most developed countries have survey activities similar to those in the United States. Periodic labor force surveys are a major source for demographic information. Special demographic surveys have been more rare. The 1946 survey on fertility in Britain by David Glass and Eugene Grebenik was a forerunner for fertility surveys that were carried out in the 1960s in Belgium, Canada, Greece, Hungary, The Netherlands, the United Kingdom, and the Soviet Union. In the 1970s similar surveys were conducted in 15 European countries as an offshoot of the World Fertility Survey (WFS) program, which operated from 1973 to 1984 but was mainly focused on developing countries. A further round of fertility surveys, the Fertility and Family Surveys in Countries of the Economic Commission for Europe Region, was carried out in the 1990s in about twenty countries under the sponsorship of the United Nations Population Fund (UNFPA).

In developing countries, the main sources of demographic information, aside from population censuses, are labor force and economic surveys, and surveys on population and health. Among the latter, the Puerto Rico studies on family planning by Paul K. Hatt in 1947 and Reuben J. Hill, Mayone Stycos, and Kurt W. Back in 1959 were some of the earliest. In India, the 1952 Mysore study was groundbreaking. In the 1960s more than 125 fertility and related surveys were carried out in the developing world, a majority in Africa. Special demographic surveys have most often been achieved through participation in international survey programs like the WFS. The ongoing Demographic and Health Surveys (DHS) program funded by the United States Agency for International Development (USAID) has sponsored over 150 surveys in the period from 1984 to 2001. Among other international programs that have contributed significantly to the availability of demographic survey data in developing countries are the World Bank–sponsored Living Standards Measurement Surveys (LSMS) program, which has carried out over 30 complex surveys since 1985; the UNICEF sponsored Multiple Indicator Cluster Survey (MICS) program, with over 120 surveys since 1995; the Centers for Disease Control and Prevention (CDC) USAID-sponsored surveys, in operation since 1985, with over 40 surveys; the Contraceptive Prevalence Surveys (CPS), also sponsored by USAID, which carried out 39 surveys over 1976–1984; and numerous smaller survey efforts.

Longitudinal Surveys

There is a basic distinction between surveys that are planned to provide a snapshot of the population under study at the time of the survey and those planned to provide repeated information on the same sample populations. The former are usually called single-round surveys, the latter are called panel or longitudinal surveys. A longitudinal survey can measure changes in the population with greater precision than could be achieved by drawing on retrospective information collected in single-round surveys (given the likelihood of recall error by respondents) or by comparing the results from two surveys that are based on independent samples. The effect of programmatic interventions in the period between surveys can also be measured more easily.

These advantages of the longitudinal design are balanced by a number of important disadvantages. Longitudinal surveys are generally more costly; the sample population is affected by death and migration; and the respondents may suffer respondent's fatigue if interviewed on too regular a basis. In developing countries an added problem is locating the exact households to be revisited, given the absence of good addresses and the inaccessibility of some sample areas. A particular example of longitudinal surveys are demographic surveillance systems (DSS) These systems reinterview the residents of a small and specific geographic area on a regular schedule. Interviews can happen as often as once every two weeks, as in the Matlab area of Bangladesh. The DSS design is ideal for studying change in a population. The major drawback is that the survey area is typically not representative of the population in the country.

Some of the problems of longitudinal surveys can be overcome in a hybrid design that combines a single round and a longitudinal survey. In this design the sample clusters are the same in each successive survey, but the individual respondents need not be the same. The characteristics of people in a specific sample cluster are more homogeneous than the characteristics of people in different clusters, thus making the samples more similar than if the samples had been totally independent. This provides greater precision in the estimates of change.

Sampling Strategies

Sampling is a difficult task even when the necessary baseline data about the population to be sampled are readily available. In the United States, most research institutions obtain their basic data from the U.S. Bureau of the Census and other government agencies that collect basic statistical information or from commercial firms that sell samples and sampling frames. Most developing countries lack updated census and other information that can serve as secure sampling frames. More often than not, special field operations are necessary to develop an appropriate sample frame by creating up-to-date listings of households or dwellings.

Probability sampling consists of randomly selecting the desired number of subjects from a complete list of all similar subjects in the sample universe. It depends on mechanical random selection and ensures that every element in the population of interest has a known, positive probability of selection. The way samples are actually drawn will depend on what the samples are expected to represent. For instance, if a sample is expected to provide information for a country as a whole and also for each of four of its provinces, each of those provinces needs to be allocated a large enough sample to permit calculation of the required indicators with the desired level of precision.

One factor that helps determine the type of sample to be drawn is whether the sampled individuals will be interviewed through a personal or a phone interview. For personal interview samples, it is typically too costly to interview people who are chosen individually from a list of all individuals in the sample universe. Kish calls this element sampling. For this and other reasons, most personal interview samples are drawn under cluster sampling. Cluster sampling selects groups of elements, with each group or cluster containing contiguous sampling elements (e.g., an urban block). Using cluster sampling implies that all the elements of the population are represented and identifiable in one of the clusters. The size of the clusters and the number of elements to be selected in each selected cluster will be determined by the objectives of the study and the field costs of the survey. The major advantage of cluster sampling is cost savings in the fieldwork; the major drawback is that the homogeneity of elements within each cluster means that the variance *between* elements is greater.

Developments in Data Processing

Some of the main bottlenecks in getting survey data published shortly after data collection have traditionally been the hardware, software, and manpower available for processing the information collected. In the 1960s and early 1970s most surveys were still processed by coding the information on special coding sheets and entering that information on punch cards that were then used in computer analysis of the data. Survey researchers typically had to operate through intermediaries at computer centers to have the data tabulated. With the advent of microcomputers in the late 1970s and the creation of appropriate software, it became possible to do most data processing in-house. Until the mid-1980s, the speed of the available processors and software limitations still made the processing of large surveys a difficult enterprise.

Large data collection efforts such as censuses were most often processed using optical readers. This avoided the onerous task of entering the data by hand and speeded up their availability for analysis. Due to special requirements of page layout and the necessarily limited length of the questionnaires, few comprehensive surveys were processed through the optical reader process.

One of the major problems in survey data processing is how to create a file that is free of structural or consistency errors in the variables. Such a file is created through detailed editing of the data and, where possible, imputation of missing data. This editing eliminates the errors introduced during the interview, in the coding process, and in data entry. The availability of microcomputers for data entry made it possible to build structural, range, and some consistency checks into the data entry program and resulted in fewer errors in initial data files. Further consistency checking can eliminate these types of errors altogether. The development of appropriate software for these stages of processing has been a major factor in the earlier availability of survey data. The Demographic and Health Surveys program developed its Integrated System for Survey Analysis (ISSA), which can handle all data entry, editing, and tabulation. The Netherlands' Institute of Statistics developed a similar program called BLAISE, while the CDC developed the widely used program called EPI-info. Statistical analysis packages such as SPSS and SAS also contributed much to the speedier publication of survey data.

The continued development of personal computers and the availability of laptops and handheld computers are further facilitating survey processing. Frequently, data are entered on a handheld computer or laptop during the interview, thus obviating the need for further data entry. In addition, checks incorporated during the interview can ensure that the resulting files are largely free of error, which minimizes the need for extensive cleaning of the data. There are already instances where survey data are instantly transmitted from the interviewer's computer to a central computer for tabulations.

The proliferation of software and equipment has also had its drawbacks, especially in developing countries. Too many different systems are in use, making it more difficult to build the capacity of organizations to process their own surveys.

Telephone Surveys

Telephone surveys are the most common and cheapest way to collect information for marketing and other purposes. For obtaining demographic survey data, they can only be used where all the sample population is reachable by phone. This excludes developing countries. In the United States, the proportion of households with a phone rose above 90 percent in the 1970s, making it possible to sample nearly as well in a telephone survey as through personal interviews. This has generated a fast-growing telephone interviewing industry.

A major advantage of telephone surveys is that the sample design has no impact on the speed of data collection. Distance between sample subjects is not a problem. Another major advantage is quality control, particularly where the telephone interviews are conducted by means of a Computer Assisted Telephone Interviewing (CATI) system. This system can control the sample selection, the flow of the interview, and the quality of data entry. A further advantage is that the use of a CATI system ensures instant availability of the data. Telephone surveys are generally considered to be unsuitable for interviews of longer than 20 minutes, particularly if the subject matter of the interview requires a high degree of cooperation. Due to their cost-effectiveness, telephone surveys are also used in combination with other methods of data collection. Short screening interviews are often done by phone to determine which respondents should receive a more comprehensive personal interview. Sampling for telephone interviews poses its own challenges, however, due to the existence of unlisted phone numbers. A technique called "list assisted random digit dial" is used to decide how many telephone numbers to select from telephone lists with different occurrences of unlisted numbers.

See also: *Census; Demographic and Health Surveys; Longitudinal Demographic Surveys; World Fertility Survey.*

BIBLIOGRAPHY

Adlakah, Arjun, Jeremiah M. Sullivan, and James R. Abernathy. 1980. "Recent Trends in the Methodology of Demographic Surveys in Developing Countries." *Scientific Report Series,* No. 33.

Baum, Samuel, Kathleen Dopkowski, William G. Duncan, and Peter Gardiner. 1974. "The World Fertility Survey Inventory." *World Fertility Survey Occasional Papers,* nos. 3–6.

Cleland, John, and Christopher Scott. 1987. *The World Fertility Survey: An Assessment.* Oxford: Oxford University Press.

Dekker, Arie. 1997. "Data Processing for Demographic Censuses and Surveys with Special Emphasis on Methods Applicable to Developing Country Environments." *Netherlands Interdisciplinary Demographic Institute (NIDI) Report No. 51.* The Hague, Netherlands: NIDI.

Hatt, Paul K. 1952. *Backgrounds of Human Fertility in Puerto Rico: A Sociological Survey.* Princeton, NJ: Princeton University Press.

Hill, Reuben, J. Mayone Stycos, and Kurt W. Back. 1959. *The Family and Population Control: A Puerto Rican Experiment in Social Change.* Chapel Hill: University of North Carolina Press.

International Development Research Center. 2002. *Population and Health in Developing Countries, Vol. 1, Population, Health and Survival at INDEPTH Sites.* Ottawa, Canada: International Development Research Center.

Kalton, Graham. 1983. *Introduction to Survey Sampling.* Beverly Hills, CA: Sage.

Lavrakas, Paul J. 1993. *Telephone Survey Methods, Sampling, Selection and Supervision.* Applied Social Research Methods Series, Vol. 7. London: Sage.

Lloyd, Cynthia B., and Catherine M. Marquette. 1992. *Directory of Surveys in Developing Countries: Data on Families and Households, 1975–92.* New York: Population Council.

Macro International Inc. 1996. *Sampling Manual.* DHS-III Basic Documentation Number 6. Calverton, MD: Macro International.

Moser, Claus A., and Graham Kalton. 1972. *Survey Methods in Social Investigation.* 2nd edition. London: Heinemann, 1971. New York: Basic Books.

Pearl, Raymond. 1939. *The Natural History of Population.* London. Oxford University Press.

Population Council. 1970. *A Manual for Surveys of Fertility and Family Planning; Knowledge, Attitudes, and Practice.* Population Council: New York.

Ryder, Norman B., and Charles F. Westoff. 1971. *Reproduction in the United States, 1965.* Princeton, NJ: Princeton University Press.

Shyrock, Henry S. Jr., Jacob S. Siegel, et al. 1971 (3rd rev. printing, 1975). *The Methods and Materials of Demography.* 2 vols. Prepared for the U.S. Bureau of the Census. Washington D.C.: U.S. Government Printing Office.

Tablin, Delphine. 1984. "Comparison of Single and Multi-round Surveys for Measuring Mortality in Developing Countries." In *Methodologies for the Collection and Analysis of Mortality Data,* eds. Jacques Vallin, John Pollard, Larry Heligman. Liège, Belgium: International Union for the Scientific Study of Population, Ordina Editions.

United Nations. 1961. *The Mysore Population Study.* (ST/SOA/Series A/34). New York, NY: United Nations.

United Nations. 1984. *Handbook of Household Surveys.* (ST/ESA/STA/SER.F/31). New York: United Nations.

Whelpton, Pascal K., and Clyde V. Kiser, eds. 1946 (rev. 1950, 1952, 1954, 1958). *Social and Psychological Factors Affecting Fertility,* 5 vols. New York: Milbank Memorial Fund.

Martin Vaessen

DEMOGRAPHIC TRANSITION

The term *demographic transition* refers to the decline in mortality and fertility from the high rates characteristic of premodern and low-income societies to the low rates characteristic of modern and high-income societies. Demographic transition is a central concept in demography, and there is a large literature examining the nature and the causes of the phenomenon. On the face of it, demographic transition is simply a description of a pattern of historical trends in vital rates. The influential discussions of demographic transition, however, interweave description with explanation of mortality and fertility declines, and this has made it difficult to separate the descriptive concept from the far more controversial "theory" of demographic transition.

History of the Concept

Although the term demographic transition originated with Frank W. Notestein in the mid-twentieth century, the first systematic effort to describe distinctive demographic regimes that represented historical stages linked to broader societal changes is credited to the work of the French demographer Adolphe Landry dating back to the first decade of the twentieth century. In Landry's formulation, elaborated in greater detail in a book published in 1934, demographic regimes are a function of the material aspirations of individuals and the productive potential of the economic system. In the "primitive" regime characteristic of subsistence economies, mortality but not fertility is constrained by economic factors, and population size tends to the maximum that economic resources can support. In the "intermediate" regime, in an effort to preserve family wealth, fertility is depressed by late marriage and celibacy, and population size falls below the maximum that the economy can support. The "modern" regime emerges when economic productivity reaches high levels and individuals have well-formulated aspirations for a high standard of living. To facilitate the achievement of those material aspirations, fertility becomes an object of conscious limitation, chiefly through various techniques of birth control but also through late marriage and celibacy. Population size is far smaller than the economy could support were individuals willing to accept lower standards of living—indeed negative population growth rates are a distinct possibility.

An alternative three-stage formulation of demographic transition was offered by the American demographer Warren Thompson in 1929. Thompson classified the countries of the world into three groups: (1) countries with high birth rates and high but declining death rates, facing the prospect of rapid population growth; (2) countries with declining birth and death rates in certain socioeconomic strata, with the rate of decline in death rates outstripping the rate of decline in birthrates; and (3) countries with rapidly declining birth and death rates, with fertility declining more rapidly than mortality, resulting in a declining population growth rate. Thompson assumed that these three groups were representative of historical stages. But by limiting his purview to contemporary demographic regimes, Thompson offered a truncated evolutionary scheme—he described neither a full-fledged pretransition regime nor a posttransition regime. In addition, Thompson had less to say about the causes of demographic change than his predecessor Landry and his successors Notestein and Kingsley Davis.

Notestein's formulation has probably been the most influential, appearing just at the onset of a five-decade period of widespread concern about the development-retarding effects of rapid population growth in Africa, Asia, and Latin America. Notestein held that the lessons he had distilled from the European historical experience were applicable to other regions and could inform public policies. Like Thompson, Notestein focused on the societal variation he observed at the time and therefore devoted limited attention to pretransitional regimes. He was aware that mortality decline was well underway in Africa, Asia, and Latin America yet fertility was essentially unchanged; these societies with high-population-growth potential constituted his first type of demographic regime. A second were those countries where fertility decline was well established but incomplete (Japan, the Soviet Union, and the southern cone of South America), and the third type were the low mortality and fertility populations of Europe, North America, and Australia. What gave Notestein's piece special power was his succinct yet compelling explanation for the declines in mortality and fertility (discussed below). One crucial element in Notestein's argument was that mortality is likely to respond more quickly than fertility to the forces of change, and therefore it is all but inevitable that societies experience a transitional period during which birth rates exceed death rates by a substantial margin, generating rapid population growth.

The Demography of Demographic Transition

Since the 1950s the standard formulation of demographic transition comprises three stages: pretransition regimes, characterized by high (and fluctuating) mortality and high fertility; transitional regimes, characterized by declining mortality and declining fertility, with mortality decline typically running ahead of fertility decline, resulting in population growth; and posttransitional regimes, with low mortality and low (and possibly fluctuating) fertility. The pretransition and posttransition regimes are assumed to be essentially in long-term equilibrium, with transitional regimes acting as a bridge between the two. In pretransition regimes, life expectancy at birth is less than 40 years and women bear on average between five and eight births over their reproductive lifespan, whereas in posttransition regimes, life expectancy at birth exceeds 65 years and women bear on average 2.5 or fewer births.

As empirical studies have accumulated, it has become apparent that pretransition and posttransition regimes are far from uniform in their vital rates. In general, pretransition mortality was lower in Europe than in Africa and Asia—life expectancy closer to 40 years in the former and 30 years in the latter. Even within Europe there was great variability in mortality rates, with the percentage of children dying in infancy ranging from over 30 percent in parts of Bavaria to 10 percent in southern England at the onset of demographic transition. Mortality was also characterized by substantial variation over time, reflecting nutritional adversity and epidemics of infectious disease. Nonmarriage and late marriage significantly reduced fertility rates in pretransition Europe, whereas marriage of women was close to universal in most African and Asian societies and generally occurred soon after menarche (the first menstrual period). As a result, in African and Asian societies fertility levels were higher, even though postpartum sexual abstinence and extended breastfeeding had a moderating effect on fertility rates. There is evidence, still subject to some dispute, that deliberate and conscious regulation of childbearing—the spacing of births—and perhaps of family size as well was common in pretransition African and Asian societies. Fertility within marriage appears to have been subject to far less control in pretransition Europe, although withdrawal was a widely known method of contraception that later was extensively practiced to control fertility in many parts of Europe.

Posttransition populations also show considerable variability in their demographic rates. Continuing declines in mortality at older ages have led to life expectancies at birth approaching 80 years in some European, North American, and East Asian countries, whereas life expectancy has slid below 70 years in eastern Europe because of deteriorating health conditions. The AIDS pandemic, affecting transitional societies especially in eastern and southern Africa, is further demonstration that improvements in health are not necessarily permanent, indeed that reductions in life expectancy on the order of 15 to 20 years can occur over a period as short as two decades. Such nonuniform trends in mortality in transitional and posttransition populations were not foreseen in the original formulations of the demographic transition. Furthermore, fertility in posttransition countries has in general failed to settle on the replacement level of an average of just over two births per woman over the reproductive lifespan. For decades, births per woman remained substantially above that level, ranging between 2.5 and 3 in the southern cone of South America (Argentina, Chile, and Uruguay) in what seemed a relatively stable posttransition regime. In contrast, in the decades since 1970, fertility has fallen below replacement in most European countries, and even below 1.5 births per woman in some countries of southern and eastern Europe.

The combinations of death rates and birth rates observed in pretransition and posttransition populations allow for modest demographic growth and decline, although over long stretches of time growth rates in pretransition societies were close to zero (typically less than 0.5 percent per year). The rate of population growth in pretransition and posttransition societies is dwarfed by the rate of growth in transitional societies—a result of the time lag between the mortality and fertility declines during the process of transition and, additionally but not universally, a temporary fertility increase early in the transitional stage. Such temporary fertility increases are in all likelihood a physiological response to improved maternal and child health and changes in postpartum practices. The "transition multiplier"—the ratio of the posttransition population size to the pretransition population size—is determined by the extent to which birth rates exceed death rates and the length of time during which that condition prevails. Transition multipliers are high when fertility decline begins from a high initial level and occurs substantially later than mortality decline and proceeds slowly.

An important aspect of the dynamics of transition is that population growth does not immediately subside once fertility falls to replacement level. The high fertility and low childhood mortality of the transitional demographic regime further accentuates the young age-structure that characterizes pretransition populations. This means that for several decades relatively large cohorts pass through the childbearing years. The additional population growth that occurs while the age-structure shifts to its posttransition shape is called population momentum. Population momentum is a substantial component of population growth over the course of demographic transition, typically contributing 30 to 40 percent of the total growth. Formal demographic analysis and simulation exercises demonstrate that population momentum is inversely related to the level of posttransition fertility and to the pace of fertility decline.

The demographic transitions in European populations differed substantially from the transitions in non-European populations in the magnitude of the rate of transitional population growth. In Europe, where the decline in fertility followed close on the heels of the decline in mortality, both starting from relatively low pretransition levels, the rate of natural increase (birth rates minus death rates) during the transitional period from 1800 to 1950 ranged between 0.5 and 1 percent per year, and the transition multiplier was roughly four (a ratio moderated somewhat by overseas emigration). In most non-European populations, mortality declines began during the first decades of the twentieth century and became steep in the decades after World War II, whereas fertility declines (from relatively high initial levels) began in earnest only after 1960 or later. As a result, many non-European countries experienced population growth rates of 2 to 3.5 percent per year for four decades or longer, and the transition multipliers (calculated using projected population numbers) range from 8 to 20. The highest multipliers are found in those countries with slow fertility declines, for example the Philippines, where the pretransition population size was about 8 million, the 2002 population was 79 million, and the posttransition population size is projected to be as high as 150 million, according to the United Nations, and Guatemala (pretransition population of 1.4 million, 2002 population of 12 million, and posttransition population projected as high as 30 million). In no European country did demographic transition produce population growth on this proportionate scale. Population multipliers of this magnitude, often combined with a pretransition population size that was large in absolute terms, are bound to have many and varied repercussions for social, economic, political, and cultural systems—some positive but no doubt also some deleterious.

Explanations for Demographic Transition

The many efforts, from Landry to the present, seeking to identify the forces generating demographic transition fall into two major sets. One regards fertility decline as an inevitable response to the population growth induced by mortality decline, which is therefore all that requires explanation. The second views fertility decline as a response to a richer and more diverse set of social, economic, political, and cultural forces.

While mortality decline has presented less of an explanatory challenge than fertility decline, there has been ample debate about its causes. Economic transformations that improved standards of living—food, clothing, sanitation, housing—appears to account for much of the decline of mortality in Europe. Samuel Preston argued in 1975, however, that economic change, as captured by growth in income per capita, accounts for only a small fraction of mortality decline in non-European populations in the twentieth century. Political stability and the emergence of effective nation-states complement the effects of economic change by leading to more reliable access to food and improved public sanitation. New medical technologies made a minor contribution to the decline of mortality in Europe in the eighteenth and nineteenth centuries but were a major factor in the sharp reduction in mortality from infectious diseases in the developing countries in the twentieth century. A final factor is improved personal hygiene (hand washing, preparation of food, and so forth), with new habits adopted in response to formal school instruction, public-health education campaigns, and word-of-mouth information.

Some scholars have argued that mortality decline is a sufficient cause of fertility decline and hence accounts for the demographic transitions of the past two centuries. Strictly speaking, the explanatory factor is not mortality decline but population growth. In 1963 Davis described household-level strain created by significantly larger younger generations vying for valued economic and social resources. Successively larger cohorts (in particular, the increase in the ratio of sons to fathers) disrupt the equilibrium of the traditional family. Other scholars have noted that mortality decline, normally accompanied by improved health of the population, should increase economic productivity and through that channel exercise a positive indirect effect on fertility. Finally, mortality decline encourages a change in personal psychologies away from fatalism toward a greater sense of self-control over one's destiny, and this facilitates the exercise of deliberate fertility regulation.

Fertility declines have occurred under widely varying social and economic circumstances but virtually never in the absence of mortality decline, and this can be taken as strong evidence that mortality decline is the primary cause of fertility decline. Theories of demographic *homeostasis* posit that human societies gravitate toward demographic regimes with growth rates near zero; multiple and diverse societal institutions act as governors on population growth and enforce the tendency to oscillate near zero growth. Marked departures meet with the appropriate demographic response—increases in fertility to make up for mortality crises, decreases in fertility in response to mortality decline, or migration that offsets increases or decreases in rates of natural increase (a key element in Davis's theory of "multiphasic response"). While appealing as a general theory of population dynamics, homeostatic theory is not very informative about the demographic transitions that occurred during the nineteenth and twentieth centuries. The end results of these transitions, as noted earlier, were multifold increases in population size. It is not clear how homeostatic theory accommodates this failure of fertility or migration to compensate for the impact of mortality declines. Moreover, the diversity of the pretransition equilibrium levels of fertility and mortality and of the lags between mortality and fertility declines, as reflected in the large variation in transition multipliers, is a major empirical fact that demands explanation. Surely the explanation lies in the conditioning influence of social, economic, and cultural forces.

In the second set of explanations for fertility decline, mortality decline is not the sole causal agent. Indeed, Notestein, in his seminal 1945 work, hardly mentioned mortality decline as a motivation for fertility decline. Instead he argued that both mortality and fertility decline in response to urbanization and changes in the economy (which changed the costs and benefits of children and led to rising standards of living and increased material aspirations) and to growth in individualism and secularism. Notestein's argument has been elaborated in a large subsequent literature on the causes of fertility decline that has featured economic forces, cultural changes, and changes in birth control costs.

Economic theories of fertility decline focus on the causal impact of changes in the costs and benefits of children and childrearing. The fundamental cause of fertility decline is the (perceived) decreasing affordability of large numbers of children. Demographers have resisted giving pride of place to microeconomic changes in models of fertility decline, perhaps because of disciplinary biases but more importantly because of weak empirical associations between macroeconomic changes and fertility decline. The Princeton European Fertility Project, for example, uncovered no systematic relationship at the provincial level between the onset of fertility decline and socioeconomic variables such as levels of urbanization and nonagricultural employment. But other empirical research that has had access to a larger number of economic variables that provide a more complete portrait of the economic system, as well as studies conducted at lower levels of aggregation (the local community or the household), attribute much greater causal impact to economic change. This includes studies on fertility declines in England, Italy, Bavaria, and Prussia. Moreover, it seems likely that cognitive dimensions—in particular, economic aspirations and expectations—mediate the relationship between economic change and fertility. The causal force may not be economic circumstances per se but rather the relationship between economic aspirations and expectations (that is, what individuals want as opposed to what they expect). This can explain why fertility declines have occurred in the presence of both improving and deteriorating economic conditions.

Mortality decline and economic change are the core elements of a model for fertility decline. High fertility is compatible neither with low mortality nor with high-income, modern economies. Both mortality regimes and economic systems have been transformed during the past two centuries, to an extent and at a rate that are extraordinary by any measure. If one wishes to go back further in the causal chain and ask why this has occurred, inevitably one is led to the scientific and technological revolutions of the past four centuries. Ultimately it is these revolutions that lengthened life expectancy and made bearing large numbers of children inconsistent with modernity.

Another stream in the literature on the causes of fertility decline emphasizes the determining role of attitudes about and values related to family life. Ron Lesthaeghe has proposed that the decline of fertility in Europe was caused by the synergistic effects of economic changes and changes in the moral and ethical domain. Lesthaeghe stresses the emergence of secularism, materialism, individualism, and self-fulfillment as dominant values that in combination undermine the satisfactions derived from having children. John C. Caldwell argued in 1982 that a shift in the morality governing family life—in particular, a higher valuation of the conjugal relationship and of investments in children—leads to a dismantling of high-fertility reproductive regimes. Fertility decline is triggered by emotional nucleation of the family, itself a response to broader economic and cultural changes. For both scholars, the critical cultural change has less to do with the value of children narrowly defined and more to do with the nature of intergenerational relations and the perceived contribution of childbearing to the achievement of a desired standard and style of living. But whether changing mentalities and moralities about family life are themselves a sufficient cause of sustained and substantial fertility decline is doubtful, absent the precondition of mortality decline. Certain cultural changes, of course, might provoke both mortality and fertility declines, for example an increase in the value placed on investments in children, per child.

A final cluster of determinants of the timing and pace of fertility decline can be gathered under the heading "costs of birth control." The argument is that various economic, social, psychic, and health factors can make birth control practices prohibitively costly, and hence the reduction or elimination of such costs is a prerequisite for fertility decline. Ansley Coale and Richard Easterlin both highlighted the potentially important causal role of the costs of birth control, and the empirical record now contains numerous studies that demonstrate that reduction in birth control costs can accelerate fertility decline. In the period since 1960, the most prominent strategy for reducing birth control costs has been the provision of contraceptives free of charge or at nominal price through public and private family planning programs. But limited access to contraception is by no means the only obstacle to use, and some scholars have argued that personal knowledge and social legitimacy of contraception are perhaps more critical than the mere provision of contraceptive technology.

Conclusion

The debate that began in the 1950s and is still continuing about the aims of population policy and the nature and scope of interventions can be viewed as a debate about how to weight the various determinants of demographic transition. If one follows Notestein's reading of the European historical experience, then the decisive factors are social and economic change, and the availability of contraceptive technology is of little importance. Davis as well leaves one less than sanguine about the likely contribution of programs that make family planning and reproductive health services more accessible and less expensive. Coale and Easterlin provide a stronger rationale for investment in such programs. Rapid population growth—a function of the gap between mortality and fertility declines—has been a primary public policy concern. But the demography of pretransition and posttransition populations differ in many other respects—posttransition, the age-structure of the population is older, individuals' lives are far lengthier, and childrearing occupies a much smaller portion of those lives. These outcomes of demographic transition increasingly are the focus of public policy debates about population dynamics.

See also: *Davis, Kingsley; Development, Population and; Epidemiological Transition; Fertility Transition, Socioeconomic Determinants of; Health Transition; Homeostasis; Landry, Adolphe; Notestein, Frank W.; Mortality Decline; Second Demographic Transition; Thompson, Warren S.*

BIBLIOGRAPHY

Caldwell, John C. 1982. *Theory of Fertility Decline.* London: Academic Press.

Chesnais, Jean-Claude. 1992. *The Demographic Transition.* Oxford: Oxford University Press.

Cleland, John. 2001. "The Effects of Improved Survival on Fertility: A Reassessment." In *Global Fertility Transition,* Supplement to Volume 27 of *Population and Development Review,* ed. Rodolfo A. Bulatao and John B. Casterline. New York: Population Council.

Coale, Ansley. 1973. "The Demographic Transition Reconsidered." In *International Population Conference,* Vol. 1. Liège, Belgium: International Union for the Scientific Study of Population.

Coale, Ansley J., and Susan Cotts Watkins, eds. 1986. *The Decline of Fertility in Europe.* Princeton, NJ: Princeton University Press.

Davis, Kingsley. 1963. "The Theory of Change and Response in Modern Demographic History." *Population Index* 29: 345–366.

Easterlin, Richard. 1975. "An Economic Framework for Fertility Analysis." *Studies in Family Planning* 6: 54–63.

Goldstein, Joshua. 2002. "Population Momentum for Gradual Demographic Transition." *Demography* 39: 65–74.

Hirschman, Charles. 1994. "Why Fertility Changes." *Annual Review of Sociology* 20: 203–233.

Landry, Adolphe. 1934. *La revolution démographique.* Paris: Sirey.

Lloyd, Cynthia, and Serguey Ivanov. 1988. "The Effects of Improved Child Survival on Family Planning Practices and Fertility." *Studies in Family Planning* 19: 141–161.

Mason, Karen Oppenheim. 1997. "Explaining Fertility Transitions." *Demography* 34: 443–454.

Montgomery, Mark, and Barney Cohen, eds. 1998. *From Death to Birth: Mortality Decline and Reproductive Change.* Washington, D.C.: National Academy Press.

Notestein, Frank W. 1945. "Population: The Long View." In *Food for the World,* ed. Theodore W. Schultz. Chicago: University of Chicago Press.

Preston, Samuel. 1975. "The Changing Relation between Mortality and Level of Economic Development." *Population Studies* 29: 231–248.

Wilson, Chris, and Pauline Airey. 1999. "How Can a Homeostatic Perspective Enhance Demographic Transition Theory?" *Population Studies* 53: 117–128.

John B. Casterline

DEMOGRAPHICS

See *Business Demography; State and Local Government Demography*

DEMOGRAPHY, HISTORY OF

Demography is the study of a human population, a definable group of people, and of additions to and subtractions from its number. A population is increased by births and immigration and decreased by deaths and emigration. In a "closed population," there is no migration and attention is paid only to reproduction and mortality. Demographers prefer to study populations that are sufficiently large to be unaffected by the idiosyncratic behavior of individuals. Nevertheless, most would argue that their findings are the best description of the behavior of the typical individual. Demographers, especially when studying recent times, are almost always interested in change; consequently, the time dimension is stronger in their work than it is in most social sciences.

Demography is not easy to practice. Its practitioners need to know the numbers and vital rates of large human aggregations and require some comprehension of mathematics and scientific concepts to do their analyses. Adequate measurements of large populations require wealth and a centralized administration and have developed slowly. Historically, such measurements were not carried out for demographic purposes but to assess military strength or the tax base. Frequently, the data were not centralized, making analysis difficult. The registration of births and deaths usually was done for legal purposes such as establishing inheritance rights and was not equally relevant to all parts of society.

The Materials of Demography

Censuses, although usually not including all individuals, were carried out in the ancient world in powerful states such as Egypt, Babylon, Persia, India, and China as well as in some Greek city-states. Republican Rome took a census every five years. More recently, the Domesday Book in eleventh-century England listed landowners, listed undertenants by a single name, and did not list other family members and non-tenants. By the fourteenth and fifteenth centuries there were tax registers in England, France, and the Netherlands and various kinds of counts in German and Italian cities as well as in Spain and Portugal.

The rise of the powerful nation-state made full censuses inevitable. William Petty (1623–1687) campaigned for them in Restoration England. Quebec held a complete census of its very small population in 1665, and at the end of the seventeenth century England, France, and Iceland took censuses that were neither aggregated nor published, while Prussia followed in 1748 and Sweden in 1749. Population registers spread in Scandinavia, starting with Sweden in 1686.

Censuses proliferated in the late eighteenth century: Switzerland in 1798, the United States (mandated by its constitution) in 1800, England and France in 1801, Ireland in 1813, and over 20 more countries by the 1860s. These were not modern censuses initially. Detailed age data and separate lines for each individual were not instituted until the middle of the nineteenth century, and training courses for enumerators came later. Norway undertook the first census sampling in 1900. Censuses in most of the developing world did not occur until the second half of the twentieth century (India, where census taking began in the 1870s, is the most important exception), and not all populations have yet been subjected to a census.

Vital registration still does not characterize much of Asia and nearly all of Africa. Christendom had an advantage in this regard because of the sacramental nature of baptisms, marriages, and funerals and an increasing tendency to record those events. Toledo in Spain made parish registration compulsory in 1497, and the Council of Trent in 1563 did the same for baptisms and marriages in the whole Catholic world. In England in 1538 Thomas Cromwell ordered the church to register all baptisms, marriages, and burials; in the following year France did the same thing for baptisms and burials. In 1635 Buddhist temple registration began in Japan.

With the decline of national churches as Protestant sects and freethinking emerged, it was inevitable in the West that church registration would be succeeded by secular state registration and that births and deaths would replace baptisms and funerals, respectively. This was already the case in the Scandinavian population registers, which were followed by civil registration in France in 1804 under the Napoleonic Code and in England and Wales in 1837. Nevertheless, death registration was not backed up by death certification, with its greater likelihood of correctly stating a cause, until 1855 in Scotland, 1865 in the Netherlands, and 1874 in England and Wales. In the United States vital registration, in contrast to the census, was a state, not a federal, responsibility. As a result, although vital registration began early in Massachusetts, the official registration area, where registration was largely complete, expanded only slowly from the late nineteenth century until its completion in 1933. The first birth statistics for the area were not published until 1915, and in spite of efforts by the American census, much less is known about nineteenth-century American demography than is known about that of Europe or Australia.

The situation in the developing world was partly rectified by the development in the last few decades of the twentieth century of national sample surveys (usually concentrated on women of reproductive age and including only 5,000 to 10,000 respondents). Successively, there were the so-called KAP surveys (on knowledge, attitudes, and practices with regard to fertility) in 1962–1973, the World Fertility Survey (WFS) from 1973 through 1984, and the Demographic and Health Surveys (DHS), begun in 1984 and still continuing. The WFS covered 61 countries; DHS surveys had been held in 69 countries by 2001, and repeated at least twice in 45 of them. All these surveys collected fertility data; the DHS and WFS collected mortality data as well, although these data usually were regarded as sufficient to provide reliable estimates only for infants and young children.

Other sources included specialized surveys, such as the Indianapolis Study of 1941; efforts by the census bureau or department to collect vital data, especially in the United States during the second half of the nineteenth century; and special demographic surveys, particularly in Francophone Africa in the 1950s. Later in the twentieth century huge demographic surveys were carried out in China (starting with the 1981 one-in-a-thousand sample survey) and India. The computer has allowed demographers to undertake their own analyses of surveys and census samples, thus lessening their dependence on statistical offices and profoundly changing the nature of the discipline.

The Analysts

The Italian Renaissance and the era of European voyages and religious missions to distant continents first stirred interest in estimating population size. The Counter-Reformation and the rise of the Jesuits also came into the picture. Estimates of urban, national, and global populations are associated with Giovanni Botero (1544–1617), Marino Marini (1614–1661), and Giovanni Riccioli (1598–1671). Botero in his 1588 publication *Cause della Grandezza. . .delle Città* analyzed the factors determining the growth and prosperity of cities and in his 1596 *Relazioni Universali* anticipated the economist T. R. Malthus's argument about the relationship between growth in population and pressure on resources.

Little demographic analysis occurred before about 1660. The exception was a continuing interest in mortality rates for the purpose of calculating annuities and tontines. There is a surviving rough life table from third-century Rome that was used for this purpose. Mortality was to continue to dominate demographic interest until the late nineteenth century, partly because it varied more than did fertility as epidemics or famines struck.

Modern demography had to wait for large-scale datasets, scientific interest in their analysis, and sufficient development in mathematics to allow that analysis. Francis Bacon (1561–1626), whom all the early English demographers credited with showing them the way, had, especially in *Novum Organum,* published in 1620, developed the inductive method and had stressed the need in science to collect facts and search for form in them to identify the underlying natural laws. The early English demographers knew and worked beside Isaac Newton (1643–1727), who was discovering the laws of physics. However, most sixteenth- and seventeenth-century demographers were, like Newton, also searching for a divine pattern and, like him, were Protestants. There are later parallels with the economist Adam Smith's "hidden hand" and Malthus's emphasis on divine underpinnings. The necessary mathematical knowledge was not intuitive, and it is no accident that demographic analysis often was advanced by astronomers such as Edmond Halley (1656–1743) and Pierre Simon La Place (1749–1827) and mathematicians such as Leonhard Euler (1707–1783).

The development of the discipline of demography is usually traced to seventheenth-century England, especially among the founders of the Royal Society. John Graunt (1620–1674), a London merchant often described as the father of demography, employed Bacon's approach and his own experience with merchant bookkeeping to analyze the London Bills of Mortality, or death records, which had been kept since 1532. His major work, published in 1662, established such canons of demography as checking and correcting the data and then searching for regularities. Graunt showed that in sufficiently large populations there was an excess of male births, higher mortality in infancy than at any other age except extreme old age, and a longer female than male lifespan and constructed a prototype of the life table that later would be made rigorous by Halley. Graunt's friend William Petty (1623–1687) applied quantitative methods to the social sciences; pioneered household enumeration, especially for studying the population of cities; and published in 1683 *Political Arithmetic,* whose title encapsulates the nature of demography. In 1696 Gregory King (1648–1712) drew upon the scattered returns of England's first census and other sources to prepare a manuscript (not published until 1801) calculating the population of England (and estimating continental and global numbers) and computing for 1695 birth, death, and marriage rates as well as age structure.

A notable eighteenth-century advance was Richard Price's (1723–1791) work on actuarial science, which laid the foundations for the British insurance industry. Price argued that knowledge in the natural sciences entails an understanding of probabilities, a view descending from the philosophers René Descartes (1596–1650), John Locke (1632–1704), and David Hume (1711–1776). But in the eighteenth century demography was no longer an exclusively English pursuit. There was a major Swiss contribution from Jean Louis Muret (1715–1796), a mathematician who first devised birth, death, and marriage rates. His contemporary Leonhard Euler (1707–1783), working mostly in Russia and Prussia, created the mathematical theory of both life tables and stable populations, the foundations of modern formal demography. In Sweden, Per Wargentin (1717–1783) employed the first Swedish census and the population registration system to publish in 1766 the first national life table. The commanding figure in eighteenth-century empirical demography was a German, Johann Peter Süssmilch (1707–1767), who published in 1741 and 1761–1762 *Die Göttliche Ordnung* (*The Divine Order with regard to the Human Species, as demonstrated by birth, death and reproduction*), an influential treatise (never translated into English). In search for proof of a divine order in the regularity of demographic events he amassed data from a huge number of sources and provided material for succeeding demographers, including T. R. Malthus (1766–1834). Malthus, in his *First Essay* (1798), with its postulate of population growth being restricted by the slow increase in resources, made a major contribution to population theory. In the succeeding editions of that work over the next three decades he assembled a mass of supporting empirical materials. Pierre Simon Laplace (1749–1827), a French astronomer and mathematician, continued the work on probability, which he applied to mortality, life expectancy, and the length of marriages.

In the eighteenth century empirical demography did not develop as rapidly as might have been anticipated, mainly because issues of cost and popular resistance delayed the advent of national censuses and vital registration systems. The situation changed rapidly in the nineteenth century. From 1855 the term *demography* came into use and from 1882 the International Conferences on Hygiene and Demography were held. A second cause for the development of the discipline was a downward movement in mortality rates in most Western countries and, toward the end of the century, the beginning of a fertility decline. The focus of the discipline shifted from analyzing stasis to analyzing change. Statisticians such as the Belgian Adolphe Quetelet (1796–1874) and the German Wilhelm Lexis (1837–1914) turned their attention to the movement over time in social measures, especially demographic ones. The analysis of geographic and social differentials in mortality, as well as its changes over time, provided guidance in the battle against disease.

The dominant figure in this effort was William Farr (1807–1883), who analyzed the causes and levels of deaths in England in the *Annual Report of the Registrar General* from 1839 to 1880, meeting a need arising partly from the problems of the new industrial cities. The analysis of fertility assumed importance once widespread fertility decline began in Western countries in the last third of the nineteenth century. Questions about live births to women appeared in the U.S. census starting in 1900 and in those in Britain and other countries in its empire starting in 1911. Methods for measuring fertility, which eventually yielded such commonly used measures as the gross and net reproduction rates, evolved in the strong demographic group in the Prussian/German Statistical Office in Berlin in the second half of the nineteenth century with the work of Richard Bockhe, leading in the twentieth century to further development by R. R. Kuczynski (1876–1947) in England and Alfred Lotka (1880–1949) in the United States. Interest in changing fertility levels emerged in various countries. In France the focus was on the low level of natural increase following the defeat in the Franco-Prussian War in 1870; in England, led by Francis Galton (1822–1911), the founder of the eugenics movement, it was on differential fertility by social class, with the supposed tendency of the less intelligent to outbreed the bright; and in the United States it was on the higher birthrate among immigrants than among the native-born. Such ideas, together with the older Malthusian concern with the pressure of population on food and other resources, would foster the development of demography in the twentieth century and often make the subject politically sensitive.

The twentieth century witnessed further development of demography's analytic techniques as the number of professionals working in the field greatly increased. Population growth models drew together mortality and fertility approaches. Stable population analysis that had originated in the work of Euler and was developed further by Laplace, Lotka, Ansley Coale (born 1917), and Álvaro López Toro (1926–1972); it was modified for quasi-stable populations by Coale, Paul Demeny (born 1932), and Samuel Preston (born 1943). Mathematical analysis by Nathan Keyfitz (born 1913) and others explored further demographic interrelations. Reacting to swings in the rate of population growth, population projection methodology developed component methods (based on separate age and sex components) stemming from work in 1895 by Edwin Cannan (1861–1935), logistic curve approaches from a 1920 paper by Raymond Pearl (1875–1940) and Lowell Reed (1886–1966), and cohort analysis from a 1936 paper by Pascal Whelpton (1893–1964). Post–World War II interest in the developing world led William Brass (1921–1999) to develop "indirect" methods for estimating vital rates and trends from limited census and survey data. This advance allowed fertility and mortality to be estimated not only for contemporary countries without vital registration but also for many historical populations.

Institutionalization

Until the twentieth century the only sense in which demography was a discipline was that there was a growing body of knowledge, both theoretical and empirical, and some teaching of that knowledge in university courses such as statistics and economics. Beginning in the 1920s that situation changed as the West become wealthier, university education expanded in volume and diversity, and interest in population phenomena was stimulated first by the eugenics movement and then by low birth rates in the West during the economic depression of the 1930s.

In the United States foundations played an initial role in the establishment of a population research center led by Warren Thompson (1887–1973) and Whelpton in Ohio in 1922 and the Office of Population Research (OPR) directed by Frank Notestein (1902–1983) at Princeton University in 1936.

The Milbank Memorial Fund in New York established its own Population Research Office in 1928 and funded population survey research in China in the following year. In 1936 the Population Investigation Committee was formed in Britain. Population courses had been given at the London School of Economics from the 1930s in the Social Biology Department and from 1936 in Princeton's OPR. A graduate department of demography was established at the Australian National University in 1952.

Demography has struggled to be accepted as a full and continuing university discipline, and its existence has depended to a considerable degree on professional associations, specialized journals, and conferences. The International Union for the Scientific Investigation of Population Problems was founded in 1928 and was reconstituted as the International Union for the Scientific Study of Population (IUSSP) in 1947. The emphasis on the term *scientific,* which is not common in other disciplines, was intended to suggest that members' research and teaching were not biased by attitudes toward birth control or eugenics. In 1931 the Population Association of America (PAA) was formed. Both the International Union and the PAA had periodic journals that provided limited outlets for publication, but in the 1930s and early 1940s more demographic articles appeared in the *Milbank Memorial Fund Quarterly.* Specialized journals appeared later: *Population* in France in 1946, *Population Studies* in Britain in 1947, and *Demography* in 1963 and *Population and Development Review* in 1975 in the United States. From its inception the International Union held periodic conferences with published proceedings.

The remarkable expansion of demography in the second half of the twentieth century was largely the product of concern about "population explosion" in the developing world during a period of unprecedented international technical assistance. The United Nations set up a Population Division in 1946, the Population Council was founded in 1952, and the Ford Foundation brought considerable funding to the field starting in 1959. Later, governments were to become even greater sources of support, with the U.S. Agency for International Development (USAID) moving toward massive financial inputs to population programs starting in the early 1960s. By the end of the 1960s the United Nations Fund for Population Activities (UNFPA, now the United Nations Population Fund) had been established. Population research centers with associated teaching programs were set up in many universities in the United States and other Western countries. They tended to focus on fertility, with a strong emphasis on developing countries. The United Nations helped establish demographic research and training centers in Asia, Latin America, and Africa. Scholarships provided by foundations, governments, and international agencies permitted many students in developing countries to take graduate degrees in the population field in Western universities. The funding also permitted the IUSSP and the United Nations to hold large international conferences.

Demography remained unsure about its disciplinary boundaries, especially in the sense of whether it was defined by its empirical studies and their analysis or could be equated with a larger area of intellectual inquiry—population studies—which includes the cause and impact of demographic change. If the latter was the case, it had a claim to be a social science and a need to draw on such fields as economics, sociology, and anthropology for methodology and explanations.

The Recent Past and the Future

By 1970 it was known that fertility decline had begun in much of the developing world except for sub-Saharan Africa. In the early 1980s the Ford Foundation ceased funding the population field, and the population centers it supported foresaw difficulties. Since that time government and international support has tended to move from demographic teaching and research to family planning programs in the developing world. Population centers had to adjust to the new conditions. Some of them developed a greater interest in public health issues in developed countries. Keyfitz wrote that further concentration on methodology would not be rewarding and that the existing methodology should be applied to the great global problems. A few demography programs disappeared, but most moved toward greater integration within universities. Research on developing countries declined. Demography had for over a century been focused on population change, and that change appeared to be coming to a halt as the demographic transition neared an end with low and nearly equal birth rates and death rates.

That halt has not occurred, with the result that demography in its organized institutional condition seems to have an assured future. The reason for this is that the demographic transition does not necessarily produce equal fertility and mortality levels but instead may lead to very low fertility and declining population numbers. By the beginning of the twenty-first century, 44 percent of the world's population lived in countries with fertility at or below the long-term replacement level and much of Europe exhibited fertility well below that level. The first demand on demographers was to investigate the resulting changes in the age structure, with the realization that the old-age pensionable population appeared to be moving in many developed countries from 10 percent in 1950 to 15 to 20 percent in 2000 and ultimately might reach levels beyond 30 percent. In the longer run, and probably first in Europe, the interest of demographers probably will focus on the nature of population decline and the efficacy of interventions to counter it.

See also: *Botero, Giovanni; Brass, William; Cannan, Edwin; Coale, Ansley Johnson; Demographic and Health Surveys; Euler, Leonhard; Farr, William; Galton, Francis; Graunt, John; Journals, Population; Keyfitz, Nathan; King, Gregory; Kuczynski, R. R.; Lotka, Alfred; Malthus, Thomas Robert; Notestein, Frank W.; Pearl, Raymond; Petty, William; Population Organizations; Population Thought: History of; Quetelet, Adolphe; Süssmilch, Johann; Thompson, Warren S.; Whelpton, P. K.; World Fertility Survey.*

BIBLIOGRAPHY

Bulatao, Rodolfo A., and Ronald D. Lee, eds. 1983. *Determinants of Fertility in Developing Countries: A Summary of Knowledge.* New York: Academic Press.

Caldwell, John, and Pat Caldwell. 1986. *Limiting Population Growth, and the Ford Foundation Contribution.* London: Frances Pinter.

Demography, 30 (4) (thirtieth anniversary issue), November 1993.

Hauser, Philip M., and Otis Dudley Duncan, eds. 1959. *The Study of Population: An Inventory and Appraisal.* Chicago: University of Chicago Press.

Hodgson, Dennis. 1983. "Demography as a Social Science and a Policy Science." *Population and Development Review* 9 (1): 1–34.

Kreager, Philip. 1991. "Early Modern Population Theory." *Population and Development Review* 17 (2): 207–227.

Lorimer, Frank. 1959. "The Development of Demography." In *The Study of Population: An Inventory and Appraisal,* ed. Philip M. Hauser and Otis Dudley Duncan. Chicago: University of Chicago Press.

McNicoll, Geoffrey. 1992. "The Agenda of Population Studies: A Commentary and Complaint." *Population and Development Review* 18 (1): 399–420.

Petersen, William, and Renee Petersen. 1985. *Dictionary of Demography: Biographies.* Westport, CT: Greenwood Press.

Population. 1995. Fiftieth anniversary volume.

Population Studies, 50 (3) (fifty-year retrospective), November 1996.

John C. Caldwell

DENSITY AND DISTRIBUTION OF POPULATION

Population distribution refers to the way in which the members of a population or of a specified subgroup of a population (for example, defined by age, sex, or ethnic status) are dispersed physically in a specific area. Population density provides a comparative measure of distribution with respect to a geographic area that usually is expressed as persons per square kilometer (or per square mile) of land. More specialized density measures also may be defined, such as population per unit of cultivatable land.

The Distribution of the World's Population

Population distribution on a global scale is highly uneven, with the greater part of the world's population living in the northern hemisphere and in countries in the less developed world. Less than 10 percent of the world's population lives in the southern hemisphere, and 80 percent lives between 20 degrees and 60 degrees north latitude. Table 1 shows the growth of the world population since 1950 and its changing distribution projected to 2050. By the year 2000 approximately 74 percent of the world's population lived in Africa and Asia (excluding the Russian Federation) on only 40 percent of the world's land area. Europe accounted for 12 percent of global population, with a further 8.6 percent in Latin America and the Caribbean, 5.2 percent in North America

TABLE 1

Size and Population Change by Major World Region, Estimates and Projections, 1950 and 2050

Region	Population (millions)			Population change (percent)	
	1950	2000	2050	1950–2000	2000–2050
United States and Canada	172	314	438	83	39
Latin America and the Caribbean	167	519	806	211	55
Europe (including Russia)	548	727	603	33	-17
Africa	221	794	2,000	259	152
Asia (excluding Russia)	1,399	3,672	5,428	162	48
Oceania	13	31	47	138	52
World	2,520	6,057	9,322	140	54

SOURCE: United Nations Population Division (2000). (2050 figures are those of the U.N.'s 2000 revision "medium" projection.)

(the United States and Canada), and 0.5 percent in Oceania.

The increased population concentration in the less developed world reflects the exceptionally rapid growth of population in those areas since the middle of the twentieth century and lower growth and in some cases stability, and more recently even decline, in the more developed countries. Table 2 shows the ten most populous countries in the year 2000. The stylized maps presented in Figure 1 show how population is distributed by country and region and the broad changes in relative sizes over time.

The Environment, Society, and the Economy

Population density per square kilometer on a global scale is related to a number of factors both in the physical environment and in society and the economy. Although the physical environment does not play a straightforward deterministic role, extremes tend to discourage human settlement. Climate is a major factor. In very cold and very hot environments the range of crops that can be grown, if any, is limited, and this inhibits human survival. Accordingly, large areas of the globe are empty. Thus, in Lapland there is only 1 person per square kilometer, and in the Gobi Desert only 1.4.

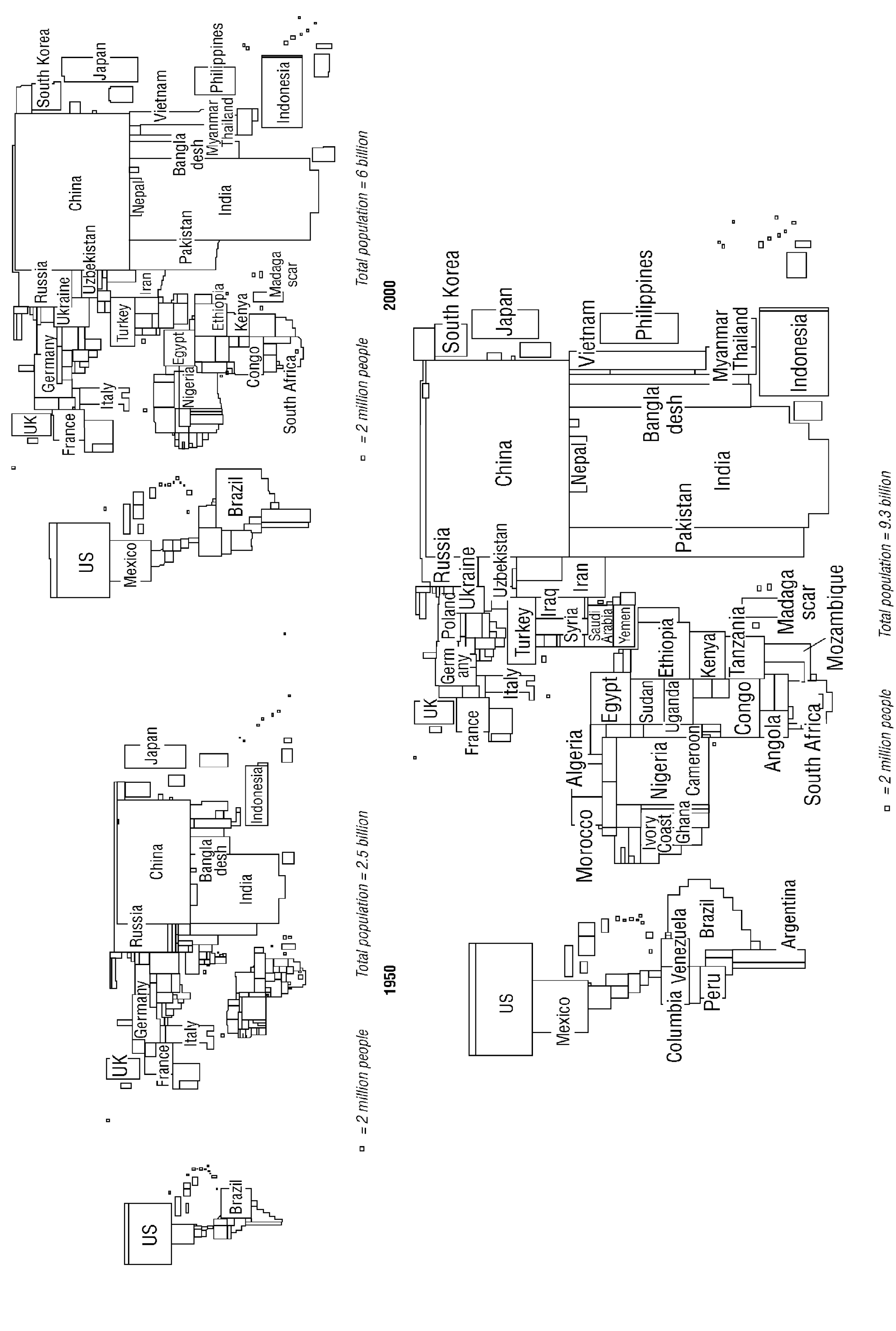
Altitude is also significant. Mountain soils are usually thin, and at high altitudes temperatures and the oxygen content of the air decrease rapidly. This makes agriculture less productive, with additional problems created by difficulty of access and transport. Lowland areas tend to attract settlement more readily, with more intensive farming and industrial and commercial development. Coastal areas are often more attractive to settlement: Around two-thirds of the world's population lives within 500 kilometers of the sea. Natural vegetation also may be a deterrent to human settlement, with, for example, the great rain forests such as the Amazon being poorly suited for high population densities. Negative factors in the environment do not always discourage settlement: For example Bangladesh, prone to major environmental hazards such as flooding, sustains a very high population density. A hot and humid environment near the equator permits cultivation to take place year-round.

Population distribution within continents and countries is also highly variable and is apt to change significantly over time. Within the countries of Western Europe, for example, population densities range from very high concentrations in the Netherlands to much lower densities in much of France and Spain. Within the United Kingdom, which is an area with overall high density, regional densities vary from over 600 persons per square kilometer in the urban counties of the southeast and northern England to well under 100 in large tracts of Wales and Scotland. Figure 2 illustrates the wide disparities in population density in the United States.

Population redistribution through migration, as well as population growth or decline, takes on increasing significance at smaller geographic scales. On a global scale migration has been of great importance historically in determining distributions of population, especially in relation to the great transatlantic migrations of the nineteenth and early-twentieth centuries. Redistribution of population also rewrote the world cultural map. Within countries industrialization and migration have gone hand in hand, entailing major redistribution from rural to

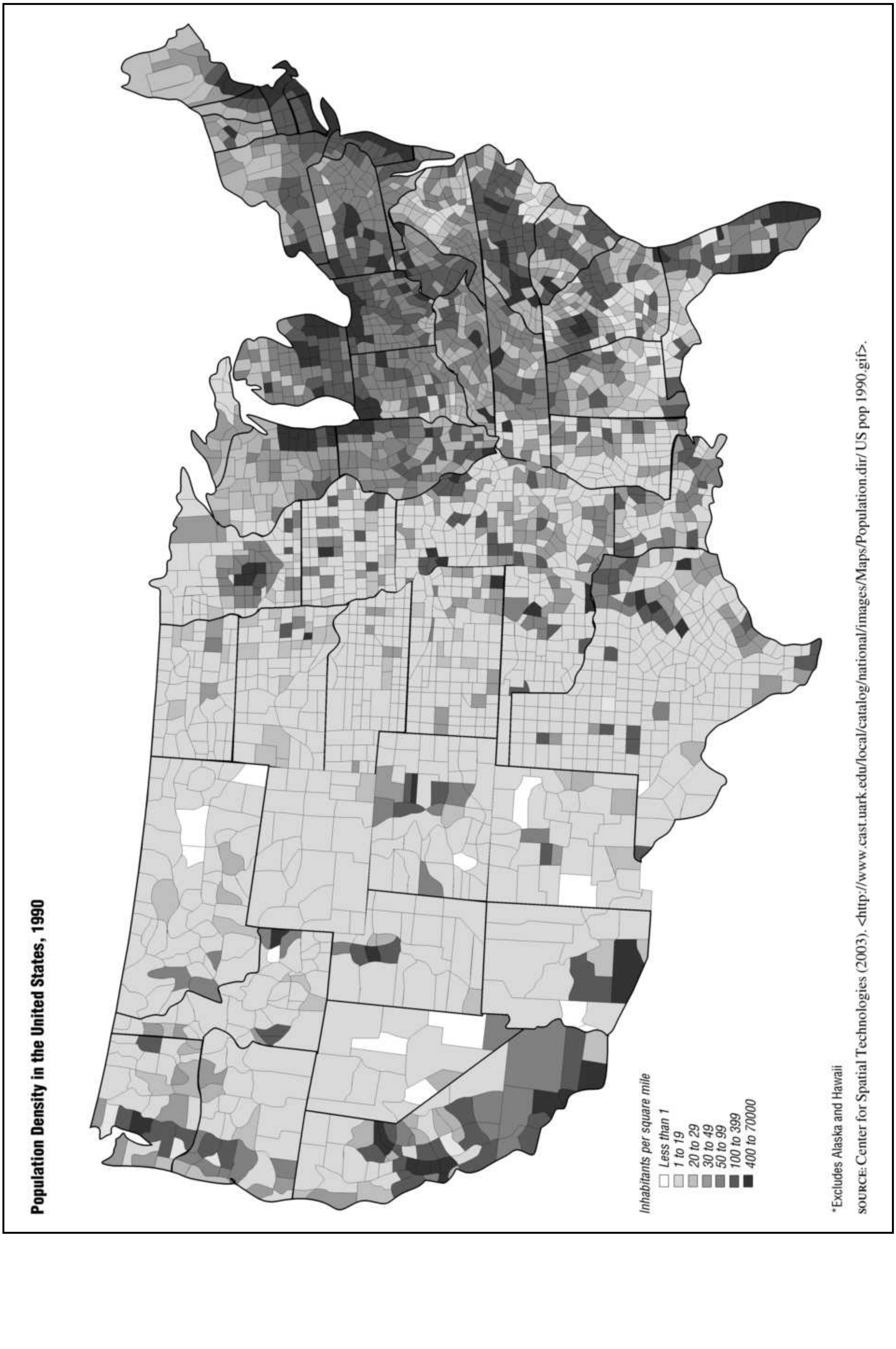
FIGURE 1

Size and Distribution of World Population by Countries, 1950, 2000, and 2050



SOURCE: Vallin (2002).

FIGURE 2



*Excludes Alaska and Hawaii

SOURCE: Center for Spatial Technologies (2003). <http://www.cast.uark.edu/local/catalog/national/images/Maps/Population.dir/US pop 1990.gif>.

TABLE 2

Ten Most Populous Countries in 2000

Rank	Country	Population (millions)	Percent of world population	Cumulative percentage
1	China	1,275	21.1	21.1
2	India	1,009	16.7	37.8
3	United States	283	4.7	42.5
4	Indonesia	212	3.5	46.0
5	Brazil	170	2.8	48.8
6	Russian Federation	145	2.4	51.2
7	Pakistan	141	2.3	53.5
8	Bangladesh	137	2.3	55.8
9	Japan	127	2.1	57.9
10	Nigeria	114	1.9	59.8

SOURCE: United Nations, Population Division (2002).

urban areas. In the countries of the more developed world, for example, in much of Western Europe, rural depopulation and urban growth have been a salient feature since 1850. In the less developed world rapid urbanization since 1945, compounded by high levels of overall population increase, has redrawn the map of population distribution in many countries. Distribution also can be affected directly by government policy, for example, by the encouragement or discouragement of international migration.

Mapping Population Density

Attempts to map population distribution and density date back to the early-nineteenth century. Graduated shading was used in a map of Prussian population densities in 1828, dots were used to represent population in France in 1830 and in New Zealand in 1863, and a variety of methods were employed to map population by the Irish railway commissioners in 1837. The later part of the nineteenth century saw the use of cartograms, in which regions are depicted as proportional to their population size rather than their geographic area. (See Figure 1.)

A simple and frequently used representation of population distribution that complements mapping is the Lorenz curve. A straight diagonal line represents an even distribution of population over the areas selected, and the larger the gap between the curve and the diagonal line, the greater the degree of concentration of population. Figure 3 illustrates both the method and the distribution of subgroups within a population compared to the population as a whole, in this case the distribution of two ethnic minority populations in Great Britain in 1991: persons of Irish and Bangladeshi origin. The horizontal axis indicates the cumulative percentage of these two groups, and the vertical axis indicates the cumulative percentage of the total population over the districts (in this case census wards) into which the country has been divided. Note the highly concentrated population of Bangladeshi origin compared to the more evenly spread Irish population.

Problems with Measures of Density

There are a number of general problems with measures of density. Population data are collected for highly variable geographic units that are rarely homogeneous in terms of economic and environmental characteristics. A density figure is simply an average with all the limitations that that implies, and care needs to be taken both in the definition of the population and in the areal or other units being used, particularly when comparisons are made at different geographic scales. Measures of population density extend beyond the crude density of population, the number of people per unit area. Useful national comparisons may be based on density defined in relation to cultivatable or cultivated land. For example, in Egypt overall population density is low in relation to the total national territory but high if population numbers are related to cultivated land, which is dependent on irrigation from the Nile.

Other calculations have been made to relate population numbers to levels of national income and standards of living. At the city level, measures such as the density of population per household or housing unit and the average number of persons per room provide a useful way of describing patterns of settlement. Thus, in the Paris agglomeration at the time of the 1999 census of population, for example, the number of persons per household varied from 2.82 in the outer suburbs to 1.87 in the inner city. The mean number of persons per room in the central area declined from 1.02 in 1962 to 0.74 in 1999.

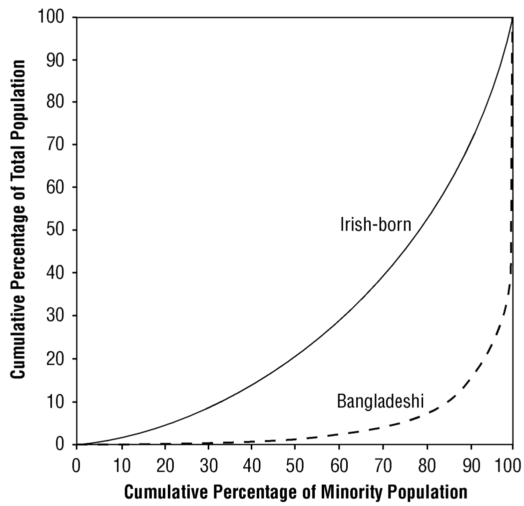
See also: *Carrying Capacity; Central Place Theory; Geography, Population; Land Use; Peopling of the Continents.*

BIBLIOGRAPHY

Chrispin, Jane, and Francis Jegede. 2000. *Population, Resources and Development,* 2nd edition. London: HarperCollins.

FIGURE 3

Lorenz Curves Comparing the Distribution of Two Ethnic Minority Groups in Great Britain in 1991 to the Distribution of the Population as a Whole



SOURCE: Peach (1996).

Clarke, John I. 1972. *Population Geography,* 2nd edition. Oxford: Pergamon.

Peach, Ceri. 1996. "Does Britain Have Ghettos?" *Transactions of the Institute of British Geographers,* new series 21: 216–235.

Plane, David A., and Peter A. Rogerson. 1994. *The Geographical Analysis of Population, with Applications to Planning and Business.* New York: Wiley.

Vallin, Jacques. 2002. "The End of the Demographic Transition: Relief or Concern?" *Population and Development Review* 28(1) 108–109.

Philip E. Ogden

DEVELOPMENT, POPULATION AND

Economic development refers to the structural transformation of human society from subsistence economy to urban-industrialism, and to the sustained rise in productivity and income that results. The transformation is seen in the structure of production, consumption, investment, and trade; in financial and other economic institutions; in occupations, educational levels, health conditions, and rural-urban residence; and in people's perceptions of the natural and social worlds and of their own agency. Political development is in some respects an overlapping process, yielding the values and institutions of the democratic state. *Development*, however, is commonly taken to mean economic development, with political development taken for granted.

Development is linked in various ways to population change. The transformation in demographic regimes from high to low birth and death rates—the demographic transition—can be added to the list of structural changes constituting development: Indeed, in terms of its direct effect on human well-being and its social and economic implications, it is arguably the most important of those changes. Population growth, unleashed by sustained mortality decline or by migration, is a force of its own in the development process, sometimes seeming to promote development, more often impeding it, and always diluting its achievements. While countries are the principal level at which such relationships have their effect, the influence of population change can extend to broader regional development and even to the global economy, with implications too for geopolitics and major environmental systems. Breaking down population growth by age group, source of growth (natural increase versus migration), and other characteristics reveals further links. The subject of population and development is concerned broadly with all such interactions: with how populations and economies impinge on each other and with the consequences that ensue.

Scale and Pace of Development

In the early 1800s, with industrialization barely underway, the world population stood at one billion; as late as 1930 it had reached just 2 billion; by the end of the twentieth century it had passed 6 billion. While dramatic enough to be described as an "explosion," this growth in population seems almost modest in comparison to the expansion of the global economy in the same period. Angus Maddison's index of gross world product (at constant prices, though the calculations required are complicated and inherently somewhat dubious over these time intervals) set at 1 in 1820, reaches 5 in 1929, 40 in 1990. It had probably exceeded 50 by 2000.

Along both dimensions this growth was extraordinarily uneven. The populations of Europe and North America expanded markedly over the nineteenth century as mortality yielded to improved living standards, the spread of education, and early public health measures. The region's share of the world population rose from about one-fifth to about one-third. Subsequently, mortality declines spread to Latin America, Asia, and Africa, creating a dramatic surge in population growth rates—and shifts in the global demographic balance that are relegating Europe and North America to the world's demographic margins (a 17% population share in 2000, a projected 12% share by 2050). The large reductions in mortality have been perhaps the most remarkable achievement of the post-World War II world. Life expectancy in the developing countries rose from about 40 years in 1950 to an estimated 64 years at the beginning of the twenty-first century.

Fertility levels followed, or seem to be following, the same regional course. In the West, aside from some forerunners (France and the United States), the decline got broadly underway in the late nineteenth and early twentieth century, spreading to the non-industrialized world after World War II but becoming widespread only in the 1960s or later. (Some regions, notably much of sub-Saharan Africa, had shown scant decline by the end of the twentieth century.)

The picture of regionally staggered onsets of demographic transition around the world, eventually (if only after a tenfold or more rise in population size) leading to conditions of low, zero, or perhaps negative population growth at low mortality levels, suggests a large measure of commonality in demographic experience. In cross-section, however, it is the diversity of demographic situations that is most striking. In the early decades after World War II arraying countries by mortality or fertility levels showed strongly bimodal distributions; in 2000, the bimodality had largely disappeared but the variance—reflecting the distance between leaders and laggards in the transition—remained high.

Economic growth used to seem well depicted by a similar kind of staged process, with poor countries successively reaching "take off" speed and embarking on rapid and sustained economic development. That expectation has only partially been borne out. In the worldwide emphasis on development that emerged with the ending of colonial rule after World War II, many countries experienced economic growth spurts, sometimes for long enough to be proclaimed *miracles,* but few by the end of the twentieth century had attained income levels comparable to those of the early industrializers. Many countries, and some whole regions (sub-Saharan Africa in the 1980s and 1990s), experienced periods of economic stagnation or retrogression. Using a standard measure of absolute poverty—expenditure averaging less than a dollar per day at 1990 purchasing power—the world's poor numbered around 1.2 billion persons (20% of the world's population) in the late 1990s.

The variegated global experience of growth in populations and incomes since the industrial revolution is depicted in summary fashion in Figure 1, based on the estimates of Maddison. (The years identified are those selected by Maddison as reflecting significant junctures in global development, but the smooth trajectories drawn in the figure skirt over intervening fluctuations.) The chart reveals the contrasts among major countries along both axes; the impressive steepening of the trajectories for China and to a lesser degree India; and the bleak performance of the African region (a doubling of population in the last quarter of the twentieth century with no overall gain in real per capita income).

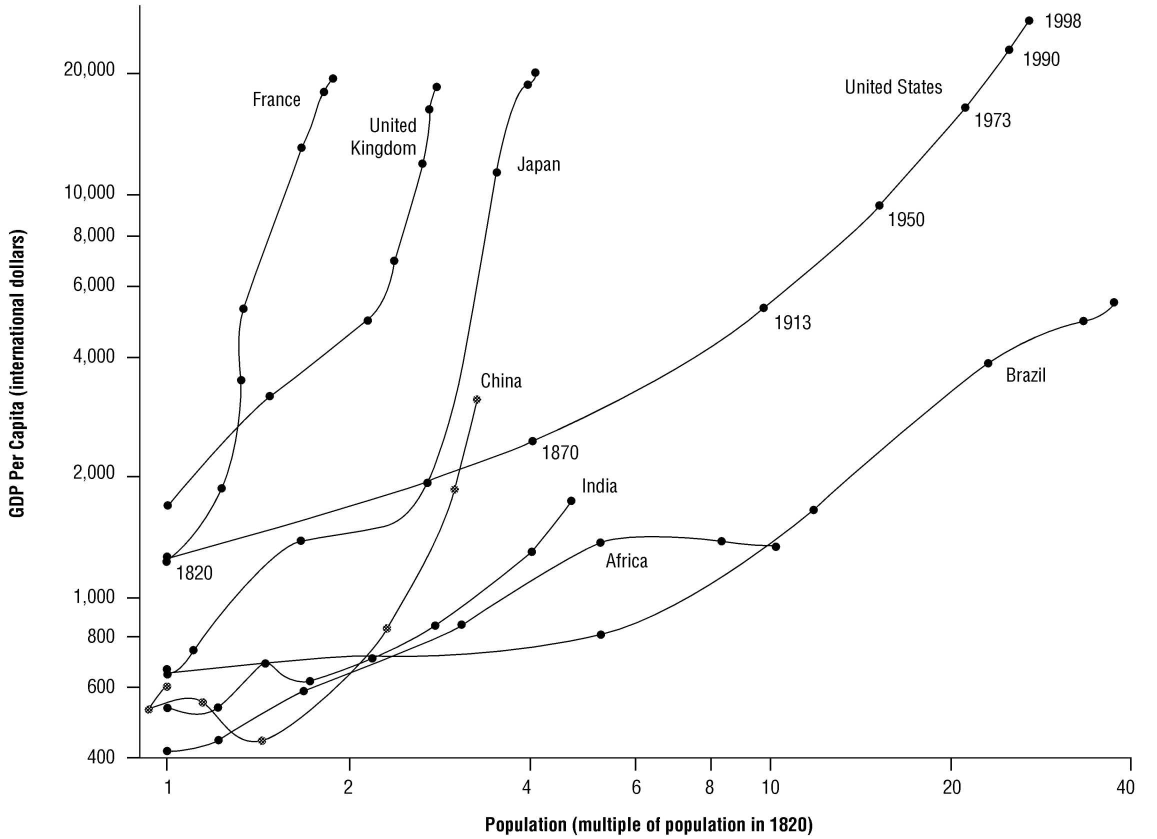
Population Size and Development

Under the mercantilist doctrine that prevailed in early modern Europe, a larger population was valued as a source of a nation's wealth. Malthusianism punctured that belief. From Malthus onward, both popular and official opinion has tended to see population growth as a threat to development. Increases in production could only too easily be dissipated in additions to population rather than invested in capital accumulation. Resource scarcities—in arable land, later also in other natural resources—were seen as always looming on the horizon and were brought nearer by demographic expansion. Malthusian views lay behind India's concerns about its population growth both prior to and after independence. They were the basis of China's sudden conversion in the 1970s to a policy of hard-nosed birth control. They attained wide prominence in the West in the same decade through the *Limits to Growth* thesis propounded by environmentalists.

Malthusian thinking had a more checkered history in economics. Resource-dependence has been

FIGURE 1

Population and Per Capita GDP Trajectories, Selected Countries and Regions, 1820–1998



Note: The seven points on each trajectory refer, left-to-right, to status in 1820, 1870, 1913, 1950, 1973, 1990, and 1998. (Trajectories do not show fluctuations between these points.)

SOURCE: Based on estimates in Maddison (2001), Appendix A. Income in 1990 dollars at purchasing power parity.

steadily reduced as technology has advanced and human capital has grown. Non-renewable resources have found vastly expanded supplies in some cases and ready substitutes in others, banishing fears of an era of diminishing returns and rendering earlier worries about the imminent exhaustion of particular resources (coal in England, for instance) almost quaint. As Harold J. Barnett and Chandler Morse wrote: "the social heritage consists far more of knowledge, equipment, institutions, and far less of natural resources, than it once did" (1963: 11–12).

Resource constraints cannot be wholly assumed away, especially if development is equated with human well-being. Fresh water is often mentioned as a potentially limiting factor; so-called positional goods, such as unique environments, are by definition scarce. Standard measures of economic performance mask the effects of changes in the natural environment. "Environmental services"—for example, pollination of crops—may be a significant ingredient of human welfare, but yet remain statistically invisible. Aesthetic criteria generally, and hence a whole range of quality distinctions—in production and consumption as well as in environmental conditions—tend to be neglected when it comes to measurement.

Population-resource interactions are mediated by human institutions: markets or management regimes that serve to ration access to the resource by potential users. In some circumstances, these arrangements break down, or possibly they never emerged in the first place, leading to depletion or degradation as the demands on the resource increase. A classic stylized account of this, intended to model possible external effects (externalities) of population growth, is Garrett Hardin's "tragedy of the commons." The tragedy is the decline through overuse—and through institutional incapacity—of an open-access, common-property resource. Analogues of these local-level externality problems exist at higher levels of social organization, even internationally.

Population Growth and Development

Twentieth-century theorizing about development was influenced by neoclassical growth models that, in contrast to the "classical" model, allowed steady expansion of both economies and populations, with technological progress given a central role in outcomes. Any adverse effects of the overall scale of the economy in relation to its resources were assumed negligible—or outweighed by positive effects. Some economists saw population growth actually boosting technological change—a case supported by the work of Danish economist Ester Boserup (1910–1999) on long-run agrarian change. Many others saw population growth as a fairly neutral factor in development performance. The range of viewpoints is captured by two major reports on the subject from the U.S. National Academy of Sciences, from 1971 and 1986: The first found a strong case for limiting population growth, the second at most a very weak one. Whatever the theoretical arguments, in the post-World War II decades, at least until the 1980s, aggregate income data did not show a significant negative effect of population growth on development: At the country level the years of fastest economic and demographic growth often coincided.

If researchers ask not about the effects of rapid population growth on development but about those of reduced mortality and fertility, the consensus is clear. As well as its obvious and immediate meaning for a society's welfare and for what is sometimes termed its human development, high mortality has various adverse effects on economic development. There is the evident waste of human resources, often embodying substantial public and private investments in education and skills. The AIDS epidemic has been particularly damaging in this respect: In many of the worst affected countries the disease cuts a swath through the educated strata of the society. High mortality is also associated with heavy morbidity, and sometimes with impaired physical and cognitive development, with detrimental economic consequences. Within families, the death of a parent may harm the educational opportunities and broader life-prospects of the children: Again, AIDS mortality is the most prominent case in point, leading to a drastic rise in orphanhood and child destitution in a number of African countries. The benefits for development of improvements in health conditions and lower levels of mortality are thus clearly apparent.

The benefits of a fertility decline are somewhat less obvious—again, aside from the immediate welfare gain if it lessens "unwanted" births or improves reproductive health. Research suggests that lower fertility may improve access to health services and education, and more generally expand opportunities to escape poverty. One important route for such benefits is through a lowering of the child dependency rate: For a period of some two decades after a fertility decline there are fewer dependent children but no fewer workers, freeing up resources for investment. This straightforward proposition, advanced in a classic study by Ansley J. Coale and Edgar M. Hoover in the 1950s, was the main economic case for the worldwide expansion of family planning programs in the 1960s. Later it lost favor, along with many other arguments specific to developing economies, in the general disdain for development economics as a distinct branch of economics. It experienced a revival in the 1990s, coming to be seen by some as an important element in explaining the "Asian miracle"—the remarkable economic performance of East and Southeast Asian countries from the 1970s to the 1990s. The dramatic falls in birth rates in this region, beginning in the 1960s, are held to have yielded a "demographic bonus" of investment that boosted the development effort—not least, through improvements in human capital. However, the conditions under which any such bonus can be put to good use may be quite exceptional, lessening the value of the Asian miracle as a general policy lesson.

Promoting Demographic Transition

As discussed above, both mortality and fertility declines are favorable for development. The rapid population growth that is their usual accompaniment (since mortality typically falls first) is an offsetting factor, but moderates as the transition proceeds. These relationships can be viewed as positive feedbacks in the development process, forming a virtuous circle by which success breeds success: Sustained economic growth on the one hand and attainment of a modern demographic regime on the other. The components of population change are ingredients in the overall pattern of development, but for the most part they have the nature of dependent variables. Demographic transition is welcomed for the immediate welfare gains that low mortality and low fertility bring, but the proper policy focus to achieve those gains is on the broad development effort.

Many researchers and development planners, however, would adopt a much less passive stance on population policy. If there are proven means of intervention that can speed the mortality and fertility declines, then the gains both for immediate welfare and for the development effort can be reaped much earlier than would otherwise happen.

Mortality. For mortality, the appropriate means of intervention were evident. The long-running debate over the relative significance of the factors bringing about mortality improvement—transference of medical knowledge from the developed countries, expansion of public health facilities, and improved social and economic conditions—have been largely resolved, particularly through the pioneering work in the 1970s of demographer Samuel H. Preston.

Preston showed that there was a fairly tight but nonlinear relationship between life expectancy and per capita income among countries at a given time, and second that this relationship has shifted systematically over time. The relationship around 1990 is shown as a scatter plot (and fitted curve) in Figure 2, based on World Bank estimates: It is steep at low income levels, but flattens out at higher levels. Figure 2 also indicates the shifts in the relationship over time, drawing on sparser historical estimates. The major shifts have been twofold: (1) a decline in the per capita income level (in purchasing-power terms) at which this flattening takes place—that is, in the income level above which further income increases can be expected to make only slight contributions to improve mortality; and (2) an overall upward shift of the life expectancy-income relationship—a country with a given real per capita income in the early twenty-first century is likely to have considerably lower overall mortality than a country reaching the same income level some decades earlier would have had.

Cross-sectional analysis of this kind indicates that the effect of development on mortality is largest for countries at the lowest income levels. At the upper income ranges mortality is increasingly dissociated from economic change, reflecting both an educated demand for health services and the affluence to afford them. In the lower- and middle-income ranges, however, at any given income level there is a diversity of mortality outcomes across countries. Differences in income distribution, levels of education, public health expenditures, and the design and reach of the health system—all of them factors influenced by development policy—are the main contributors to that diversity.

Fertility. The degree to which fertility can be lowered by policy interventions has been a highly controversial issue in population and development studies, despite the casual assumption of many that the standard interventions—family planning programs—are of proven efficacy. But effective interventions of some sort are needed: The demographic bonus or any other economic advantages accruing from fertility decline are of interest because of the presumption that there are policy measures that can lower fertility other than through the normal course of development itself. Otherwise those advantages are reduced to the status of some helpful positive feedback generated by successful development.

At a broad level the factors behind fertility transition are not mysterious. Principally, there is a falling "demand" for children, traceable to a host of actual and anticipated changes in families' circumstances—in survivorship rates, in the family economy, in educational and labor market opportunities, and in related normative images of family and society. Also contributing to fertility decline are greater knowledge and availability of modern contraceptive methods and, in some situations, strong government efforts to promote smaller families. Development affects fertility mainly through alterations in the setting within which fertility decisions (and other decisions that incidentally bear on fertility) are taken. Three routes can be distinguished: (1) through alterations in the array of economic benefits and costs associated with marriage and childraising; (2) through shifts in social and administrative pressures on individuals and couples bearing on fertility-related decisions or their outcomes; and (3) through changes in internalized values concerning marriage and fertility instilled by education, socialization, and acculturation. The three routes are not wholly distinct, making for possibilities of double-counting.

(1) *Economic benefits and costs.* Fertility, like other kinds of behavior subject to individual choice, responds to changes in expected net economic benefits attaching to it. The increasing monetization of exchange relations that comes with economic development gives greater salience to this calculus. (Of course, no careful or even conscious calculation of benefits and cost need be assumed.) The economic shifts that take place are mostly in the direction of reducing the net benefits of high fertility.

The time entailed in childraising may be seen as more costly—for the poor, competing with opportunities to increase their earnings; for the better off, competing also with newfound forms of consumption.

Education beyond primary level becomes increasingly necessary for labor market success and its cost is often onerous even when supposedly publicly financed. This cost, together with other direct costs of children and the physical demands of their upbringing, is more likely to be borne fully by parents rather than shared among kin.

Social changes make any anticipated economic returns from children less assured. The insurance value of children is lessened as modern financial institutions emerge.

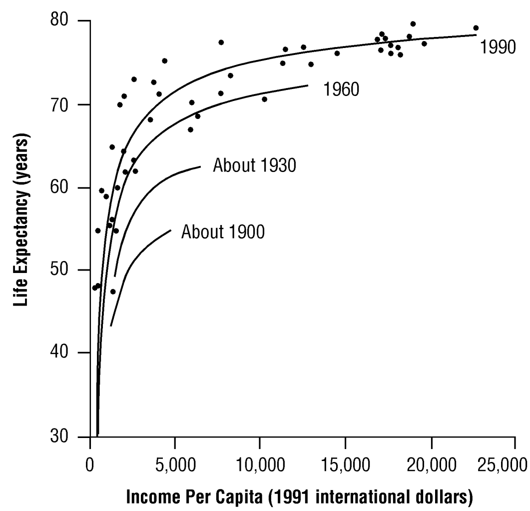
Improvements in health conditions presumably also affect the economics of fertility, altering individual planning horizons and parents' expectations of death or debility both for themselves and for their children.

Finally, government-supported family planning programs may lower the economic costs of birth control. How important those costs are, is disputed. Economist Lant Pritchett (1994, p. 25) points out that, under any reasonable assumption about the economics of children, those costs can be no more than a very small fraction of the (capitalized) net return—or net cost—anticipated from having a child.

(2) *Social and administrative pressures.* Social pressures from kin or community are probably felt less on the direct question of family size (except regarding childlessness and very small families) than on related matters such as age at marriage, approval or disapproval of particular practices of birth control, and restrictions on sex roles. Social influence entails scope for *contagion* and *bandwagon* effects. These effects are of course not confined to societies

FIGURE 2

Relationship between Life Expectancy and Per Capita Income at Different Time Periods



Note: Underlying data are for countries. Plotted points shown refer only to 1990.

SOURCE: World Bank, *World Development Report 1993*, after Preston (1975).

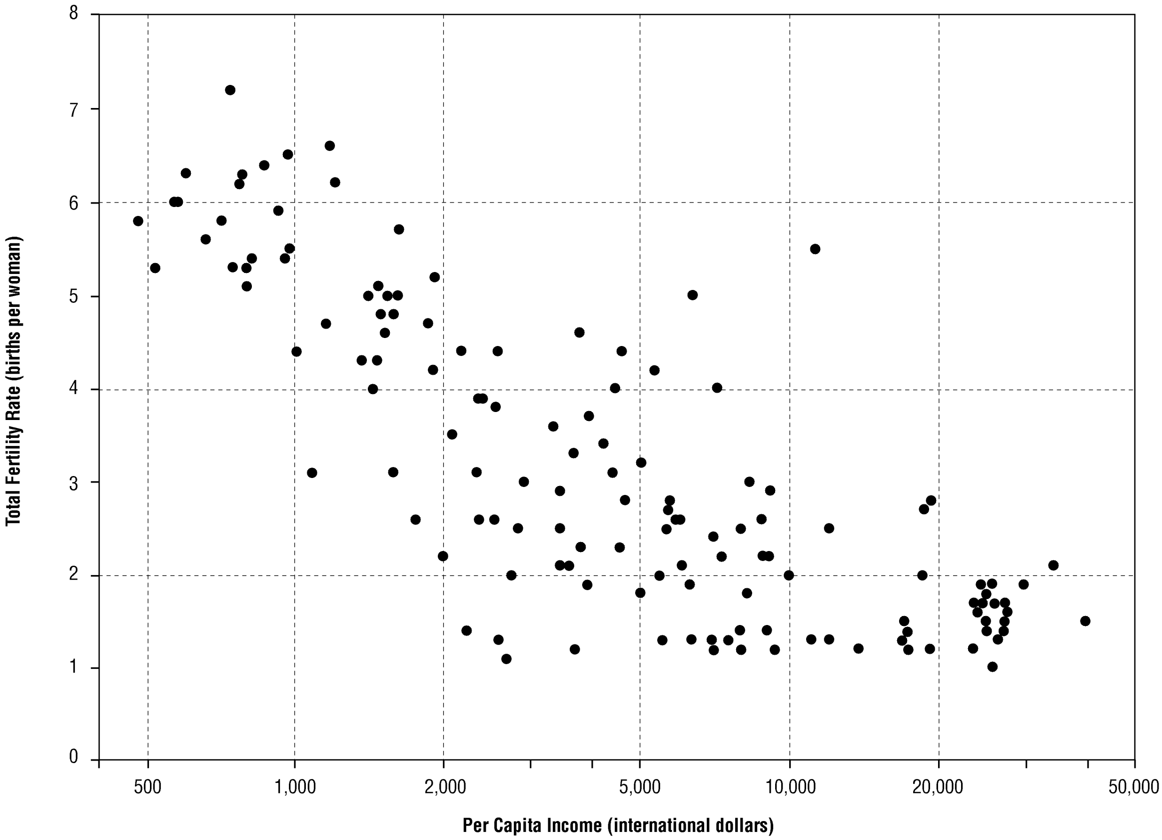
experiencing demographic transition: It is likely that social pressures in contemporary low-fertility societies reinforce economic rationales for one- or two-child families by implicitly censuring family sizes above three.

In some countries in particular periods there have also been administrative pressures that bear directly on fertility. Such pressures peaked in the 1970s in Asia, principally in China and (more briefly) India, but also, less rigorously, in Indonesia and some other countries. Except for China, the pressures ebbed with the decline of fertility.

(3) *Internalized values.* The effects of values on fertility are not well understood or agreed upon. Some researchers believe them to have an independent effect on fertility, others as being rationalizations of behavior. They may be enduring realities—so that, for example, fertility decline could be a way of maintaining traditional family values in a changed economic setting. Or they may be altered by contact with new conditions. Some amount of value change is undeniable. For members of subsistence societies, almost osmotically but with many plausible transmission routes, perceptions of the family, of authori-

FIGURE 3

Total Fertility Rate against Per Capita Income for 137 Countries, 2000



Note: Income at purchasing power parity. Upper-right outliers are Namibia.and Saudi Arabia.

SOURCE: World Bank, *World Development Indicators* (2002).

ty, of the future, even of time, gradually come into alignment with those to be found in the modern industrialized world.

The combined net effect of these various changes has been strongly antinatalist, promoting the shift from quantity to "quality" of children. Disentangling the contributing factors to the fertility transition, however, has been a perennial source of argument, particularly over the putative roles of *development* (often narrowly construed as income growth) and *ideational change* (often construed as acceptability of family planning). The income-fertility relationship, shown as a scatter plot in Figure 3, makes clear both that a broad negative relationship exists and that there is a lot of variance remaining to be attributed to other factors. But such factors would necessarily include also the many aspects of development poorly captured by measures of income.

Population and Development Futures

In broad outline, the global economic and demographic trends observed over the second half of the twentieth century would support an expectation over the first half of the twenty-first century of continued, if uneven, improvement in economic conditions and, partly in consequence, an approaching end of the demographic transition. That demographic outcome, indeed, is the future built into the medium-variant population projections of the United Nations, which (in the 2000 revision) portray the world's fertility dropping from 2.8 children per woman in the 1990s to 2.1 (replacement level) by around 2050, and life expectancy increasing in the same period from 65 years to 74 years. The world population, under this scenario, would rise from 6 billion in 2000 to 9 billion in 2050, but by then the annual increment would have dropped from 80 million people to around 40 million—and zero (and perhaps negative) population growth would be in sight. Closely tied to these trends would be a substantial aging of population, continued rapid urbanization in the less developed regions, and continuation of the major shift in the balance of world population toward the South.

Both in evaluating this scenario and in probing its ingredients, consensus quickly wanes. The range of interpretations of past experience is magnified in looking ahead. The most sanguine outlook is sketched in economist Richard A. Easterlin's *Growth Triumphant,* in which the population explosion is a passing phenomenon, ushering in a future of sustained economic growth led by ever-higher material aspirations. Erstwhile poor countries successively build the complex economies and settlement densities already found in the rich countries. Economic globalization is frequently depicted as a route to such affluence, open to all, although bringing with it not just new opportunities but also new systemic fragilities.

More cautious or circumspect assessments of the future extrapolate emerging problems as well as favorable trends. Such problems include: supporting the necessary scale of transfer payments to the aged as their numbers multiply; avoiding fertility collapse to levels far below replacement, with its eventual implication of radical population decline; maintaining the quality of socialization and education of children in the face of crumbling families and weakened local communities; lessening the ecological damage associated with rising average consumption levels; and coping not only with the large remaining public health agenda in poor regions but also with new or reemerging infectious disease threats. The future food situation, though in the aggregate far from dire by many informed accounts, is increasingly technology-dependent and regionally disparate. The greenhouse effect, the atmospheric warming caused by increased amounts of carbon dioxide and other gases, has the potential to create ramifying changes in the environment, affecting crop production (perhaps positively), disease vectors, natural ecosystems, sea levels, and weather patterns. Greenhouse gas emissions are linked to population growth as well as to industrialization.

Population change will also have political consequences, and political developments, in turn, clearly have the capacity to modify future economic and demographic trends. "Failed states," according to Robert D. Kaplan, owe their ungovernability partly to population growth and the ecological degradation and poverty tied to it. Environmentally-related political instability, some have argued, will become common in many regions. But while examples of economic retrogression and associated political turbulence will surely continue to be found in the future, so too will cases of recovery and eventual return to paths of stable positive growth.

At the international level, the changes in relative population sizes and in age distributions among countries that are occurring will have major political implications. Combined with persisting economic differences they identify potential faultlines of international conflict. Large-scale migration from poor to prosperous countries is another politically sensitive issue that will not lessen in importance—filling some part of the demographic deficits created by very low fertility, and in doing so creating the increasingly ethnically-diverse societies of the Western world.

See also: *Demographic Transition; Economic-Demographic Models; Fertility Transition, Socioeconomic Determinants of; Mortality Decline; National Security and Population.*

BIBLIOGRAPHY

Ahlburg, Dennis A., Allen C. Kelley, and Karen Oppenheim Mason, eds. 1996. *The Impact of Population Growth and Well-Being in Developing Countries.* Berlin: Springer-Verlag.

Barnett, Harold J., and Chandler Morse. 1963. *Scarcity and Growth: The Economics of Natural Resource Availability.* Baltimore: Johns Hopkins Press.

Birdsall, Nancy, Allen C. Kelley, and Steven W. Sinding, eds. 2001. *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World.* Oxford: Oxford University Press.

Boserup, Ester. 1981. *Population and Technological Change: A Study of Long-Term Trends.* Chicago: University of Chicago Press.

Coale, Ansley J., and Edgar M. Hoover. 1958. *Population Growth and Economic Development in*

Low-Income Countries. Princeton: Princeton University Press.

Demeny, Paul, and Geoffrey McNicoll, eds. 1998. *The Earthscan Reader in Population and Development.* London: Earthscan Publications.

Easterlin, Richard A. 1996. *Growth Triumphant: The Twenty-first Century in Historical Perspective.* Ann Arbor: University of Michigan Press.

Furedi, Frank. 1997. *Population and Development: A Critical Introduction.* New York: St Martin's Press.

Hirsch, Fred. 1976. *Social Limits to Growth.* Cambridge, MA: Harvard University Press.

Kaplan, Robert D. 1996. *The Ends of the Earth: A Journey at the Dawn of the Twenty-first Century.* New York: Random House.

Kuznets, Simon. 1979. *Growth, Population, and Income Distribution.* New York: Norton.

Maddison, Angus. 2001. *The World Economy: A Millennial Perspective.* Paris: Organisation for Economic Co-operation and Development.

Population and Development Review. 1975–. New York: Population Council, quarterly.

Preston, Samuel H. 1975. "The Changing Relation Between Mortality and Level of Economic Development." *Population Studies* 29: 231–248.

Pritchett, Lant H. 1994. "Desired Fertility and the Impact of Population Policies." *Population and Development Review* 20: 1–55.

United Nations Department of Economic and Social Affairs. 1973. *Determinants and Consequences of Population Trends,* rev. edition, Vol. 1: *New Summary of Findings on Interaction of Demographic, Economic, and Social Factors.* New York: United Nations.

U.S. National Academy of Sciences. 1971. *Rapid Population Growth: Consequences and Policy Implications,* Report of the Study Committee of the Foreign Secretary, National Academy of Sciences. Baltimore: Johns Hopkins Press.

U.S. National Academy of Sciences. 1986. *Population Growth and Economic Development: Policy Questions.* Report of the Working Group on Population Growth and Economic Development, National Research Council. Washington, D.C.: National Academy Press.

World Bank. 2001. *World Development Report 2000/2001: Attacking Poverty.* New York: Oxford University Press.

Geoffrey McNicoll

DIETARY REGIMES

Dominant patterns of food consumption have changed substantially as human societies evolved during tens of thousands of years of gathering and hunting, millennia of traditional pastoralism and settled farming, and a century of modern intensive agriculture. As a result, nearly 90 percent of humanity now enjoys at least an adequate food supply, and an increasing share of the world's population now worries about excess, rather than about shortages, of food.

Diets of Foraging Societies

The enormous diversity of foraging societies—ranging from maritime hunters with relatively easy access to highly nutritious aquatic animals to foragers in arid environments where tubers and seeds provided the bulk of food energy—means that there has never been a single typical gatherer-hunter diet. Societies exploiting the constant presence or regular migrations of mollusks, fatty fish (cod, salmon), and marine mammals (seals, whales) had by far the highest intake of both animal protein and lipids. These maritime foragers could have derived 30 to 50 percent of their food energy from animal protein. The only land foragers who could have approached that pattern, at least seasonally, were the cooperative hunters of megaherbivores; the best example of this strategy is mass killings of North American bisons by driving them over precipices. Given the typically low success rates in hunting the fast-running mid-size and small herbivores living on grasslands and in forests, most foragers had only a limited supply of animal foods. And, as nearly all small and most mid-size animals are very lean, their diets were particularly short of fat.

Archaeologists have used remains and nutrient analyses of wild plant and animal foods consumed by foragers that survived into the twentieth century to estimate the dominant composition of prevailing pre-agricultural diets. These reconstructions conclude that plant foods, generally consumed within hours after being gathered, supplied 65 to 70 percent of all food energy. Proteins made up about a third of food energy (a share nearly three times as high as that recommended at the end of the twentieth century), and lipids about 20 percent. Average intakes of vitamins and minerals were generally well above the modern recommended daily allowances (RDA). These conclusions may not be representative of all foraging societies, because of the limited number of examined archaeological sites and because the foraging societies that survived into the twentieth century did so in mostly marginal environments. These marginal environments include, counterintuitively, tropical rain forests where hunting success is low, as most animals are arboreal, and hence relatively small and inaccessible in high canopies.

Pre-Industrial Diets

Archaeological findings and written documents offer a wealth of information about the composition of diets in antiquity, but translating these accounts into quantitative summaries of average or typical intakes is very difficult. Information about crop yields and animal productivity cannot be converted into average supply rates because of large, and highly variable, post-harvest food losses. Perhaps the only permissible generalization in accord with documentary and anthropometric evidence is the absence of any clear upward trend in per capita food supply during the millennia of traditional pre-industrial farming. In fact, stagnation or deterioration of food supply had not been uncommon. A reconstruction of ancient Mesopotamian ration lists indicates that daily energy supplies between 3000 and 2400 B.C.E. were about 20 percent above the early-twentieth-century mean for the same region. Similarly, the Han dynasty records show that during the fourth century B.C.E. a peasant was expected to provide each of his five family members with nearly half kilogram of grain a day, the rate equal to the North Chinese mean during the 1950s.

As the following examples illustrate, better information available for the last four centuries of the second millennium does not show any substantial nutritional improvements until the latter half of the nineteenth century. Annual per capita grain and meat supply in Rome fell by 25 to 30 percent during the seventeenth century. At the end of the eighteenth century, Sir Frederic Morton Eden found that the poorest English peasants consumed little or no milk or potatoes, no oatmeal, and seldom any butter, but occasionally a little cheese; he noted that even bread, their chief staple, was in short supply. Similarly, a third of the rural population in Eastern Prussia could not afford enough bread as late as 1847.

Diets of most pre-industrial populations were thus highly monotonous, not very palatable, and barely adequate in terms of basic nutrients. In most of Europe pre-industrial diets were dominated by bread (mostly dark, often with little or no wheat flour), and included coarse grains (oats, barley, buckwheat), turnips, cabbage, and, after 1570, potatoes. These ingredients were served in thin soups and stews, with evening meals indistinguishable from breakfasts and midday food. Similarly, in Asian peasant diets cereals—millet, wheat, rice, and after 1530, corn—supplied more than four-fifths of all food energy. Major sources of protein included soybeans in East Asia and lentils and chickpeas in the South. Millet, tubers such as cassava and yams, and legumes like peanuts were the staples of sub-Saharan Africa, and corn and beans were dominant throughout pre-Colombian America. Quinoa and a huge variety of potatoes were essential for survival in the Andean environment.

Vegetables and fruits enlivened the monotony of cereal and legume staples, but, unless preserved by pickling or drying, they were only seasonally abundant in temperate climates. Common European vegetables included turnips, cabbages, onions and carrots, while apples, pears, plums, and grapes brought the largest fruit harvests. Cabbages, radishes, onions, garlic, and ginger were the main vegetables consumed in China, and pears, peaches, and oranges were favorite fruits. Two quintessential Mesoamerican vegetables, tomatoes and peppers, became cultivated worldwide after 1600.

Typical pre-industrial meat consumption was very low, averaging no more than 5 to 10 kilograms per year, and roasts and stews were usually eaten only during festive occasions. Consequently, animal foods provided less than 15 percent of all dietary protein, and saturated animal fats supplied only around 10 percent of all food energy. Low meat consumption persisted not only during the early phases of European modernization in the nineteenth century, but into the twentieth century as well. Median annual meat intake in France was only about 20 kilograms per capita during the 1860s, and it was barely above 10 kilograms per capita in England. Monotonous diets, major consumption inequalities in both regional and socioeconomic terms, and recurrent food shortages and even famines persisted until the nineteenth century in Europe and well into the twentieth century in Asia and Africa, leaving the majority of peasants in all traditional farming societies with food supplies below optimal levels necessary for healthy and vigorous life.

Diets in the Age of Mechanized Agriculture

Major dietary change got under way in Europe only in the mid-nineteenth century and its scope ranged from eliminating any threat of famine to the founding of restaurants and emergence of the *grande cuisine.* Slow decline in the average consumption of staples was accompanied by growing intakes of animal foods and sugar. Cheaper imports of cane sugar and the introduction of the diffusion process to produce sugar from beets after 1860 in Europe and North America made refined sucrose easily obtainable for the first time in human history. This period of rapid dietary change led Ernst Engel (1821–1896), a German statistician, to formulate the eponymous law stating that the poorer a family, the higher its share of total expenditure spent on food. The law remains valid today—for nations as well as families: While an average American family spends only about one-seventh of its disposable income on food, the percentage is still more than 40 in China's cities.

The pace of Western dietary change accelerated after World War II as increasingly mechanized agriculture, supported by high energy subsidies and relying on new high-yielding crops, began producing surpluses of food. Mechanized agriculture improved the quality and variety of food, and supplied both staples and fancy foodstuffs at relatively decreasing prices. Foodstuffs that were previously too expensive or simply inaccessible began appearing in everyday diets. Chilled shipments of out-of-season fruits and vegetables and a growing trade in ocean fish and specialty foodstuffs eventually erased the seasonal availability of all but a few perishable plant species and diffused food items whose consumption was previously confined to specific areas (such as cactus pears, litchi, salmon, and sea bass).

Diets in the Twenty-First Century

Average per capita food supply at the beginning of the twenty-first century is in excess of 3,000 kilocalories per day in all Western nations and very close to 3,000 kilocalories per day in Japan. More than 30 percent, and in some circumstances even more than 40 percent, of all food energy comes from lipids, annual meat consumption is in excess of 70 or even 100 kilograms per capita, and in comparison to all preindustrial diets, the modern Western diet is too high in sodium and too low in indigestible fiber. Incredibly, in spite of the surfeit of food and the common fortification of such staples as flour, many people in Western societies have micronutrient deficiencies, and several million people in North America go hungry.

The actual food energy requirement in modern, largely sedentary societies is only about 2,000 kilocalories per day, and the huge gap between the supply and the need explains both a great deal of food waste and the unprecedented extent of obesity that is being incessantly, and not very successfully, combated by ubiquitous dieting. Western diets in general, and obesity in particular, have been associated with the rise of such widespread "civilizational" diseases as cardiovascular illnesses and diabetes. The Mediterranean diet has been advocated as a healthy alternative, but the average intakes of Mediterranean populations have been shifting in the direction of less healthful Northern diets with declining consumption of bread, fruit, potatoes, and olive oil.

An excessive quantity of inexpensive food is accompanied by a still-increasing diversity of food supply brought by extensive intra- and intercontinental trade (including perishable foodstuffs ranging from tuna fish to grapes), by the commingling of food traditions in nations with large immigrant populations, and by the globalization of many previously spatially restricted food and beverage items such as leavened breads, pizza, sushi, beer, and wine. At the same time, more single-person households, high rates of female employment, and reduced willingness to cook have brought an astonishing rise in the consumption of fast foods whose dominant ingredients are saturated fat (in hamburger, pizza, and taco empires) and refined sugar (in doughnut and coffee shops). The picture of modern food customs would not be complete without noting extensive food faddism, cultism, and quackery, practices ranging from megavitamin regimens to pseudo-scientific diets (from vegan to macrobiotic), and consumption of both natural and synthetic food supplements (from echinacea extracts to zinc lozenges). A new concept, made possible by genetic engineering, is the use of food as medicine (called "nutraceuticals").

In contrast to the rich world's food surpluses, average daily food supplies below 2,000 kilocalories per capita are still common in the world's most impoverished countries where some 95 percent of the world's more than 800 million malnourished people can be found (about 200 million in India, 140 million in China). Dietary transitions that took more than a century in the West are being compressed into just a few decades in many rapidly modernizing Asian countries. They are marked, on one hand, by declining consumption of cereal grains and even more rapid reduction in the consumption of legumes and, on the other hand, by rising intakes of plant oils, animal foods (meat as well as aquacultured fish and crustaceans), fruits, and sugar. Post-1980 China is the best example of this process as it has moved from a barely adequate diet dominated by staple grains and basic vegetables to a total per capita supply nearly equaling the Japanese mean (about 2800 kilocalories per day in 2000).

In spite of the indisputable globalization of tastes, national and regional food preferences are evident around the world and food taboos, only weakly held in the West in the early twenty-first century, remain strong among nearly two billion Muslims and Hindus. Further homogenization of tastes will be accompanied by further diffusion of "exotic" foodstuffs and by the development of hybrid cuisines and new eating habits. Regardless of the unpredictable specifics of future dietary changes, there is no doubt that these new global trends will demand more resources for production of higher-quality and specialty foods—more fertilizers and pesticides for perfect fruit, high-protein feed for aqua-cultured carnivorous fish—and for their worldwide distribution. Manipulating these trends through pricing is hardly an option in a world where commodity prices have been in a prolonged and nearly universal decline. Public education about healthy nutrition is imperative, but it is an uphill task in societies suffused with gluttony-promoting advertisement and hedonist values, and lacking dietary discipline.

See also: *Food Supply and Population; Nutrition and Calorie Consumption.*

BIBLIOGRAPHY

Flandrin, Jean-Louis, and Massimo Montanari, eds. 1999. *Food: A Culinary History from Antiquity to the Present.* New York: Penguin Books.

Kiple, Kenneth F., and Kriemhild Coneè Ornelas, eds. 2000. *The Cambridge World History of Food.* Cambridge, Eng.: Cambridge University Press.

Smil, Vaclav. 2000. *Feeding the World.* Cambridge, MA: MIT Press.

Vaclav Smil

DIFFUSION IN POPULATION THEORY

Theorizing about the forces driving the transition from high to low fertility has been dominated by opposition between *structural explanations* and those referred to as *diffusion-based explanations.* The same opposition is ubiquitous, if less obvious, in the literature on health and mortality, international migration, and spatial and residential patterns. This contrast is not unique to population theory: A similar division is widely seen in the literature on the emergence of nation-states in political sociology, within the theory of social organizations, and in the study of the economic behavior of individuals and firms.

An important illustration of this opposition and one that has long been a problem in population theory relates to the explanation of the secular fertility decline in Western Europe that began around 1850. The phenomenon was initially thought to be a result of economic, social, and political transformations that altered the social context within which childbearing took place. These transformations are seen as *structural* changes, that is, changes emerging from larger societal transformations that alter the economics of fertility (for example, changes that affect the conditions of individuals' decision-making about childbearing). Some of these transformations are directly related to industrialization and the shifting division of labor and occupational structure. Others, such as the transition to a regime of low infant and child mortality, are thought to be secondary products of these large-scale transformations (and perhaps only loosely connected to them) but with a direct effect on fertility.

The empirical evidence from historical and contemporary societies stubbornly refuses to fit neatly into the patterns of conventional interpretations.

Fertility declined in Western Europe in areas where such structural changes both did and did not occur. Onset was remarkably concentrated in time, much more so than the timing of onset of structural changes. In addition, the attainment of low fertility regimes follows a geographic contour that is more consistent with ethnic, cultural, linguistic, and political cleavages than anticipated by the structural explanation.

Similarly, what explanation exists for the more recent sharp fertility decline in Bangladesh, where economic development and large-scale industrialization are still elusive goals but where the total fertility rate dropped from 7 children per woman to nearly 3.5 children per woman in thirty years? Or for the statistics in Brazil where the total fertility rate is 2.8 children per woman at the outset of the twenty-first century after topping 6.5 children per woman just forty years before? According to classic indicators of economic development and industrialization, even though Brazil has experienced deeper economic transformations than Bangladesh, its fertility levels are still not commensurate with the relatively limited influence of these changes. Further, the internal regional disparities in economic development are overshadowed by a remarkable homogeneity of fertility regimes.

The inconsistencies between fertility patterns predicted by structural explanations and those actually observed has led many researchers to abandon the structural perspective in favor of one that emphasizes the importance of dissemination of new ideas and the diffusion of modern fertility behaviors.

An analogous, and even older, controversy between structuralist and diffusionist theories exists over explanations of changes in mortality and health regimes. On one side are explanations that interpret the secular mortality decline as a result of economic transformations and improvements in standards of living. On the other side, mortality decline is seen as a result of the spread of medical technology and of the dissemination of advances in public health and individual hygiene that reduce exposure to infectious diseases.

Anatomy of the Theoretical Divide

What is the main distinction between a structuralist explanation and one based on diffusion? Structural explanations of behavioral changes seek the cause in the alteration of preferences and opportunities that result from either changes in the positions that individuals occupy (individual social mobility) or from the reshuffling of resources associated with a given social position (e.g., structural social mobility or redistribution of wealth). In contrast, diffusion explanations attempt to identify a mechanism that leads to cumulative adoption of behaviors by some individuals, even when their social position, or the resources associated with them, change only minimally or remain unaltered. In diffusion models, the behavior *spreads* and is adopted by individuals irrespective of their socioeconomic positions, including among those whose social or economic positions are such that a hypothetical cost–benefit calculation would not necessarily favor the new behavior. An individual adopts the new behavior as a result of a reevaluation of choices in light of the behavior of other people, not as a strategic response or accommodation to a realigment of resources associated with the individual's position in the social system. Diffusion models are built on the central idea that individuals transfer partial or total control of their own behavior to others. The implied decision process is at least as complicated as those normally associated with structural explanations.

Diffusion processes do not always involve adoption of new behaviors. In fact, they may include abandonment of a recently adopted behavior or resistance to change. The course of fertility decline in Europe revealed a marked tendency to proceed along, or be halted by, ethnic, linguistic, and religious boundaries. The resulting geographic clustering of fertility levels and patterns has been construed as evidence for the hypothesis that fertility changes were strongly driven by ideational or cultural changes, transmitted by diffusion mechanisms, rather than as supporting a structural explanation of fertility decline. The existence of a clustering of fertility changes along cultural lines could be evidence of diffusion of either a new behavior (such as adoption of contraception along with acceptance of a low-fertility norm) in areas were fertility declined below what would be expected based on existing levels of industrialization and urbanization (structural changes), or of resistance to the new behavior (rejection of birth control and adherence to a high-fertility norm) in areas where fertility remained higher than expected.

Thus there is a contrast between an explanation that infers an expected behavior from a reading of individual socioeconomic positions (the structuralist explanation), and an alternative explanation that infers a pattern of expected behavior from the likely adherence of actors to ethnic, religious, or cultural prescriptions or beliefs shared by others in the same community, including individuals belonging to different social classes or occupying different socioeconomic positions. In the latter case, the likelihood of adherence to prescriptions increases as a function of others' adherence to them (or others' resistance to the novel behavior). Who is included in the group referred to as "others" is a key ingredient of the theory, as is the identification of the exact mechanisms that secure adherence to prescriptions and beliefs.

Both the structuralist and the diffusionist explanations rest on the idea that individuals are decision makers, acting in uncertain environments, sorting through limited information on prices, utilities, constraints, and potential outcomes of alternative behaviors, elucidating their own preferences, and ultimately taking some course of action. Whereas investigators are normally careful to produce a thorough definition of the decision-making process associated with the structuralist explanation, they all too often fail to specify the decision-making process associated with diffusion—to the point that the process appears, in many instances, to consist of passive contagion and the irrational or *arational* adoption of a behavior. Lack of theoretical specificity leads to accepting diffusion explanations as concession to failure, a fall-back position taken when one cannot confirm a structuralist explanation.

In both sociology and demography, most of the evidence adduced to distinguish between the two contending explanations of behavioral change is derived from aggregate, not individual, data. Since the individual adoption process is not well specified, it is unclear what type of aggregate evidence would be determinative. This leads to the common but methodologically flawed practice of inferring the validity of a diffusion explanation from the failure to support the validity of a structural one. A central problem in sociology and demography, and in economics as well, is the inability to identify key processes from observables.

The Identification Problem or How to Falsify Diffusion Theories with Observables

The only way to convincingly choose between a diffusionist or a structuralist theory is by observing patterns of behavior under conditions that hold the distribution of individuals by social positions and the distribution of resources associated with those positions constant, while allowing variations in conditions that trigger the spread of the behavior (participation in social networks, etc.). If the prevalence of the behavior grows, it cannot possibly be due to structural factors (they are constant) but to diffusion. The difficulty, however, is that at least one of the three mechanisms of diffusion identified above mimics the effects of structural changes: namely, when social positions or resources associated with them change as a result of the process of diffusion itself. Put another way, if we are to identify diffusion effects, the ideal experiment cannot allow the diffusion feedback mechanism to operate and simultaneously maintain invariance in individual characteristics. Thus, even under ideal conditions, it is difficult to sort out precisely how much of the ultimate change in behavior is due to all diffusion mechanisms, and how much to secondary changes in the social structure induced by diffusion itself. In the cases of interest here, including the study of fertility, the conditions are far from ideal; hence it is virtually impossible to make the necessary distinctions. This limitation is irrelevant when the feedback mechanism is weak or if its operation requires long time lags.

Needless to say, there are few ideal experiments. With few exceptions, the evidence marshaled in favor or against diffusion either coarsely identifies the processes of diffusion that the theorist postulates as empirically relevant or, worse, is unspecific, simply referring to *what is left over* after accounting for measurable conditions associated with individual positions and resources.

A behavior model must be a representation of individuals choosing among a set of alternatives, under a set of constraints. The model must seek to account for the persistence (or abandonment) of a behavior over time. This can be done most efficiently by imagining that individuals may occupy two states, one representing adoption of the target behavior and the other adoption of a different behavior (or refusal to adopt the behavior). Transitions between these two states are a function of the individuals' characteristics associated with social and economic conditions (costs and utilities), external characteristics acting as constraints or facilitators, the influence of external sources of ideas, and the influence of each individual's linkages to social networks. To the extent that individuals' transition rates are dependent on factors affecting the stock of external sources of ideas or their interaction with social networks, a diffusion explanation acquires greater credibility.

Advances in the empirical identification of diffusion as a feasible mechanism that triggers large-scale behavioral transformations depends on the ability of the scientific community (a) to precisely define the empirical processes through which external sources of influence and those associated with social networks alter the willingness, the ability, and/or the readiness of individuals to adopt or resist behavioral change, and (b) to gather empirical information on the mechanisms through which external sources and social networks operate to produce change.

Conclusions: Where Do We Go From Here?

The theoretical divide described above is still a reality in various areas of demography and continues to be a subject of theoretical debate in sociology and economics. Its nature, however, has been redefined and enriched. Testing theories that pose diffusion as a plausible phenomenon no longer rests on dubious arguments about residual explanations without identifying the precise mechanisms involved. Instead, there have been significant theoretical improvements, drawing elements from social network and social learning theories and applying ideas from economics on relations between individual behavior and aggregate properties of a system. These developments offer the prospect of progress toward the objective described in (a) above.

In addition to advances in theory and modeling, there is a need for more and richer information on aggregate and individual patterns of change. Efforts to identify social networks through both large-scale longitudinal surveys and ethnographically based research are promising developments addressing the issue raised in (b) above.

See also: *Action Theory in Population Research; Culture and Population; Demographic Transition; Fertility Transition, Socioeconomic Determinants of; Mass Media and Demographic Behavior; Social Networks; Values and Demographic Behavior.*

BIBLIOGRAPHY

Carlsson, Gosta. 1966. "The Decline of Fertility: Innovation or Adjustment Process?" *Population Studies* 20: 149–174.

Cavalli-Sforza, Luca L., and Marcus W. Feldman. 1981. "Cultural Transmission and Evolution: A Quantitative Approach." *Monographs in Population Biology,* No 16.

Cleland, John, and C. Wilson. 1987. "Demand Theories of the Fertility Transition: An Iconoclastic View." *Population Studies* 41: 5–30.

Coleman, J. S. 1990. *Foundations of Social Theory.* Cambridge, MA: Harvard University Press.

Lesthaeghe, Ron, and C. Vanderhoeft. 2001. "Ready, Willing, and Able: A Conceptualization of Transitions to New Behavioral Forms" In *Social Processes Underlying Fertility Changes in Developing Countries,* ed. John Casterline and B. Cohen. Washington D.C.: National Research Council Press.

Montgomery, Mark, and John Casterline. 1993. "The Diffusion of Fertility Control in Taiwan: Evidence from Pooled Cross-Section, Time Series Models." *Population Studies* 47(3): 457–479.

Palloni, Alberto. 2001. "Diffusion in Sociological Analysis: How Useful Is It for the Study of Fertility and Mortality?" In *Social Processes Underlying Fertility Changes in Developing Countries,* ed. John Casterline and B. Cohen. Washington, D.C.: National Academy Press.

Rogers, Everett M. 1995. *The Diffusion of Innovations,* 4th edition. New York: The Free Press.

Rosero-Bixby, Luis, and John B. Casterline. 1993. "Interaction Diffusion and Fertility Transition in Costa Rica." *Social Forces* 73(2): 435–462.

———. 1993. "Modelling Diffusion Effects in Fertility Transition."*Population Studies* 47(1):147–167.

Strang, David. 1991. "Adding Social Structure to Diffusion Models: An Event History Framework." *Sociological Methods and Research* 19: 324–353.

Valente, Thomas W. 1995. *Network Models of the Diffusion of Innovations.* Cresskill, NJ: Hampton Press.

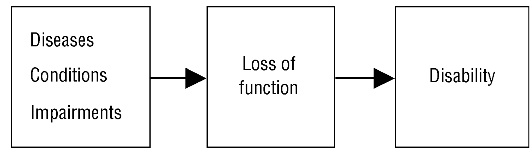
Alberto Palloni

DISABILITY, DEMOGRAPHY OF

Disability is one dimension of morbidity, or ill health. In the United States disability is defined as the inability because of poor health to perform tasks or social roles that are considered normal for one's age. Disability is the end of a process of health change that begins with the onset of diseases and conditions that may lead to the impairment or loss of function—the loss of the physical ability to perform certain tasks or motions—and then to disability. The process is termed the "disability process" by Lois Verbrugge and Alan Jette and is shown in Figure 1.

FIGURE 1

Dimensions of Population Health Problems



SOURCE: Verbrugge and Jette (1994).

Definitions

The distinction between disability and impairment and loss of function is that disability can be affected by the circumstances of a person's environment or the demands of social roles, whereas loss of function is internal to the person. Loss of function occurs "within the skin"; disability results from a combination of factors "within" and "outside the skin." A complication of cross-national research on disability is that countries that employ the World Health Organization's International Classification of Impairment, Disability, and Handicap (ICIDH) define disability the way researchers in the United States define impairment and use the word *handicap* to define what is known as disability in the United States.

Disability thus often is defined in terms of the normal tasks in various age groups. For young people school disability is the inability to attend a mainstream school. For those in the working ages work disability is the inability to perform the tasks required at work. For older persons disability often is defined in terms of the inability to live independently and provide self-care. Operationally, this often is measured as the ability to perform what are called "activities of daily living" and "instrumental activities of daily living."

As these definitions make clear, changes in the environment without changes in innate ability can affect the level of disability. This fact underlies the Americans with Disabilities Act of 1990. Schools that provide services for children with functioning problems can reduce school-age disability; workplace adaptations can reduce work disability; and the development of technology and assistive devices as well as changes in housing design can reduce old-age disability.

Levels of Disability

The level of disability is related to both age and sex. Generally, as a person's age increases, the level of disability increases because of the greater incidence of specific diseases and conditions, both physical and mental, and loss of function. For instance, among non-institutionalized American males in 1997 the proportion with disability or some limitation in activity ranged from 7 percent at age 18 to 36 percent at age 65 and over. Women generally report higher levels of disability in the older ages; the proportion with limitations in activity among women 65 and over was 42 percent in 1997. This is related to women's higher levels of morbid diseases such as arthritis.

Persons of lower socioeconomic status have higher levels of disability than do those of higher status. In the United States in 1997, 25 percent of persons with family incomes less than $20,000 were limited in activity; this was true of only 6 percent of persons from households with incomes of $75,000 and over. The relationship between socioeconomic status and disability is caused by numerous risk factors and life circumstances related to lower status and the earlier onset of all dimensions of morbidity.

Unlike mortality, disability is not an "absorbing" state. It is a state of impaired health from which a person can recover and that a person then can reenter. People may experience a number of periods of significant disability in their lives or may never be disabled. Although many people experience significant disability in the last year of life, some individuals die without experiencing loss of function or disability.

The level of disability has declined since the early 1980s among some segments of the American population. This is generally true for the older population, but the decline appears to be concentrated among those with higher socioeconomic status.

The level of disability in a population results from a combination of the rate of incidence of disability and the rates of survival among those with and without disability. It is possible for mortality decline to result in a longer-lived disabled population and increases in age-specific levels of disability. Researchers in a number of countries have found evidence that would support this set of circumstances for the period of the 1970s. Many countries, however, have experienced reductions in disability along with reductions in mortality that began by the 1980s.

The Decline in Disability

The decline in disability in the United States appears to be related to the increase in education among the older population. It is possible that this trend reflects current educational shifts and may not continue with increases in education at higher levels. In addition, the pattern of change for some younger cohorts is not promising. Middle-aged cohorts born in the baby-boom years report higher levels of disability at these ages than earlier cohorts did. In the past age-specific disability increased regularly as a cohort aged, implying that the baby boom cohort may have higher levels of disability in old age than current cohorts of older persons.

See also: *Accidents; Aging of Population; Disease, Burden of.*

BIBLIOGRAPHY

Blackwell, Debra L., and Luong Tonthat. 2002. "Summary Health Statistics for the U.S. Population: National Health Interview Survey, 1997." *Vital and Health Statistics* 10: 204.

Crimmins, Eileen M., and Yasuhiko Saito. 2001. "Trends in Disability-Free Life Expectancy in the United States, 1970–1990: Gender, Racial, and Educational Differences." *Social Science and Medicine* 52: 1629–1641.

Freedman, Vicki A., and Linda G. Martin. 1998. "Understanding Trends in Functional Limitations among Older Americans." *American Journal of Public Health* 88: 1457–1462.

Manton, Kenneth G., and XiLiang Gu. 2001. "Changes in the Prevalence of Chronic Disability in the United States Black and Nonblack Population above Age 65 from 1982 to 1999." *Proceedings of the National Academy of Sciences* 98: 6354–6359.

Reynolds, Sandra, Eileen M. Crimmins, and Yasuhiko Saito. 1998. "Cohort Differences in Disability and Disease Presence." *The Gerontologist* 38: 578–590.

Verbrugge, Lois M., and Alan M. Jette. 1994. "The Disablement Process." *Social Science and Medicine* 38: 1–14.

Eileen M. Crimmins

DISASTERS

Disasters are sudden, large-scale events that result in substantial numbers of deaths and injuries or severe economic losses. Natural disasters, the subject of this article, are disasters that are not precipitated by human agency. A disaster occurs when vulnerable people are severely impacted by a hazard in a way that recovery is unlikely without external aid. Vulnerability is a function of a group's socioeconomic condition; the poor are more vulnerable than the rich.

Deaths and Injuries

According to the International Federation of Red Cross and Red Crescent Societies (IFRC), a total of 39,073 people were reported killed by disasters in 2001. This figure is lower than the decade's annual average of around 62,000. Earthquakes proved to be the world's deadliest disasters, accounting for over half the year's toll. Over the decade, however, hydrometeorological hazards have claimed 71 percent of all lives lost to disasters.

From 1992–2001, countries of Low Human Development (LHD) have accounted for just one-fifth of the total number of disasters, but over half of all disaster fatalities. On average 13 times more people die per reported disaster in LHD countries than in countries of high human development. In 2001, a total of 170 million people were reported affected by disasters (IFRC 2002).

Economic Losses

In the 10 years ending in 2001, economic losses from natural disasters averaged nearly $580 billion a year. In real terms, this is a 7.7 fold increase in losses from the decade of the 1960s. Because of the relative size of developed- and developing-world incomes, the per capita impact of the economic losses was 20 times greater in the developing countries. According to a 2000 study by the World Bank, between 1990 and 1998, 94 percent of the world's major natural disasters and 97 percent of all natural disaster-related deaths occurred in developing countries.

The staggering total of losses in the developing world is a consequence of the vulnerability of low income countries to natural hazards. The cost of disasters to developing countries extends beyond the immediate impact on the poor. Studies indicate that natural disaster losses can eliminate economic growth. "The escalation of severe disaster events triggered by natural hazards and related technological and environmental disasters are increasingly posing a substantive threat to both sustainable development and poverty-reduction initiatives" (UN, ISDR, p. 3).

Future Trends

Natural disaster losses are forecast to increase dramatically during the first 50 years of the twenty-first century. The global cost of natural disasters is anticipated to exceed $300 billion annually (in 2000 dollars) by the year 2050—a five-fold increase over the 1990s. Two broad demographic trends directly contribute to the increasing losses from natural hazards in the developing world: the increase in population and the concentration of population in large cities. World population will likely increase by 2 billion persons between 2000 and 2025, and by a further billion by 2050, almost all of it in the developing world. The urban concentration is also rising. In developing countries, more than 40 percent of the population now live in urban areas, a percentage that is projected to reach 57 percent by 2030 (and up to 75 percent in Latin America and the Caribbean). Urbanization increases risk by concentrating people and investments in limited geographic zones. As a result, natural hazards can inflict substantial damage in a very short time. Hurricane Andrew, for example, inflicted $20 billion in damages in a few hours when it struck the Miami, Florida area in 1992.

Large cities are highly vulnerable to natural disasters, more so since substantial proportions of their populations are often poorly housed in fringe settlements. Nearly half the world's largest cities are situated in major earthquake zones or tropical cyclone tracks. Substantial increases in economic losses from disasters are highly probable.

See also: *Accidents.*

BIBLIOGRAPHY

Blakie, Piers, Terry Cannon, Ian Davis, and Ben Wisner. 1994. *At Risk: Natural Hazards, People's Vulnerability, and Disasters.* Routledge: New York.

Charveriat, Celine. 2000. *Natural Disasters in Latin America and the Caribbean: An Overview of Risk.* Washington, D.C.: Inter-American Development Bank.

Freeman, Paul K., Leslie A. Martin, Reinhard Mechler, Koko Warner, and Peter Hausmann. 2001. *Catastrophes and Development: Integrating Natural Catastrophes into Development Planning,* Disaster Risk Management Working Papers Series No. 4. Washington, D.C.: The World Bank.

International Federation of Red Cross and Red Crescent Societies (IFRC). 2002. *World Disaster Report 2001: Focus on Recovery.* Bloomfield, CT: Kumarian Press Inc.

Mitchell, James K., ed. 1999. *Crucibles of Hazard: Mega-Cities and Disasters in Transition* New York: United Nations University Press.

Munich Reinsurance Company (Munich Re). 2002. *Topics: Annual Review: Natural Catastrophes 2001* Munich, Germany: Munich Reinsurance Company.

United Nations Population Fund (UNFPA). 1999. *The State of the World Population 1999.* New York: United Nations Population Fund.

World Bank. 2001. *World Development Report 2000/2001: Attacking Poverty.* New York: Oxford University Press.

INTERNET RESOURCES.

Bendimerad, Fouad. 2000. *Megacities, Megarisk.* Disaster Management Facility, World Bank <http://www.worldbank.org/dmf/knowledge/megacities.html>

United Nations International Strategy for Disaster Reduction (ISDR). 2002. *Natural Disasters and Sustainable Development: Understanding the Links Between Development, Environment and Natural Disasters,* Working Paper No. 5 [Revised Edition]. <http://www.unisdr.org>.

United States Bureau of the Census (Census Bureau). 1999. *World Population Profile: 1998.*<http://www.census.gov/ipc/www/wp98001.html/>

Paul K. Freeman

DISEASE, BURDEN OF

Statistics on the health status of populations have been collected for centuries but typically have been collected for specific purposes. Vital registration systems have been in existence since the seventeenth century in some European countries and provide valuable information on numbers of dead by age and sex, and, in combination with census counts, on the overall level of mortality and its changes. Where all or most deaths are certified as to the underlying cause by a qualified medical practitioner—a much later development, even in Europe—these systems are a useful source of data on leading health problems. In countries where vital registration is still deficient, estimates of death rates by cause of death for the population classified by age and sex can be built up from data on mortality collected in surveys or through demographic surveillance systems, supplemented by a "verbal autopsy" (questioning relatives of the deceased) to arrive at the cause of death based on reported symptoms at or around the time of death.

Data on the incidence or prevalence of specific diseases and injuries have been collected in many countries for decades to serve as the basis for determining epidemiological priorities and for the evaluation of specific disease control programs. However, these data are often fragmentary or limited to a specific sub-population and are of limited value for assessing overall population health levels.

To give guidance in setting global priorities for the health sector, the causes and extent of ill-health and premature mortality in populations around the world need to be assessed. To be truly useful, such assessments must take into account not only the conditions leading to premature death, defined with reference to some standard survival curve, but also the prevalence, severity, and duration of the nonfatal consequences, or sequelae, of diseases and injuries. The Global Burden of Disease Study was initiated in the early 1990s to assess the contribution of over 100 diseases and injuries to premature death and ill-health in 1990, using a single metric. The study was subsequently expanded to include the estimated impact of ten major risk factors on disease and injury burden worldwide, also as of 1990. A revision of the study, under preparation, provides similar information for the year 2000.

Measuring the Disease Burden

The concept of capturing both the fatal and nonfatal effects of a specific disease or injury in a single metric is attractive for policy formulation since it permits a more complete assessment of the benefits of specific interventions. Clearly, an event-count framework, such as the number of deaths and the number of incident cases, is inappropriate as a guide for health policy since that framework does not take into account the public health implications of preventing deaths at younger versus older ages, nor does it capture variations in the duration and severity of non-fatal incident cases. In order to overcome these limitations, a time-based metric was constructed to gauge the total loss from disability and premature death—namely, Disability-Adjusted Life Years (DALYs). DALYs combine the number of years of life lost (YLLs) due to death prior to the normal life span and the number of years lived with a disability, weighted by the severity of the disability (YLDs). Hence for any disease, DALYs = YLLs + YLDs.

To estimate YLLs, a standard life expectancy of 82.5 years for females and 80.0 years for males was used to yield age-specific life expectancy targets or *norms* for the assessment of years of life lost at each age. For the calculation, the world was divided into eight regions and the same life expectancy target was assumed to apply to each region. To calculate YLDs, all major sequelae were identified for each disease or injury (e.g., measles, ischaemic heart disease, or motor vehicle accidents). A total of 107 diseases and injuries were considered, yielding a set of 483 disabling sequelae. For each of these sequelae and for each age and sex group, the incidence and average duration of the disability were estimated, and the resulting estimate of total person-years of disabled life were weighted by an assessment of the severity of the disability (see below). The results for each disability were applied to the total of incident cases in 1990 to calculate YLDs for the cause.

The disability weights were arrived at in the following manner. A representative sample of 22 *indicator conditions* was taken from the full set of 483 sequelae, spanning the range of severity from very mild (e.g., vitiglio on the face) to very severe (e.g., quadriplegia). Based on the opinions of public health experts familiar with the characteristics of each condition, the person trade-off technique and other health-state valuation methods were used to assign each indicator condition a disability weight in the range from 0 (perfect health) to 1 (death). The resulting weights were then grouped into seven broad severity classes and each class given the average weight of the conditions in it. All remaining 461 conditions were then assigned to one of the seven classes based on their characteristics.

Finally, an age-weighting function was introduced to assign greater weight to years lived (or lost) at younger ages, its shape reflecting empirical evidence about societal values. Thus, for example, several studies have shown that individuals prefer to save the lives of young adults over young children, if forced to choose. A 3 percent discount rate was also applied to both YLLs and YLDs to bring future years back to present-value terms. Thus, for example, a year of life lived at age 40 sometime in the future has a different, less certain value for society than a year of life lived by a 40 year old today.

Data Sources

Vital registration data on causes of death were used, with adjustments for miscoding and underreporting, for about 80 countries. For India and China, sample registration systems and disease surveillance points yielded reliable data on mortality conditions for representative samples of the population. Other available sources such as demographic and epidemiological surveillance sites and community-based research studies were used to estimate disease patterns in some regions, particularly in sub-Saharan Africa and parts of Asia. For each disease, experts provided estimates of incidence, duration, and case-fatality rates, by age, sex, and region, which were modeled via the disease modeling software DISMOD to ensure internal consistency of all epidemiological parameters. Projections to 2020 were also made on the basis of a broad deterministic model relating levels of income, education, and smoking to observed mortality rates over the period from 1950 to 1990.

Findings

Each disease or injury was classified into one of three broad groups:

- Group I, communicable, maternal, perinatal, and nutritional conditions;
- Group II, non-communicable diseases;
- Group III, injuries.

Worldwide, one death in every three is from a Group I cause. Virtually all of these deaths are in developing regions. One death in ten is from Group III causes (injuries), and just over half of all deaths worldwide in 1990 were from Group II causes (non-communicable diseases). In most developing regions, Group II causes of death already exceeded Group I causes in 1990, indicating that the epidemiological transition was well advanced. In these regions, the ratio of Group II to Group I deaths in 1990 was 4.5 in China and 2 in Latin America. The transition was less advanced in India, where the ratio was 0.8, and least advanced in sub-Saharan Africa, with a ratio of 0.4.

Just over 50 million people died worldwide in 1990, the leading causes of death being ischaemic heart disease (6.3 million deaths); stroke (4.4 million); lower respiratory diseases (primarily pneumonia, 4.3 million; diarrheal diseases (2.9 million); perinatal conditions, (2.4 million); and chronic obstructive pulmonary disease (primarily chronic bronchitis and emphysema, 2.2 million). Looking at years of life lost, however, yields a different ranking because the various causes of death have different average age patterns. The leading causes of YLLs were lower respiratory infections (11.7% of global YLLs for 1990), diarrheal diseases (10.2%), and perinatal conditions (8.9%)—followed at some distance by ischaemic heart disease (4.5%), measles (3.9%), and tuberculosis and stroke (3.5%). Arguably, this ranking is much more relevant for prioritization of programs to prevent premature mortality than the ranking by numbers of deaths.

When disease burden is assessed on the basis of DALYs, rather than deaths, conditions that are not leading causes of death but are nonetheless prevalent

TABLE 1

Leading Causes of Loss of Disability-Adjusted Life Years (DALYs), 1990

World	DALYs (million)	% total	Developed Regions	DALYs (million)	% total	Developing Regions	DALYs (million)	% total
1. Lower respiratory infections	112.9	8.2	Ischaemic heart disease	16.0	9.9	Lower respiratory infections	110.5	9.1
2. Diarrheal diseases	99.6	7.2	Unipolar major depression	9.8	6.1	Diarrheal diseases	99.2	8.1
3. Perinatal conditions	92.3	6.7	Cerebrovascular disease	9.4	5.9	Perinatal conditions	89.2	7.3
4. Unipolar major depression	50.8	3.7	Road traffic accidents	7.1	4.4	Unipolar major depression	41.0	3.4
5. Ischaemic heart disease	46.7	3.4	Alcohol use	6.4	4.0	Tuberculosis	37.9	3.1
6. Cerebrovascular disease	38.5	2.8	Osteoarthritis	4.7	2.9	Measles	36.5	3.0
7. Tuberculosis	38.4	2.8	Trachea/Bronchus/Lung cancers	4.6	2.8	Malaria	31.7	2.6
8. Measles	36.5	2.6	Dementias	3.8	2.4	Ischaemic heart disease	30.7	2.5
9. Road traffic accidents	34.3	2.5	Self-inflicted injuries	3.8	2.3	Congenital abnormalities	29.4	2.4
10. Congenital abnormalities	32.9	2.4	Congenital abnormalities	3.5	2.2	Cerebrovascular disease	29.1	2.4
Top 10 causes	583.1	42.3	Top 10 causes	69.0	42.9	Top 10 causes	535.3	43.9

SOURCE: World Health Organization (Murray and Lopez, 1996a, Table 5.2).

and disabling are given increased prominence. Worldwide, about 1.38 billion DALYs were lost as a result of premature deaths and new incident cases of disease and injury in 1990. The leading causes of DALYs in developed and developing regions are shown in Table 1. The global pattern more or less mirrors that suggested by YLLs, with the notable exception of depression, which ranks as the fourth leading cause of DALYs lost worldwide and the second leading cause in developed countries. As might be expected, more than half of the top ten leading causes of DALYs lost in developing regions are Group I causes, reinforcing the need for strengthened disease control measures for communicable diseases in poorer populations. Preliminary results for 2000 suggest a similar pattern, with the exception of HIV/AIDS, which was estimated to have caused 6.1 percent of the global DALYs lost in 2000, making it the third leading cause of DALYs lost in that year.

In terms of underlying causes of the burden of disease and injury, by far the most significant of those quantified was protein-energy malnutrition, which alone was estimated to have caused 16 percent of DALYs lost in 1990, followed by unsafe water and sanitation (6.8%). Unsafe sex, tobacco, alcohol, and occupational risks each causes about 2.5 percent to 3.5 percent of the disease and injury burden, about the same as measles and malaria. Quantifying disease burden both in terms of disease outcomes (e.g., lung cancer, ischaemic heart disease) and underlying attributable causes (e.g., tobacco, high blood pressure) provides critical input for allocative decisions in health sector programs.

Conclusion

The burden of disease approach has stimulated wide interest and debate about the construction of summary measures of population health, such as DALYs, and on the applicability of these methods in various countries. The data requirements for estimating mortality, incidence, prevalence, and duration of disease and injury in an internally consistent fashion has stimulated a reevaluation of the utility of traditional data collection in the health sector and has identified key gaps in knowledge about the causes and levels of major health problems. In developed countries, this has led to greater efforts to improve the cross-population comparability of survey data on the prevalence of disabling conditions; in developing countries, it has demonstrated the urgency of improving knowledge about the levels, patterns, and causes of adult mortality. As more children survive to adulthood, reliable data on their survival and trends in leading causes of death and disability will become increasingly important.

See also: *Disability, Demography of; Epidemiological Transition; Health Transition; Mortality Decline.*

BIBLIOGRAPHY

Murray, Christopher J. L., and Alan D. Lopez. 1996a. *The Global Burden of Disease: a Comprehensive Assessment of Mortality and Disability from Dis-*

eases, Injuries and Risk Factors in 1990 and Projected to 2020. Cambridge, MA: Harvard School of Public Health on behalf of the World Health Organization and the World Bank.

———. 1996b. "Evidence-based Health Policy: Lessons from the Global Burden of Disease Study." *Science* 274: 740–743.

———. 1997a. "Mortality by Cause for Eight Regions of the World: Global Burden of Disease Study." *Lancet* 349: 1,269–1,276.

———. 1997b. "Alternative Projections of Mortality and Disability by Cause, 1990–2020: Global Burden of Disease Study." *Lancet* 349: 1,498–1,504.

Alan D. Lopez

DISEASE, CONCEPTS AND CLASSIFICATION OF

The classification of diseases is the subject of the branch of medicine called nosology. Contemporary classification efforts range from those primarily intended to clarify and standardize the nomenclature of diseases, such as the College of American Pathologists' Systematized Nomenclature of Medicine (SNOWMED) and the National Institute of Health's Unified Medical Language System (UMLS), to taxonomies focused on diagnostic terminology that emphasize an ordered hierarchical system reflecting natural relationships between diseases, such as the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD).

The Early History of Disease Classification

The classificatory approach to disease is ancient, but the classification of diseases in a modern sense dates roughly from the fifteenth and sixteenth centuries. The concept that diseases are directly identifiable through their symptomatology is most evident in the revolutionary work of Paracelsus (born Theophrastus von Hohenheim, 1493–1541). Paracelsus's suggestion that natural symptoms may provide direct evidence leading to a probable diagnosis or classification of a disease despite a potentially unobservable cause of the illness was evident in practice by the seventeenth century, when nosology took form.

Throughout the eighteenth century the pathological view was guided by the concept that a specific cause could be identified for all episodes of ill health, and physicians concentrated on the observation of symptoms and the categorization of disease. Even the inevitability of death from natural causes and the presumption of a biologically acceptable risk of infant death gave way to perceptions that a cause for all illnesses could be diagnosed and that these causes of disease constituted social problems that could be resolved.

Swedish naturalist Carolus Linnaeus (1707–1778), best known for his botanical classifications, attempted to provide a systematic classification of diseases during that period. His classification is notable for including a broad range of morbidity conditions, including functional health limitations (loss of movement, impeded motion, etc.) and mental health conditions as they were understood at the time (delirium, melancholia, bulimia, etc.). In a fashion similar to his botanical classification, Linnaeus designated genera, species, and subspecies of disease. Not surprisingly, his classification is not predicated on a single classificatory principle. Linnaeus did emphasize symptomatology. However, his classification reflects elements of alchemy, astrology, and the prevailing miasmatic environmental view of disease. Other, similar classification attempts by individual physicians of that time (e.g., Francois Bossier de Lacroix's *Nosologia Methodica* and William Cullen's *Classification*) were not theoretically grounded and did not embody a clear notion of symptoms derived from causal agents. Arguably, the effect was to produce complex nosologies, competing classifications, and confusion.

The Nineteenth Century and the Advent of Germ Theory

Competing conceptions of disease were and still are also rooted in strongly held social hypotheses and are debated in the context of political, economic, and religious interests. The establishment over the course of the early nineteenth century of various "centres of calculation" in England, including the General Register Office (GRO), the Alkali Inspectorate, and the inspectors of the Passenger Acts and Factory Acts, provided a governmental context for often lively debates about the development of morbidity and mortality measurement (Bartley et al. 1997). Social Darwinists, using the concepts developed by the scientist Francis Galton, even challenged the wisdom of efforts directed at reporting and eradicating all diseases, especially the apparently "selective" preponderance of infant deaths among the poor. The rising influence of insurance companies and the actuarial trades generated corporate and economic interest in accurate statistics. However, related implications for the payment of benefits probably added to local and familial pressures to record and report information selectively. Religious institutions, including both the Anglican Church and non-Anglican denominations, had a vested interest in the registration of vital events and in conceptions of disease that included moralistic and attributional causation. Even in the present time diseases are often considered to be caused by moral failings on the part of those who suffer their effects.

The early foundations of disease classification reflected both the sociopolitical context of the nineteenth century and the contest between highly moralistic conceptions of the underlying cause of disease and principles of scientific reporting and classification. Popular conceptions of disease in turn influenced many public health initiatives, which frequently were directed toward improving the moral behaviors (idleness, drunkenness, etc.) of the lower classes that were considered the cause of their suffering.

Despite an early understanding of the infectious nature of many diseases, through most of the nineteenth century classifications of disease were not informed by the concepts of germ theory. Instead, the major prevailing concepts of disease were grounded in the remnants of a miasmatic view of disease. For many diseases the idea of disease vectors and infectious transmission came slowly. Poisonous vapors, atmospheres, environments, and toxins were conceived to be responsible for even infectious diseases. Edwin Chadwick's etiological hypothesis, which stated that poverty and environmental conditions including sanitation were primarily responsible for harmful disease environments, refined the miasmatic view and shaped the sanitary movement in England.

In midcentury, the prevailing nosological classification treatise in America was Daniel Drake's *Systematic Treatise,* which arranged diseases into five large classes (autumnal fevers, yellow fever, typhus fevers, eruptive fevers, and phlogistic fevers) and was strongly influenced by a miasmatic or environmental conception of disease. Drake's *Treatise* differed, however, from the work of many of his predecessors in visualizing at least some diseases (e.g., cholera and malaria) as being due to minute animalcules or germs that typified various environments. In fact, germ theory represented a rapid but not unanticipated transformation. Many physicians and scientists were rethinking the pathology of diseases over the last half of the nineteenth century. The two names that are most commonly associated with the new germ theory are those of Robert Koch and Louis Pasteur. Koch's bacterial swab test for the tuberculin bacillus and Pasteur's work on surgical septicemia and rabies were among the major medical developments that quickly altered both clinical practice and the widespread conceptions of disease among practitioners. The bacterial age of medicine, perhaps more than any subsequent medical development, altered fundamental conceptions of disease. The external miasmatic locus of disease became internal, the moral became the biological, the natural became seemingly preventable, and a new medical science was enshrined in both concepts and regulatory institutions.

Regulation of Statistical Reporting and the Evolving Quality of Classifications

The later nineteenth century was also a period of dramatic change in the statistical reporting of diseases. After the British adoption of civil registration (1837) and the formation of the American Statistical Association in Boston (1839), Massachusetts in 1842 became the first state to implement a modern record-keeping system for deaths and cause of death information in the United States. Over the next half century changes in both reporting institutions and classifications of disease were dramatic. For example, the nomenclature for tuberculosis, the leading nineteenth-century killer throughout much of the Western world, evolved in regard to recorded deaths, as shown in Table 1 for two Massachusetts mill towns, Northampton and Holyoke. In 1850 all these deaths were recorded as being due to consumption. By 1880 the vast majority were labeled phthisis, a term that had long been in use. Eventually, after the advent of Koch's bacterial test and an international classification of diseases (1900), virtually all such deaths were labeled using the still-current nomenclature of pulmonary tuberculosis.

Despite the evolving nomenclature, the recorded causes of death also demonstrate continuing social biases. Gender, ethnicity, occupation, and wealth and other social distinctions were associated with both the likelihood of attributing specific diagnoses to individuals and the quality of reported diagnoses as modern classification systems evolved. Three-quarters of the reports of deaths from unintentional injuries to men, for example, gave informational circumstances of the accident, while only a third of those for women included such qualifying information. Even for infectious diseases within similar age ranges, such as tuberculosis deaths in persons age 15 to 64, men were significantly more likely to have more detailed diagnoses recorded. Riess (1997) identifies the major changes in recording the causes of death over the nineteenth century as being due to (1) the shifting ecology of disease, (2) shifting definitions of health and disease, (3) shifting definitions of death and causes of death, (4) the changing construction of death records, and (5) changes in the use of medical statistics. To these factors should be added the dramatic changes in population composition such as those resulting from the aging, urbanization, immigration, and industrialization of the Western world.

TABLE 1

Percentage of Deaths in Northampton and Holyoke, Massachusetts, for Selected Literal Causes, 1850–1912

Years	Consumption	Phthisis	Tuberculosis
1850–1852	22.44	0.00	0.00
1860–1862	18.69	3.16	0.00
1870–1872	13.40	1.26	0.00
1880–1882	4.88	9.90	0.46
1900–1902	1.51	3.02	4.75
1910–1912	0.11	0.88	6.57

SOURCE: Compiled by author.

The ICD Family of Disease Classifications and Professional Nosology

As medical science and reporting systems advanced, so did demands for a standardized classification of diseases for both clinical and statistical purposes. A number of medical statisticians, including William Farr (1807–1883), the Register General of the GRO, and French physician Jacques Bertillon (1851–1922), attempted to provide more refined classifications of disease and establish the principles on which classifications were based. The notable efforts of Bertillon to refine a classification of diseases using principles informed by germ theory were dramatically advanced when the French government convened in 1900 the first international conference to revise and promote the Bertillon International Classification of Causes of Death (ICD). Successive conferences were held by the French government in 1909, 1920, 1929, and 1938. The continued standardization and development of a central family of classifications was ensured in 1946 when the International Health Conference entrusted the World Health Organization (WHO) with the responsibility for the sixth revision of the International Lists of Diseases and Causes of Death and expanded the classification to include nonfatal diseases.

The WHO has maintained responsibility for the ICD family of disease classifications, the most widely used system for nosology. The ICD (current version in use in 2003 is 10) is a generic disease classification used for most cause of death nosology (list of diseases). However, clinical modifications (currently ICD 9cm) and special-purpose nosologies (e.g., ICD-0 for oncology and ICF for functioning, disability, and health), modeled after the ICD, are also widely used. As demands for contextual and qualifying information have increased in the last several decades, the basic ICD codes for diseases have been extended with additional qualifying codes. For example, V codes were added to record reasons for encounter or factors related to health status, E codes to record external causes of injury and ill health, M codes for the morphology of neoplasms, and so on. This entire ICD family of classifications is maintained by the WHO in cooperation with collaborating centers throughout the world that sometimes offer their own embellishments.

Although disease classification systems have a long history, professional nosology involving the coding of diseases from literal diagnoses expanded dramatically in the last half of the twentieth century. Many hospitals began experimenting with clinical use of the 1948 ICD. In 1962 the U.S. Public Health Service produced an adaptation (ICDA) for use in hospital records. This was followed by ICD8 and ICD9cm for clinical use. However, nosologists were often considered clerical workers who performed a necessary but only tolerated task. The profession achieved stature in the late twentieth century as the critical importance of the efforts of its practitioners to medical research became clear. However, nosology has begun to decline once again in the face of an increasing use of electronic records and the growing promise of automated nosology.

The Predictability of Change in Concepts and Classifications

The evolving history of disease and the growth in knowledge of diseases guarantee continual change in both concepts and classifications of diseases. Those conceptions and classifications have experienced and reflected radical changes in underlying etiologies, shifting sociopolitical environments, the changing composition of host populations, and the growing social organization of medicine. Just as the advent of germ theory had a strong influence on conceptions and classifications of diseases in the nineteenth century, advancing knowledge of diseases will continue to change conceptions and classifications in the twenty-first century.

The genomic revolution, bringing profound advances in understanding the genetic foundations of disease, is one likely source of such change (Cantor and Smith 1999). Another source is the still-controversial advances in evolutionary biology, which threaten to erode entrenched boundaries between infectious and noninfectious, or chronic and acute, diseases (e.g., Ewald 2000). A third source of change will be trends in the incidence and nature of diseases themselves and in their host populations. The growing impact of poorly defined chronic conditions that are relegated to residual, symptomatic diagnoses, such as Alzheimer's disease, fibromyalgia, Gulf War syndrome, and chronic fatigue, challenges existing concepts and classifications. The increasing age, growing urbanism, declining fertility, and changing socioeconomic and occupational composition of the world's population will alter the emphases placed on different groups of diagnoses. Even among conditions that once were assumed to be well understood, such as childhood asthma, trends in disease challenge existing etiologies. Indeed, an overly rigid adherence to diagnostic classifications inherited from the nineteenth century may occasionally be an obstacle to future growth in the understanding of disease, just as heavily moral and religious conceptions of disease retarded the advancement of germ theory and the development of current concepts and classifications.

See also: *Bertillon, Jacques; Causes of Death; Disease, Burden of; Farr, William.*

BIBLIOGRAPHY

Armstrong, David. 1986. "The Invention of Infant Mortality." *Sociology of Health and Illness* 8(3): 211–232.

Bartley, George, Davey Smith, and David Blane. 1997. "Vital Comparisons: The Social Construction of Mortality Measurement." In *The Sociology of Medical Science and Technology,* ed. M. A. Elston. Oxford, Eng.: Blackwell.

Cantor, Charles R., and Cassandra L. Smith. 1999. *Genomics: The Science and Technology behind the Human Genome Project.* New York: Wiley.

Cassedy, James H. 1986. *Medicine and American Growth 1800–1860.* Madison: University of Wisconsin Press.

Commission Internationale Chargée de Reviser les Nomenclatures Nosologiques. 1903. *Nomenclatures des Maladies (Statistique de Morbidité—Statistique des Causes de Décès) avec Notices et Annexes par Jacques Bertillon.* Mountévrain: Impr. Typographique de l'Ecole d'Alembert.

Ewald, Paul. 2000. *Plague Time: The New Germ Theory of Disease.* New York: Anchor Books.

Foucault, Michel. 1963. *The Birth of the Clinic: An Archeology of Medical Perception.* London: Tavistock.

Hacking, Ian. 1975. *The Emergence of Probability.* Cambridge, Eng.: Cambridge University Press.

Hess, Volker. 1993. *Von der Semiotischen Zur Diagnostischen Medizin: Die Entstehung der Klinischen Methode zwishen 1750 und 1850. Aghandlungen zur Geschichte der Midizin und der Naturwissenshaften, No. 66.* Husum, Germany: Matthiesen Verlag.

Riess, Günter B. 1997. "Cause of Death as a Historical Problem." *Continuity and Change* 12: 175–188.

Starr, Paul. 1982. *The Social Transformation of American Medicine.* New York: Basic Books.

Douglas L. Anderton

DISEASE AND HISTORY

Like climate and geography, disease belongs to a category of influences whose importance is easy to acknowledge but difficult to specify. It is indisputable that disease is an important human experience that occupies time; causes discomfort, pain, and death; diverts resources from other uses; and may kill individuals or groups of people at critical moments. However, it is difficult to decide how much weight to assign to the disease experience, show that resources diverted to coping with disease would otherwise have been deployed in a particular way, or prove that a death or many deaths altered the course of events. The historical challenge that disease poses is evident in the two levels on which historians discuss the issue.

Two Views of Disease

On one level, disease has monumental significance. According to Roy Anderson and Robert May, infectious diseases have been "the most significant agents of natural selection acting on human populations since the. . .agricultural revolution." Because Europeans, Asians, and Africans shared a particularly competitive disease pool, they carried with them to the Americas, Australia and New Zealand, and the Pacific islands an advantage of prior exposure to many diseases as well as diseases new to those territories that caused sickness and death in virgin-soil populations. Andrew Nikiforuk claims that "an alarming tide" of new and resurgent diseases threatens in the twenty-first century to undo human gains in material comfort, population size, and longevity. Disease plays the role of a Greek god, powerful but unpredictable. For Nikiforuk, the presence of malaria accounts for the decline of the civilization of classical Greece and its absence accounts for rapid population growth and civil war in modern Sri Lanka. The fourteenth-century Black Death made English the language of intellectual discussion and created the commercial revolution. The main actors in this drama are dread diseases—leprosy, plague, smallpox, and syphilis—that kill and maim and diseases known for the vast range of their effects, such as malaria, tuberculosis, and influenza. On this level disease is given an implausible degree of credit, and the cause-and-effect relationships remain indecipherable and murky.

On the other level, disease appears as a background force with profound but unspecifiable importance and is given implausibly little credit as a historical force. Nevertheless, it is on this level that the most useful insights have been acquired. Three approaches merit discussion here. First, there is the history of attempts to explain disease, all of which have proved unsatisfactory or incomplete. Second, there is the increasingly rich history of diseases: the profile of maladies that cause sickness and death. Third, there is the deployment of information about disease as a cause of sickness and death in an attempt to diminish morbidity and mortality.

Explaining Disease

In written history attempts to explain disease date from classical antiquity. Hippocrates, in a summary of older traditions, incriminated airs, waters, and places: the complex of environmental circumstances in which people live. The Ayurvedic tradition in India and the Greek physician Galen, working in the second century C.E., pointed instead to imbalances in the body among entities called humors. Hippocratic ideas emphasized the usefulness of avoiding certain things, such as swamps, whereas Ayurvedic-Galenic ideas pointed to medical treatment and to behaviors designed to conserve health. In the West the Galenic tradition carried more weight until the late seventeenth century, when the physician Thomas Sydenham and others revived Hippocratic ideas. From the claim that environmental forces, perhaps especially the decomposition of organic matter, give rise to disease and from the allied idea that diseases are transmitted through the air arose the notion of controlling disease by cleansing the environment. That laid the foundations of public health, which initially, after 1840, was directed less often at disease matter carried in the air than at such matter carried in water, especially water contaminated with human waste.

Two contrary explanations for disease and its transmission arose in the nineteenth century. First, after noticing the disease-ridden life of impoverished urban residents, protomedical sociologists incriminated crowding, bad housing, a lack of air and sunlight, and other circumstances of the urban environment as disease enablers or provocateurs, although not agents. Asiatic cholera and tuberculosis, the first a fearsome epidemic disease and the second the leading cause of death in Western Europe in the nineteenth century, fit this conception of disease causation and transmission. Second, evidence began to accumulate in mid-century that specific disease agents could be identified, and not just for a few diseases. By the 1890s the scientists Louis Pasteur and Robert Koch had identified enough germs to give precedence to the idea that specific diseases are caused by specific pathogens. Germ theory temporarily displaced the conditions of poverty as the leading explanation for disease, even though the germ theorists initially claimed far too much, associating germs with all diseases and failing to clarify the process of causation.

None of these ideas has maintained its dominance. Germ theory reigned from about 1890 to about 1970 before giving way to a revival of modernized humoral ideas that stress the individual's responsibility to conserve health. It encountered difficulty in explaining why lower socioeconomic groups so often die earlier and suffer more sickness than do elites, even in social democracies. At the end of the twentieth century these three traditions—humoral, sociological, and biomedical—all played important roles in explaining disease.

Profiling and Theorizing about Disease

More and more research attention was directed toward discovering the major diseases of the past. Scientists learned how to detect specific diseases from skeletal remains, complementing the insights of morbid pathology into the postmortem signs of disease first acquired in the early nineteenth century. Researchers also learned how to decode some of the diseases mentioned vaguely in historical texts, recognizing tuberculosis, typhus, bubonic plague, dysentery, and some forms of heart disease. They learned how to construct profiles of the major diseases and injuries causing sickness and death for a few areas in the seventeenth and eighteenth centuries and for many more areas of the world in the nineteenth century.

This research, which remains in progress, has produced a general description of evolution in the leading causes of death in recent times, a description that has some theoretical elements and is associated with the name of the demographer Abdel Omran and the idea of epidemiologic transition. Omran's original formulation identified three disease eras: one of pandemic infections, another of receding pandemics, and a third dominated by chronic diseases of the body organs. Death rates declined in the second and third stages, giving rise to population growth and increased longevity.

More recently the term *health transition* has been used to describe these phenomena. Under that term scholars have tried to add to the theoretical understanding of change over time in the identity of diseases causing sickness and death and to learn more about how to control and manage disease. Health transition theory also corrects some of the misleading elements of older ideas: Pandemics did occur in the distant past, but they were not the major killers, which instead were commonplace diseases that are mostly familiar in the early twenty-first century. This new approach also has been able to assimilate many important distinctions in regard to disease and its avoidance, such as exposure and resistance, nutritional status while sick, and immune status. However, there is still nothing available to formulate a general theory of disease in the past.

Collecting Information about Disease

Whereas informed eighteenth-century medical commentators in the West preferred the idea that diseases are inconstant, capable of changing in the same person from one day to the next, and nonspecific in their origins, the idea arose in the nineteenth century that diseases are specific, having particular causes, pathways, periods of incubation, durations, lethalities, biases by sex and age, and other distinctive characteristics. One effect of this idea was the promotion of efforts to create disease taxonomies, which led to the development at the century's end under French guidance of an international scheme of disease classification. By the end of the twentieth century that scheme had evolved through ten editions into a classification of diseases and injuries under 26 headings, each with many subdivisions.

Progress in identifying diseases; uncovering the postmortem signs of disease as well as the signs, symptoms, and chemistry of disease among the living; and classifying diseases increased the importance of knowing the diseases that were said to cause sickness and death. Some countries and cities had long tried to collect information about diseases causing death; that effort gained momentum in the nineteenth and early twentieth centuries, at least among rich countries that could afford the required investment of expertise and money. However, most of the world's population remained undiagnosed in regard to the causes of death. Even in rich countries the causes of most sickness episodes were not recorded. Some diseases were "notifiable," especially communicable diseases about which early warning was wanted. However, the sicknesses of everyday life and many noncommunicable diseases and injuries were poorly counted and recorded. Nevertheless, this idea led to an effort to produce a schedule of all the diseases in the world causing sickness and death, rank them by their scale and effect and perhaps also by their preventability or treatability, and then try to reduce the number of unnecessary deaths from about 54 million persons a year across the globe around 2000 to the 30 million or fewer that would take place if all the world were as well served by disease prevention as the rich countries are.

Disease remains a threat in the present and the future. Too many people, especially infants and children, die each year in light of the degree of human understanding of disease and the potential to control it. There is also too much sickness, much of which could be avoided through less poverty, the application of public health measures and medical knowledge and by a global population better informed about germ theory and risk factor theory. Moreover, there remains the threat of new or resurgent diseases that could defy the means of control currently available. Nevertheless, what is most remarkable about disease and history is the marked retreat of disease since about 1800. It is principally the waning of communicable diseases, especially diseases of childhood, that accounts for the rising life expectancy of the last 200 years, arguably the most important achievement of humankind during that period.

See also: *Black Death; Epidemiological Transition; Health Transition; Mortality Decline; Tuberculosis.*

BIBLIOGRAPHY

Anderson, Roy, and Robert May. 1991. *Infectious Diseases of Humans: Dynamics and Control.* Oxford: Oxford University Press.

Bobadilla, José Luis, Julio Frenk, Rafael Lozano, et al. 1993. "The Epidemiologic Transition and Health Priorities." In *Disease Control Priorities in Developing Countries,* ed. Dean T. Jamison, W. Henry Mosley, Anthony R. Measham, José Luis Bobadilla, et al. Oxford: Oxford University Press.

Crosby, Alfred. 1972. *Columbian Exchange: Biological and Cultural Consequences of 1492.* Westport, CT: Greenwood.

Hays, J. N. 1998. *The Burdens of Disease: Epidemics and Human Response in Western History.* New Brunswick, NJ: Rutgers University Press.

Johansson, S. Ryan, and Carl Mosk. 1987. "Exposure, Resistance, and Life Expectancy: Disease and Death during the Economic Development of Japan, 1900–1960." *Population Studies* 41: 207–235.

Karlen, Arno. 1996. *Man and Microbes: Disease and Plagues in History and Modern Times.* New York: Putnam.

Kiple, Kenneth F., ed. 1993. *The Cambridge World History of Human Disease.* Cambridge, Eng.: Cambridge University Press.

———. 1997. *Plague, Pox, and Pestilence.* New York: Barnes & Noble.

McNeill, William. 1977. *Plagues and Peoples.* Garden City, NY: Anchor.

Murray, Christopher J. L., and Alan D. Lopez, eds. 1996. *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020.* Cambridge, MA: Harvard University Press.

Nikiforuk, Andrew. 1992. *The Fourth Horseman: A Short History of Epidemics, Plagues and Other Scourges.* London: Fourth Estate.

Omran, Abdel. 1971. "The Epidemiologic Transition: A Theory of the Epidemiology of Population Change." *Milbank Memorial Fund Quarterly* 49: 509–538.

Riley, James C. 2001. *Rising Life Expectancy: A Global History.* Cambridge, Eng.: Cambridge University Press.

James C. Riley

DISEASES, CHRONIC AND DEGENERATIVE

Chronic and degenerative diseases (CDDs) are morbid pathological processes characterized by slow development, long duration, and gradual deterioration in the functioning of the affected tissue, organ, or

TABLE 1

Revision Dates for the International Classification of Diseases (ICD)

Period in Use	ICD Revision	U.S. Adaptation for Morbidity
1949–1957	ICD-6	
1958–1967	ICD-7	
1968–1978	ICD-8	ICDA-8
1979–1998	ICD-9	ICD-9-CM
1999 and after	ICD-10	ICD-9-CM

SOURCE: NCHS (2001).

organ system. These diseases generally involve asymptomatic preclinical stages, gradual progression to manifest symptoms, and terminal stages ranging from mild discomfort to lethality. Their incidence is correlated with age and in many cases is approximately proportional to the fifth, sixth, or seventh power of age. Their durations typically extend from the time of the initial symptoms to the time of death. Their prevalence reflects the cumulative effects of incidence and duration. They can kill afflicted individuals in a variety of ways. For example, persistent high blood pressure (hypertension, a chronic condition) is a risk factor for stroke (an acute manifestation of cerebrovascular disease), which may be lethal if it is not treated immediately.

CDDs are generally noncommunicable (noninfectious). There are numerous exceptions, however, including AIDS, which is caused by human immunodeficiency virus types 1 and 2 (HIV-1 and HIV-2); stomach ulcers/cancers caused by the bacterium *Helicobacter pylori*; liver cancers caused by hepatitis B virus; and cervical cancers caused by human papillomaviruses. Other significant pathogens include herpes simplex virus types 1 and 2 (possibly linked to Alzheimer's disease and schizophrenia), human herpes virus 6 (possibly linked to multiple sclerosis), and *Chlamydia pneumoniae* (possibly linked to Alzheimer's disease and heart disease).

Classification of Diseases

The International Classification of Diseases (ICD) is a statistical classification system for mortality and morbidity that is maintained and updated every one or two decades by the World Health Organization (WHO). The periods covered by the last five revisions and their adaptations for use in the United States are listed in Table 1.

The ICD-9-CM (clinical modification) adapts the ICD for hospital indexing and other clinical uses, adding codes for factors that influence health status and contact with health services. The alphabetical indexes of the ICD-9 and ICD-9-CM contain approximately 60,000 and 75,000 distinct diagnostic entries, respectively. In practice, however, 1998 U.S mortality files indicate that the ICD-9 describes approximately 5,600 causes of death.

Causes of Death

Estimates of the incidence and prevalence of major CDDs are limited by the progressive nature of those diseases and the lack of disease registries covering the population. Consequently, substantial use is made of cause of death data from national vital statistics files. These data are coded according to WHO protocols embodied in the ICD's underlying cause selection rules, where the underlying cause of death is defined as "(a) The disease or injury which initiated the train of events leading directly to death, or (b) the circumstances of the accident or violence which produced the fatal injury" (WHO 1975).

An important limitation is that each tabulated underlying cause of death is an aggregation of etiologically distinct diseases. For example, the top 15 underlying causes of death at age 65 and older in the United States in 1998, with the range of ICD-9 codes indicated in parentheses, were:

1. Heart diseases (390–398, 402, 404–429)
2. Malignant neoplasms (140–208)
3. Cerebrovascular diseases (430–438)
4. Chronic obstructive pulmonary diseases (490–496)
5. Pneumonia and influenza (480–487)
6. Diabetes mellitus (250)
7. Accidents and adverse effects (E800–E949)
8. Nephritis, nephrotic syndrome, and nephrosis (580–589)
9. Alzheimer's disease (331.0)
10. Septicemia (038)
11. Aortic aneurysm (441)
12. Atherosclerosis (440)
13. Hypertension (with or without renal disease) (401 and 403)
14. Chronic liver disease and cirrhosis (571)
15. Suicide (E950–E959)

These 15 causes accounted for 87 percent of deaths among the elderly in 1998. Only pneumonia/influenza and septicemia (numbers 5 and 10) are clearly infectious in nature, accidents and adverse effects (number 7) may involve chronic debilitation and treatment (e.g., hip fracture), and suicide (number 15) is associated with depression and chronic mental illness. The remaining 11 causes represent predominantly noninfectious CDDs, accounting for 79 percent of deaths. All 15 "causes" are aggregations of distinct elementary disease/injury components.

Another limitation is that each death can have only one tabulated underlying cause—the one cause that supposedly initiated the train of events leading directly to death. To the extent that there are other, nonunderlying ("contributory") causes indicated on the medical condition field of the death certificate, there is additional information on the impact of CDDs over time and across populations. For example, the top five nonunderlying causes of death at age 65 and older in the United States in 1998 were heart diseases (number 1 above), hypertension (number 13), chronic obstructive pulmonary diseases (number 4), diabetes mellitus (number 5), and cerebrovascular diseases (number 3). Malignant neoplasms (number 2) were ranked ninth. Furthermore, the joint three-way occurrence of heart diseases, hypertension, and diabetes mellitus on the death certificates was 3.3 times higher than expected, assuming independent causes. Combined with cerebrovascular diseases, the joint four-way occurrence was 11.8 times higher than expected under conditions of independence. Similar results for other cause combinations demonstrate that nonunderlying causes reflect complex processes and distinctive patterns of joint dependence. Conversely, these results indicate that analytic models based on independent causes (e.g., multiple decrement life tables) may be substantially biased.

A third limitation relates to the accuracy of reported causes of death. Autopsy and medical record studies show that accuracy decreases across the categories of malignant neoplasms, heart diseases, and cerebrovascular diseases, with substantial variation within each category. Most errors are due to incorrect diagnoses and incorrect sequencing of the underlying cause when multiple and possibly interacting diseases are operating at the time of death.

TABLE 2

Life Expectancy at Age 65 in the United States and Japan, Selected Years 1950–1998

	Males		Females	
Year	U.S.	Japan	U.S.	Japan
1950–1951	12.8	11.3	15.1	13.3
1970	13.1	12.5	17.0	15.3
1980	14.0	14.6	18.3	17.7
1998	16.0	17.1	19.2	22.0

SOURCE: Preston et al. (1972); Kinsella and Velkoff (2001).

Mortality Statistics

Seventy-five percent of deaths in the United States in 1998 occurred at age 65 and older, and this rate is gradually increasing. Most deaths involved CDDs as underlying or contributory causes. The average reported number of causes was 2.0 per 1998 U.S. death at ages 65 to 94, 1.9 at ages 95 to 99, and 1.8 at ages 100 and older. When stratified by underlying cause, the averages ranged from 1.8 for malignant neoplasms to 2.9 for diabetes mellitus. Different causes exhibited different patterns of change over age and time and unique multiway associations consistent with their nature as distinct, related physiological processes.

Quantification of temporal changes in CDDs presents major challenges because of the lack of comprehensive models. Summary measures based on total and cause-specific life tables generally are used for public policy planning. For example, recorded life expectancies at age 65 in the United States and in Japan since the middle of the twentieth century for selected years are shown in Table 2.

Life expectancy at age 65 increased significantly after 1950 in both countries, but the relative increases in Japan were more than double those in the United States, with the largest differences being for females in the period 1980–1998. Comparisons of age and cause patterns of mortality in the United States, Japan, and Sweden have shown that the U.S. cause, but not age, pattern was similar to Sweden's. In a 1988 study Machiko Yanagishita and Jack Guralnik identified declines in cerebrovascular and heart diseases as the primary reasons for Japan's surpassing Sweden in the mid-1970s as the top-ranked country in life expectancy. The top three causes of death in Japan during 1965–1980 were cerebrovascular diseases, malignant neoplasms, and

TABLE 3

Age-Standardized Death Rates in the United States: Top Four Underlying Causes, Selected Years 1950–1998

Underlying Cause	1950	1970	1980	1998
Heart diseases	586.6	492.7	412.1	272.4
Malignant neoplasms	193.9	198.6	207.9	202.4
Cerebrovascular diseases	180.7	147.7	96.4	59.6
Chronic obstructive pulmonary diseases	N/A	28.3	37.2	42.0

SOURCE: NCHS (2001).

heart diseases. Japanese statistics through 1999 show that malignant neoplasms have replaced cerebrovascular diseases as the top-ranked cause of death and that heart diseases have replaced cerebrovascular diseases in the second-place ranking.

Comparisons of mortality patterns within and between countries must consider changes in incidence, prevalence, duration, severity, and treatment of the various CDDs. Each one exhibits unique patterns consistent with the complex and heterogeneous nature of the underlying disease processes. For example, the temporal changes in age-standardized underlying cause death rates (per 100,000 population) for the top four causes identified above for the U.S. are shown in Table 3.

The table clearly shows that the patterns of change differ significantly by cause, with large relative declines for cerebrovascular and heart diseases, a trend reversal for malignant neoplasms, and large relative increases for chronic obstructive pulmonary diseases.

Morbidity Measures

Recognition of the complex nature of CDDs has led to the development of procedures for summarizing the population health impact of these diseases in ways that do not require full specification of the relevant physiological processes. These procedures generally employ age-specific prevalence estimates from national health surveys and epidemiological studies that are combined with life-table statistics, using the method developed by Daniel Sullivan in 1971. For example, Diane Wagener and her colleagues used this method in a 2001 study to estimate that 17 percent of male life expectancy and 19 percent of female life expectancy at birth in the United States in 1995 was lived with some degree of activity limitation as a result of chronic health conditions.

In a 1996 study Christopher Murray and Alan Lopez presented comprehensive analyses of the morbidity and mortality burden of lethal and nonlethal diseases for developed and developing countries worldwide. Those authors extended Sullivan's method to measure disease burden two ways: (1) using *disability-adjusted life expectancy* (DALE), which is the expected number of years of life lived in full health, and (2) using *disability-adjusted life years* (DALYs), which are additive, time-weighted measures of the severities of specific diseases, including years of life lost to premature deaths from lethal diseases.

Murray and Lopez reported that 86 percent of deaths in developed countries in 1990 were due to noncommunicable diseases (i.e., noninfectious CDDs), with 22 to 25 percent of remaining life expectancy at age 60 spent disabled. Corresponding results for developing countries indicated that 47 percent of deaths were due to noncommunicable diseases, with 31 to 48 percent of remaining life expectancy at age 60 spent disabled. Murray and Lopez projected that the global fraction of deaths from noncommunicable diseases would rise from 55 percent in 1990 to 73 percent in 2020 (from 86 percent to 89 percent in developed and from 47 percent to 70 percent in developing countries). They provided quantitative estimates of the impact on DALYs of a range of disease risk factors, including alcohol, tobacco, illicit drugs, air pollution, inadequate sanitation, physical inactivity, and malnutrition.

In a 2000 study Colin Mathers and his colleagues estimated DALEs for 191 countries: Japanese females and males were both top ranked within the respective sex, followed by French females and Swedish males, respectively.

Morbidity/Mortality Pathways

Studies of monozygotic and dizygotic twins indicate that 25 to 30 percent of variability in the length of life is heritable. Heritable single-gene defects produce 1,500 distinct, rare diseases, 98 percent of which emerge by age 50. Natural selection accounts for their rarity; existing equilibriums may be altered by effective medical treatments.

Factors contributing to the nonheritable 70 to 75 percent of length of life variability include environmental, nutritional, behavioral, and lifestyle influences beginning with fetal, postnatal, and childhood development; socioeconomic and demographic factors such as race/ethnicity, gender, education, income, occupation, stress, social support, and other social conditions; and epidemiologic risk factors such as diet, exercise, weight, tobacco, alcohol, cholesterol, and blood pressure.

Continued progress against major CDDs can be expected to result from improved understanding of the pathways through which CDDs develop, innovative forms of primary prevention, and medical diagnostic and pharmaceutical treatment protocols that permit disease detection and treatment at successively earlier stages in the morbid process.

See also: *Cancer; Cardiovascular Disease; Disease, Burden of; Epidemiological Transition; Mortality Decline.*

BIBLIOGRAPHY

Fogel, Robert W., and Dora L. Costa. 1997. "A Theory of Technophysio Evolution, with Some Implications for Forecasting Population, Health Care Costs, and Pension Costs." *Demography* 34: 49–66.

Himes, Christine L. 1994. "Age Patterns of Mortality and Cause-of-Death Structures in Sweden, Japan, and the United States." *Demography* 31: 633–650.

Japan Statistical Yearbook. 2002. Tokyo: Statistics Bureau and Statistics Center, Ministry of Public Management, Home Affairs, Posts and Telecommunications.

Jimenez-Sanchez, Gerardo, Barton Childs, and David Valle. 2001. "Human Disease Genes." *Nature* 409: 853–855.

Kinsella, Kevin, and Victoria A. Velkoff. 2001. *An Aging World: 2001.* Washington, D.C.: U.S. Census Bureau, Series P95/01-1, U.S. Government Printing Office.

Mathers, Colin D., Ritu Sadana, Joshua A. Salomon, Christopher J. L. Murray, and Alan D. Lopez. 2000. "Estimates of DALE for 191 Countries: Methods and Results." *Global Programme on Evidence for Health Policy Working Paper No. 16.* Geneva: World Health Organization.

McKusick, Victor A. 2000. "Online Mendelian Inheritance in Man, OMIM (TM)." Bethesda, MD: McKusick-Nathans Institute for Genetic Medicine, Johns Hopkins University, and National Center for Biotechnology Information, National Library of Medicine.

Murray, Christopher J. L., and Alan D. Lopez. 1996. *The Global Burden of Disease,* Volume 1. Cambridge, MA: Harvard University Press.

National Center for Health Statistics (NCHS). 2001. *Health, United States, 2001: With Urban and Rural Health Chartbook.* Hyattsville, MD: National Center for Health Statistics.

Pennisi, Elizabeth. 2001. "Behind the Scenes of Gene Expression." *Science* 293: 1064–1067.

Preston, Samuel H., Nathan Keyfitz, and Robert Schoen. 1972. *Causes of Death: Life Tables for National Populations.* New York: Seminar Press.

Stallard, Eric. 2002 (in press). "Underlying and Multiple Cause Mortality at Advanced Ages: United States 1980–1998." *North American Actuarial Journal* 6(3).

Strohman, Richard. 2002. "Maneuvering in the Complex Path from Genotype to Phenotype." *Science* 296: 701–703.

Sullivan, Daniel F. 1971. "A Single Index of Mortality and Morbidity." *HSMHA Health Reports* 86: 347–354.

Thompson, Craig B. 1995. "Apoptosis in the Pathogenesis and Treatment of Disease." *Science* 267: 1456–1462.

Wagener, Diane K., Michael T. Molla, Eileen M. Crimmins, Elsie Pamuk, and Jennifer H. Madans. 2001. "Summary Measures of Population Health: Addressing the First Goal of Healthy People 2010, Improving Health Expectancy." *Statistical Notes,* No. 22. Hyattsville, MD: National Center for Health Statistics.

World Health Organization (WHO). 1975. *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, Based on the Recommendations of the Ninth Revision Conference, 1975.* Geneva: World Health Organization.

Yanagishita, Machiko, and Jack M. Guralnik. 1988. "Changing Mortality Patterns That Led Life Expectancy in Japan to Surpass Sweden's: 1972–1982." *Demography* 25: 611–624.

Zimmer, Carl. 2001. "Do Chronic Diseases Have an Infectious Root?" *Science* 293: 1974–1977.

Eric Stallard

DISEASES, INFECTIOUS

Infectious diseases are caused by microbial agents (e.g., bacteria, fungi, parasites, prions, and viruses) or by their toxic by-products. Infectious diseases have been an inevitable and ubiquitous part of life since humans evolved. Although the contagious nature of many diseases had been observed since early in recorded history, the microbial origin of infectious diseases was not scientifically established until the late nineteenth century, when Robert Koch (1843–1910) demonstrated that the bacterium Bacillus anthracis is the causative agent of anthrax infection. Koch set forth four postulates that must be fulfilled to establish the microbial cause of an infectious disease:

1. Identify a specific organism from a patient with the disease;
2. Obtain a pure culture of that organism;
3. Reproduce the disease in experimental animals using the pure culture; and
4. Recover the organism from the infected animals.

Since Koch's time, causative agents and routes of infection have been described for thousands of infectious diseases of humans and animals. The impact of an infectious disease on an individual or animal can range from trivial to fatal. The impact of an infectious outbreak on a society can range from negligible to devastating.

Infectious diseases are undoubtedly among the most powerful factors that influence human demographics. In some cases, the impact of disease has been widespread, direct, and dramatic, as when epidemics and pandemics of plague, syphilis, cholera, and influenza caused substantial and concentrated morbidity and mortality in the fourteenth to twentieth centuries. At other times, the influences have been less direct, as in the late-nineteenth century when trypanosomiasis (African sleeping sickness) rendered large tracts of Africa uninhabitable until its insect vector, the tsetse fly, was controlled.

Classification Systems of Infectious Diseases

Several unofficial classification systems exist for infectious diseases. Some are based on causative agent and others on route of transmission. The following broad categories by causative agent are generally utilized in academic and microbiologic research institutions:

Bacterial diseases (e.g., salmonellosis, tuberculosis, syphilis);

Viral infections (e.g., West Nile encephalitis, measles, chickenpox, poliomyelitis, HIV);

Fungal infections (e.g., yeast infections, histoplasmosis);

Parasitic protozoan (e.g, cryptosporidiosis, malaria) and metazoan infections (e.g., hookworm, onchocerciasis);

Prion diseases (infectious proteins that are the agents of bovine spongiform encephalopathy or "mad cow disease" and Creutzfeldt-Jacob disease in humans); and

Rickettsial diseases (e.g., typhus and Rocky Mountain spotted fever).

Classification of diseases by route of transmission is typically used in public health and prevention-oriented disease control programs. Categories include:

Diseases transmitted from person-to-person, including respiratory illnesses transmitted by coughing (e.g., influenza and tuberculosis) and systemic diseases transmitted via sexual contact (e.g, HIV, syphilis, and gonorrhea);

Food-borne and waterborne diseases, including illnesses transmitted via the fecal-oral route (e.g., typhoid and hepatitis A) or via contaminated water (e.g., cryptosporidiosis and giardiasis);

Bloodborne infections (e.g., hepatitis B and C);

Healthcare-acquired (nosocomial) infections, including surgical wound infections (e.g., staphylococcal infections);

Diseases transmitted by animals or insects, including zoonotic infections (e.g., Escherichia coli H7:O157 and rabies) and vectorborne infections (Lyme disease and yellow fever);

Infections acquired from the environment (Legionnaires' disease, inhaled in water droplets, and coccidioidomycosis, acquired from dust or soil).

Sometimes, vaccine-preventable diseases (such as rubella, mumps, and pertussis—whooping cough), infections of travelers (many diarrheal diseases), and antibiotic-resistant bacterial infections (such as methicillin-resistant Staphylococcus aureus) are regarded as unique categories, as are opportunistic infections (such as Pneumocystis pneumonia and cytomegalovirus retinitis), that are generally restricted to persons with immunodeficiencies. A sad commentary on contemporary society is represented by the category of infectious agents that may be used as biological weapons (including smallpox virus, anthrax spores, and botulinum toxin).

The International Statistical Classification of Diseases and Related Health Problems, issued by the World Health Organization (WHO), is the major official codification of all diseases, conditions, and injuries. The tenth revision (ICD-10) is the latest in a series that began in 1893 as the Bertillon Classification or International List of Causes of Death. The ICD is continually being revised as new conditions, including emerging infections, are described. Every infectious and non-infectious disease of humans is assigned a unique 3-digit number (plus multiple decimal places) in the ICD system. These numbers are used in many medical and public health records, including hospital discharge reports, billing records, and death certificates. The Control of Communicable Diseases Manual, the widely available and standard American Public Health Association handbook of infectious diseases, lists ICD codes for each of the several hundred infectious diseases it describes in its alphabetically arranged entries.

Control of Infectious Diseases in Developed Nations

Rapid progress in control of infectious diseases characterized the late nineteenth and early-twentieth centuries. Deaths from infectious disease declined markedly in the United States during the first half of the twentieth century (see Figure 1). This major demographic change both contributed to, and is reflected in, the sharp drop in infant and child mortality and the more than 30-year average increase in life expectancy at birth achieved over the ensuing years.

In 1900, the three leading causes of death were pneumonia, tuberculosis (TB), and diarrhea and enteritis, which (together with diphtheria) were responsible for one-third of all deaths (see Figure 2). About 40 percent of these deaths were deaths of children below the age of five. Cancer accounted for only 3.7 percent of deaths, because few people lived long enough for it to develop. Coming into the twenty-first century, heart disease and cancers account for almost three-quarters of deaths, with 5 percent due to pneumonia, influenza, and human immunodeficiency virus (HIV), the cause of acquired immunodeficiency syndrome (AIDS).

In 1900, 30.4 percent of children in the United States died before their fifth birthdays; in 1997, the figure was 1.4 percent. Despite this overall progress in the developed world, the twentieth century also witnessed two of the most devastating epidemics in human history. The 1918 influenza pandemic killed more than 20 million people, including 500,000 Americans, in less than a year—more deaths in a comparable time period than in virtually any war or famine. The last decades of the century were marked by the recognition and pandemic spread of HIV, resulting in an estimated 22 million deaths by the year 2000. UNAIDS (the Joint United Nations Programme on HIV/AIDS) projects another 65 million deaths by 2020. These episodes illustrate the volatility of infectious disease death rates and the unpredictability of disease emergence.

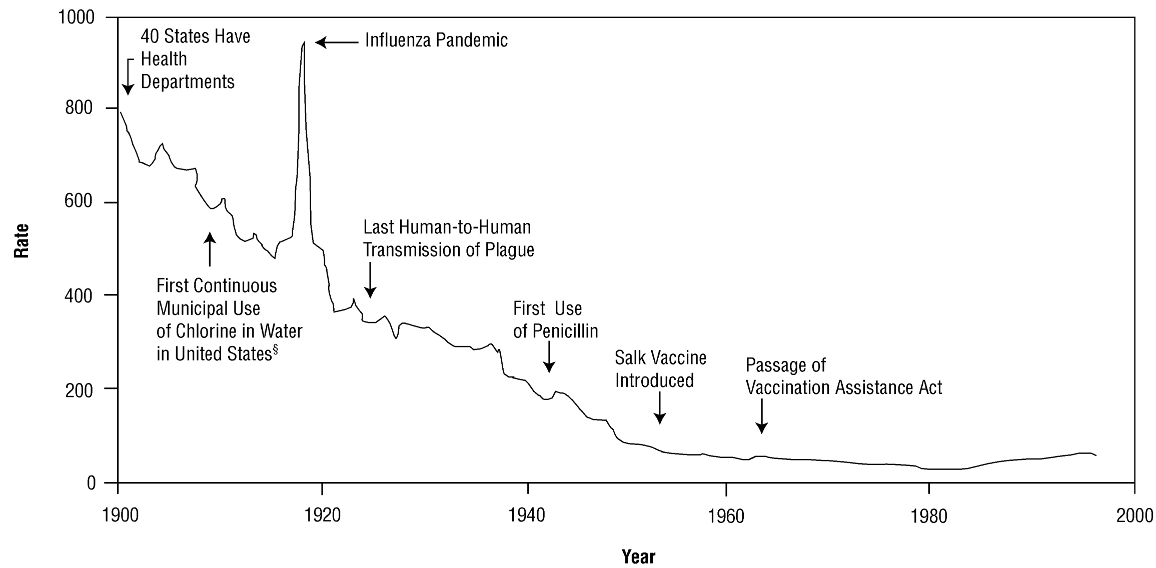
Twentieth century landmarks in disease control in the United States included major improvements in sanitation and hygiene, the implementation of universal childhood vaccination programs, control of food-borne diseases, and the introduction of antibiotics.

Sanitation and hygiene. The nineteenth century shift in U.S. population from country to city that accompanied industrialization, along with successive waves of immigration, led to overcrowding and poor housing. The municipal water supplies and rudimentary waste disposal systems that existed at the time were quickly overwhelmed. These conditions favored the emergence and spread of infectious illnesses, including repeated outbreaks of cholera, TB, typhoid fever, influenza, yellow fever, and food-borne illnesses such as shigellosis.

By 1900, however, the incidence of many of these diseases had begun to decline, due to the implementation of public health improvements that continued into the twentieth century. Sanitation departments were established for garbage removal, and outhouses were gradually replaced by indoor plumbing, sewer systems, and public systems for

FIGURE 1

Crude Death Rate* for Infectious Diseases—United States, 1900–1996



*Per 100,000 population per year.
SOURCE: Adapted from Armstrong G.L.A. Conn, and R.W. Pinner (1999); §American Water Works Association. "Water Chlorination Principles and Practices." 1973. *AWWA Manual M20.* Denver, CO: American Water Works Association.

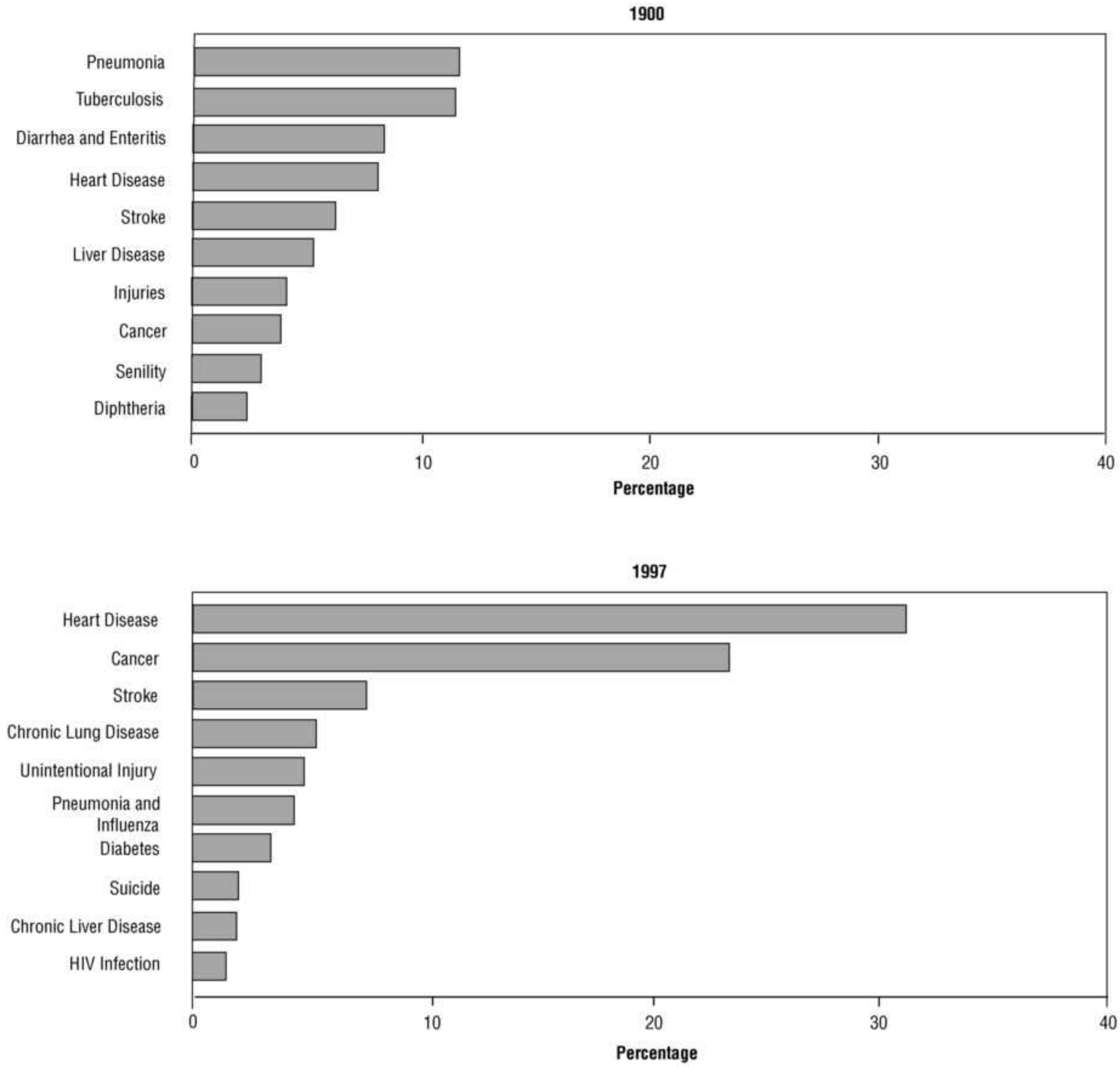
solid waste disposal. The incidence of cholera, which reached its peak between 1830 and 1896, a period during which Eurasia and North America experienced four pandemics, began to fall, as water supplies were insulated from human waste by sanitary disposal systems. Chlorination and other treatments of drinking water began in the early 1900s and became widespread by mid-century, sharply decreasing the incidence of cholera, as well as typhoid fever and other waterborne diseases. The incidence of TB declined, as improvements in housing reduced crowding and TB control programs were put in place. In 1900, TB killed 200 out of every 100,000 Americans, most of them city residents. In 1940 (before the introduction of antibiotic therapy), TB remained a leading killer, but its mortality rate had decreased to 60 per 100,000 persons.

Vaccination programs. The advent of immunization also contributed greatly to the prevention of infectious diseases. Strategic vaccination campaigns virtually eliminated diseases that were common in the United States during the beginning and middle decades of the century—including diphtheria, tetanus, pertussis, polio, smallpox, measles, mumps, rubella, and Haemophilus influenzae type b meningitis. Starting with the licensing of the combined diphtheria-pertussis-tetanus (DPT) vaccine in 1949, state and local health departments began providing childhood vaccinations on a regular basis, primarily to poor children. In 1955, the introduction of the Salk polio vaccine led to the federal appropriation of funds to support childhood vaccination programs initiated by states and local communities. In 1962, a federally coordinated vaccination program was established through the passage of the Vaccination Assistance Act—a landmark piece of legislation that has been continuously renewed and in the early twenty-first century supports the purchase and administration of a full range of childhood vaccines. WHO's Expanded Program on Immunization seeks to extend these benefits globally.

The success of vaccination programs in the United States and Europe gave rise to the twentieth-century concept of *disease eradication*—the idea that a selected disease could be eliminated from all human populations through global cooperation. In 1980, after an 11-year campaign (1967–1977) involving 33 nations, WHO declared that smallpox had been eradicated worldwide—about a decade after it had been eliminated from the United States

FIGURE 2

The 10 Leading Causes of Death as a Percentage of all Deaths—United States, 1900 and 1997



SOURCE: Gerstman, B.B. (1998). *Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology*. New York: Wiley-Liss.

and the rest of the Western Hemisphere. Polio and dracunculiasis (also called guinea worm disease, a waterborne, parasitic non-vaccine-preventable illness) were targeted for global eradication in the early twenty-first century, and many other infectious diseases may be targeted in the future, including measles, Haemophilus influenzae type b infections, filariasis, onchocerciasis, rubella, and hepatitis B.

Control of food-borne diseases. One of the disease control duties assumed by state and local health departments in the twentieth century was the regulation of food handling practices at food processing plants, restaurants, and retail food stores. The need for such regulation is illustrated by the famous story of Typhoid Mary, an Irish immigrant cook and typhoid carrier who worked at a number of New York restaurants in the 1920s and infected more than a hundred people before the New York City health department placed her under house arrest. The story of Typhoid Mary (who was treated very harshly) illustrates not only the growing expectation among Americans that government should promote public health, but also a tendency (which continues to this day) to associate infectious disease problems with immigrants or minority populations, rather than with specific risk factors or behaviors. During the 1980s, for example, the gay community was unjustly blamed for the AIDS epidemic, and in the early 1990s, the Navajo Nation was stigmatized when an outbreak of hantavirus pulmonary syndrome occurred in their community.

The second half of the twentieth century saw a notable rise in illness caused by nontyphoidal Salmonella species, and an explosion of knowledge made possible by modern molecular techniques resulted in identification of a growing list of previously unrecognized, and in some cases, new food-borne and waterborne agents. These include Escherichia coli O157:H7, Campylobacter spp., Cryptosporidium parvum, Listeria monocytogenes, Legionnella spp., and caliciviruses. A 1999 report estimated an annual incidence of 76 million food-borne illnesses in the United States, with 325,000 hospitalizations and 5,000 fatalities. In 1993, the largest outbreak of waterborne illness in U.S. history occurred when an estimated 400,000 persons in Milwaukee, Wisconsin were infected with the parasite Cryptosporidium.

Factors linked to the continued challenges of food-borne and waterborne illnesses include (1) changing dietary habits that favor foods more likely to transmit infection (e.g., raw seafood, sprouts, unpasteurized milk and juice, and fresh fruits and vegetables that may be inadequately washed); (2) globalization of the food supply; (3) mass production practices; and (4) aging and inadequately maintained water supply systems. Mass food production and distribution, while resulting in an abundant and usually safe food supply, has also increased the potential for large and geographically dispersed outbreaks of illness.

Antibiotics. The discovery of the antibiotic penicillin—and its development into a widely available medical treatment—was a major landmark in the control of infectious diseases. Penicillin and other antibiotics that were subsequently developed allowed quick and complete treatment of previously incurable bacterial illnesses. Discovered fortuitously in 1928, penicillin was not developed for medical use until the 1940s, when it was produced in significant quantities and used by the Allied military in World War II to treat sick or wounded soldiers.

Antibiotics have been in civilian use since the end of World War II, and have saved the lives and health of millions of persons with typhoid fever, diphtheria, bacterial pneumonia, bacterial meningitis, syphilis, gonorrhea, plague, tuberculosis, and streptococcal and staphylococcal infections. Drugs have also been developed to treat viral diseases (e.g., amantadine, ribavirin, zidovudine, and acyclovir); fungal diseases (e.g., nystatin, ketoconazole, and amphotericin B); and parasitic diseases (e.g., chloroquine, mebendazole, and metronidazole).

Unfortunately, these therapeutic advances have been tempered by the emergence of drug resistance in bacteria, parasites, viruses, and fungi. Diseases that have been significantly affected by antibiotic resistance include staphylococcal infections, gonorrhea, tuberculosis, pneumococcal infections, typhoid fever, bacterial dysentery, malaria, and HIV/AIDS. Reasons for the swift development of antimicrobial resistance include the natural tendency of organisms to mutate and share genetic material. However, this process has been facilitated by the following factors: (1) injudicious prescribing of antibiotics by the medical, veterinary, and agricultural industries; (2) unrealistic patient expectations resulting in requests for antibiotic treatment of nonbacterial infections; (3) the economics of pharmaceutical sales; and (4) the growing sophistication of medical interventions, such as transplant surgery and chemotherapy, that require the administration of large quantities of antibiotics. Growing antibiotic resistance poses a substantial threat to the gains in infectious disease control and warrants fresh approaches to promoting wise antibiotic stewardship by prescribers, patients, and industry so that the efficacy of these drugs can be sustained for future generations.

Animal and insect control. The twentieth century witnessed major advances in the control of disease transmission by animal and insect pests. In the United States, nationally sponsored, state-coordinated vaccination and animal control programs eliminated dog-to-dog transmission of rabies. Malaria, which had been endemic throughout the Southeast, was reduced to negligible levels by the late 1940s, through regional mosquito control programs that drained swamps and killed mosquito larvae in bodies of water.

The threat of plague epidemics in the United State was also greatly diminished. During the early

1900s, infected rats and fleas were introduced via shipping into port cities along the Pacific and Gulf coasts (e.g., San Francisco, Seattle, New Orleans, Galveston, and Pensacola), as well as into Hawaii, Cuba, and Puerto Rico. The most serious outbreaks occurred in San Francisco from 1900 to 1904 (121 cases/118 deaths) and 1907–1908 (167 cases/89 deaths). The last major rat-associated outbreak of plague in the United States occurred in 1924 and 1925 in Los Angeles. This outbreak, which was characterized by a high percentage of pneumonic plague cases, included the last identified instance in the United States of human-to-human transmission of plague (via inhalation of infectious respiratory droplets from coughing patients).

The introduction of West Nile virus, transmitted from birds to humans via mosquitoes, into North America in 1999 underlined the importance of maintaining insect control programs. In the four years after West Nile virus was first reported in New York City, it had spread to 43 states. Moreover, during the summer of 2002, West Nile virus infections were reported in patients who received organ transplants or blood from infected persons.

Opportunities and Challenges for the Twenty-first Century

Future advances in molecular biology, bioinformatics, and other areas are likely to revolutionize the detection, treatment, control, and prevention of infectious diseases during the twenty-first century. Advances in microbial genomics will enable epidemiologists to identify any microbial species, subtype, or strain within hours or minutes. A detailed understanding of human genetics will help physicians target vaccines and prophylactic drugs to the most susceptible individuals, while improved knowledge of human immunology will stimulate the development of vaccines that not only prevent disease but also boost the immunity of people who are already infected with HIV or other pathogens. Moreover, indepth knowledge of climatic and environmental factors that influence the emergence of animal- and insect-borne diseases (facilitated by the availability of remote sensing technologies) will inform public health policy and allow public health authorities to predict outbreaks and institute preventive measures months in advance.

Although the impact of technology on the control of infectious diseases has been overwhelmingly positive, certain twentieth-century technological advances have created new niches and modes of transmission for particular pathogens; for example: (1) The bacteria that cause Legionnaire's disease have been spread through modern ventilation systems; (2) HIV and hepatitis B and C viruses have been spread through unscreened blood donations; (3) Food-borne diseases like Salmonellosis and E. coli O157 infections have been spread through centrally processed food products that are distributed simultaneously to many states or countries; and (4) Airplanes have replaced ships as major vehicles of international disease spread. More people are traveling to tropical rain forests and other wilderness habitats that are reservoirs for insects and animals that harbor unknown infectious agents. This incursion is due not only to economic development (e.g., mining, forestry, and agriculture), but also to missionary or other volunteer work and an expanded tourist trade that caters to individuals who wish to visit undeveloped areas.

In the United States, increasing suburbanization, coupled with the reversion of agricultural land to secondary growth forest, has brought people into contact with deer that carry ticks infected with Borrelia burgdorferi, the causative agent of Lyme disease, and has brought household pets into contact with rabies-infected raccoons.

A development with potentially profound implication for disease prevention and treatment is the blurring of the distinction between infectious and chronic diseases. Infectious causes may be found for many chronic cardiovascular, intestinal, and pulmonary diseases. Current research suggests that some chronic diseases formerly attributed to lifestyle or environmental factors are actually caused by or intensified by infectious agents. For example, most peptic ulcers—long thought to be due to stress and diet—are now known to be caused by the bacterium Helicobacter pylori. Several types of cancers, including some liver and cervical cancers, are linked to infectious agents. Chlamydia pneumoniae infection has been proposed as a contributor to coronary artery disease, and enteroviruses appear to be associated with type 1 diabetes mellitus in some children. Thus, in the future it is possible that some forms of cancer, heart disease, and diabetes, may be treated with antimicrobial drugs or prevented by vaccines.

The general success in reducing morbidity and mortality from infectious diseases during the first three-quarters of the twentieth century led many medical and public health experts to become complacent about the need for continued research into treatment and control of infectious microbes. However, subsequent developments—including the appearance of AIDS, the reemergence of tuberculosis (including multidrug-resistant strains), and an overall increase in U.S. infectious disease mortality between 1980 and 1998 (see Figure 1)—have reinforced the realization that as long as microbes can evolve and societies change, new diseases will inevitably arise. Furthermore, infectious diseases continue to be responsible for almost half of mortality in developing countries, where they occur primarily among the poorest people. About half of infectious disease deaths in these countries can be attributed to just three diseases—HIV/AIDS, TB, and malaria. WHO estimates that these three diseases cause over 300 million illnesses and more than 5 million deaths each year.

See also: *AIDS; Black Death; Emerging Infectious Disease; Epidemics; Influenza; Tuberculosis.*

BIBLIOGRAPHY

Armstrong, Gregory L., Laura A. Conn, and, Robert W. Pinner. 1999. "Trends in Infectious Disease Mortality in the United States during the 20th Century." *Journal of the American Medical Association* 281: 61–66.

Center for Disease Control. 1998. "Ten Great Public Health Achievements—United States, 1900–1999." *Morbidity and Mortality Weekly Report* 48: 241–243.

———. 1998. "Achievements in Public Health, 1900–1999: Impact of Vaccines Universally Recommended for Children—United States, 1990–1998." *Morbidity and Mortality Weekly Report* 48: 243–248.

———. 1997. "Status Report on the Childhood Immunization Initiative: Reported Cases of Selected Vaccine-preventable Diseases—United States, 1996." *Morbidity and Mortality Weekly Report* 46: 665–671.

Chin, James, ed. 2000. *Control of Communicable Diseases Manual,* 17th edition. Washington, D.C.: American Public Health Association.

Crosby, Alfred W., Jr. 1976. *Epidemic and Peace, 1918.* Westport, CT: Greenwood Press.

Estes, J. Worth, and Billy G. Smith, eds. 1997. *A Melancholy Scene of Devastation: The Public Response to the 1793 Philadelphia Yellow Fever Epidemic.* Canton, MA: Watson Publishing International.

Etheridge, Elizabeth W. 1992. *Sentinel for Health: A History of the Centers for Disease Control.* Berkeley: University of California Press.

Fleming, William L. "The Sexually Transmitted Diseases." In *Maxcy-Rosenau Public Health and Preventive Medicine,* 11th edition, ed. John M. Last. New York: Appleton-Century-Crofts.

Garrett, Laurie. 1994. *The Coming Plague: Newly Emerging Diseases in a World Out of Balance.* New York: Farrar, Straus and Giroux.

Hinman, Alan. 1990. "1889 to 1989: A Century of Health and Disease." *Public Health Rep* 105: 374–380.

Khan Ali S., Alexandra M. Levitt, and Michael J. Sage. 2000. "Biological and Chemical Terrorism: Strategic Plan for Preparedness and Response: Recommendations of the CDC Strategic Planning Workgroup." *Morbidity and Mortality Weekly Report* 44(RR04): 1–14.

Kortepeter, Mark G., and Gerald W. Parker. 1999. "Potential Biological Weapons Threats." *Emerging Infectious Diseases.* 5: 523–527.

Lederberg, Joshua, and Robert Shope, eds. *Emerging Infections: Microbial Threats to Health in the United States.* Washington D.C.: National Academy Press.

Mead, Paul S., Laurence Slutsker, Vance Dietz, Linda F. McCaig, Joseph S. Bresee, Craig Shapiro, Patricia M. Griffin, Robert V. Tauxe. 1999. "Food-related Illness and Death in the United States." *Emerging Infectious Diseases* 5: 607–625.

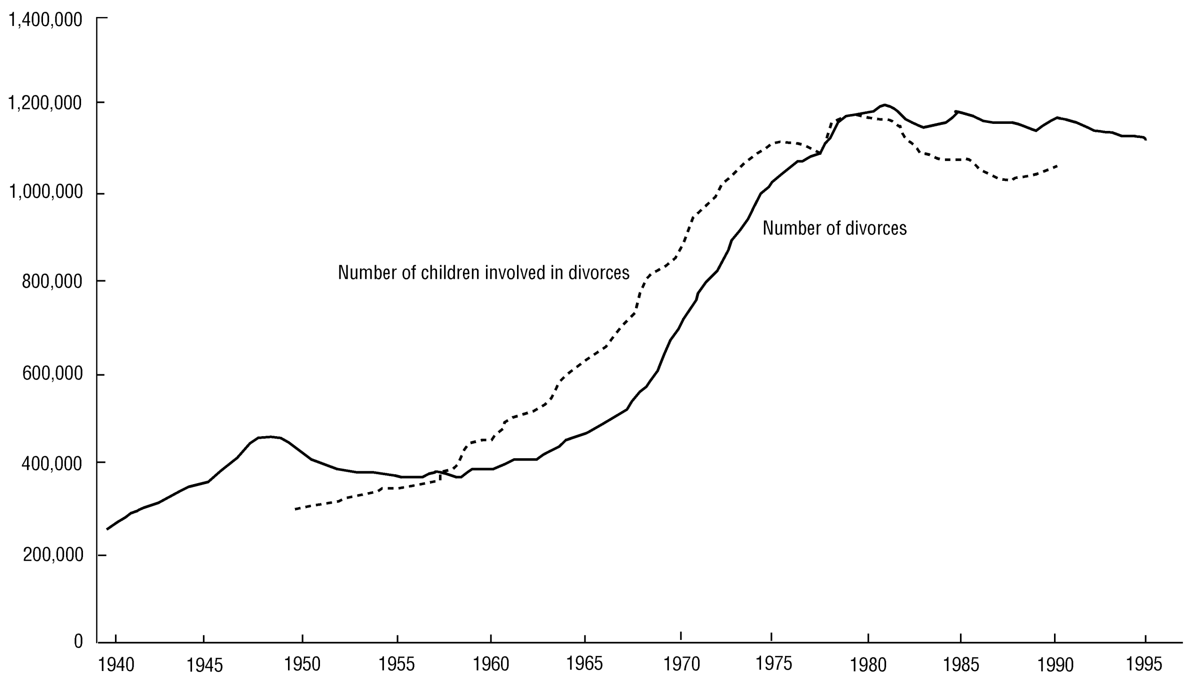
Mullan, Fitzhugh. 1989. *Plagues and Politics: The Story of the United States Public Health Service.* New York: Basic Books.

Selvin, Molly. 1984. "Changing Medical and Societal Attitudes Toward Sexually Transmitted Diseases: A Historical Overview." In *Sexually Transmitted Diseases.* ed. King K. Holmes, Per-Anders Mardh, P. Frederick Sparling, and Paul J. Wiesner. New York: McGraw-Hill.

D. Peter Drotman
Alexandra M. Levitt

FIGURE 1

Number of Divorces and Estimated Number of Children Involved in Divorce in the United States: 1940–1995



Note: No data available on number of children involved in divorces before 1950 and after 1990.

SOURCE: Clarke (1995) and U.S. Census Bureau (2002).

DIVORCE

The legal dissolution of marriage has reached historically high levels in most industrial societies. In the United States, divorce rates have been increasing for more than a century. They increased steeply in the 1960s and 1970s and subsequently leveled off, as shown in Figure 1. Slightly less than half of all first marriages in the United States in the early twenty-first century end in divorce. This proportion is roughly the same in Sweden. The figures are somewhat lower (around 40% per marriage) for other Nordic countries, the United Kingdom, Belgium, and most countries of the former Soviet Union. In most other industrial societies, divorce rates are rising, although they are still considerably lower than in the United States.

With the exception of parts of Asia and Latin America, dissolution of marriage is also common, although statistically less well documented, in the developing world. The proportion of women separated or divorced between the ages of 45 and 59 increased on average from 7 percent in the 1980s to 10 percent in the 1990s in Latin America and the Caribbean (the corresponding figures are 5 percent and 9 percent in Europe as a whole and 9 percent and 14 percent in other developed regions). As a combined effect of death, separation, and divorce, in many countries in sub-Saharan Africa, more than one-third of women experience dissolution of marriage before reaching the end of childbearing years.

The rise in divorce in the industrialized countries has been attributed to (1) smaller gains from marriage than in the past; (2) the declining social stigma of divorce; and (3) a relaxation of divorce laws, as represented by the introduction of no-fault divorce. These factors are thought to mutually reinforce each other. For example, increases in divorce reduce social stigma and foster the liberalization of divorce law. Higher expectations of divorce may encourage precautionary behavior (for example, waiting to have children) that itself may reduce the benefits of staying married. In turn, expectation of ease of divorce may encourage less careful deliberation before entering into marriage, which in itself could increase the likelihood of divorce. The plateau in divorce rates in the United States since about 1980 remains largely unexplained.

Although divorce ends individual marriages, most often the individuals who divorce remarry, often to partners who are themselves divorced. Current U.S. remarriage rates imply that about three-quarters of divorced men and two-thirds of divorced women eventually remarry. Divorce and remarriage have, in concert, changed family structure, increasing the number of single-parent headed households and of marriages in which one or both of the spouses was formerly divorced, and increasing the prevalence of step-relationships within families.

The principal impact of divorce that concerns social scientists is its effect on children. Social scientists working with observational data are not able to determine directly whether children of divorce are worse off than those of parents who remain married. Studies that have tried to control for factors other than divorce have yielded mixed results, but some have found that children of divorce do fare worse in various ways in comparison to children brought up in intact marriages. Another consequence of divorce is the economic hardship associated with the dissolution of households, which often falls disproportionately on women.

Higher rates of divorce might be expected to increase the quality of marriage in a society by allowing those in unsatisfactory marriages to choose new partners. On the other hand, it can also be argued that higher divorce rates may have negative consequences for all marriages because couples will be reluctant to make marriage-specific investments, like having children, which might enhance the advantages of marriage. The validity of either of these theories remains unproven.

Marriages most at risk of divorce include those entered into at an early age. There is also a socioeconomic gradient to divorce, such that those with more education and higher income face slightly lower risks of divorce. Part of the effect of socioeconomic status is mediated through age at marriage (those who attend college are less likely to marry young), but multivariate analysis reveals that, even after controlling for age at marriage, those couples who are poor and less educated face slightly higher risks of divorce.

The age pattern of divorce, or more accurately the duration pattern, is such that following the first year, divorce rates decline consistently as the length of the marriage increases. Contrary to popular belief, there is no increase in divorce after seven years of marriage (the *seven year itch*) apparent in the U.S. pattern. Part of the declining risks of divorce related to duration may be due to the winnowing out of marriages with high risks of divorce. But the advantages of marriage (and associated disadvantages of divorce) are themselves also thought to increase with time. There are more likely to be children, the division of household labor becomes more established, and the amount of other forms of so-called marriage-specific capital increases.

The economic theory of marriage and divorce, pioneered by the economist Gary Becker emphasizes—by analogy with the theory of comparative advantage in international trade—the benefits of marriage that come from the sexual division of labor. According to this theory, the advantages have declined over time as women have entered the labor market and thereby reduced men's comparative advantage as income earners. At the same time, the theory argues that technological advances in the home have reduced women's comparative advantage in housework. In contrast, sociological theories of divorce emphasize the increasingly individualistic and hedonistic orientation of modern societies, and the decline in normative expectations that marriage should be a life-long commitment.

Measures

Divorce, like other demographic rates, can be measured cross-sectionally at a given time (period measure) or along the lifecycle (cohort measure), and at the aggregate or individual level.

The most commonly used aggregate measures are annual rates of divorce. The simplest measure, called the *crude divorce rate,* is estimated by dividing the total number of divorces in a year by the total mid-year population. The crude divorce rate can be influenced by changes in the population at risk. For example, if age-at-marriage is delayed, the proportion of married people will decrease and the rate will decline even if the risks of divorce to married people remain the same.

A more refined measure, that takes into account the number of marriages at risk, is the *general divorce rate,* which divides the total number of divorces by the number of married women (a proxy for the number of marriages). The general divorce rate can be thought of as the chance that a randomly chosen couple will divorce in a given year. It is less influenced by changing population composition although it can be influenced by changes in the distribution of marriages by duration. For example, a population with many recent marriages may have a higher general divorce rate because divorce rates are higher for new marriages. The general divorce rate is less often reported than the crude divorce rate because it requires estimation of the number of married women in the population.

In the United States, the crude divorce rate in 1998 was 4.2 per 1000, down from a peak of 5.2 per 1000 in 1980 but nearly double the rate observed in the 1950s. The general divorce rate was 19.5 per 1000 in 1996, slightly more than double the rate observed in the 1950s.

Age- and duration-specific measures of divorce can be used to estimate individual probabilities of divorce. For example, the above-cited estimate that 1 of every 2 first marriages in the United States ends in divorce is calculated by constructing a nuptiality table (analogous to a life table) from marital-duration-specific divorce rates. Estimation of duration-specific rates can be difficult to because it requires counts of marital duration not only for couples that divorce, but also those that remain intact. To calculate such refined rates, data from sample surveys, rather than data from censuses or national registration systems, are often used.

In Europe, a period measure called the total divorce rate, applying to a synthetic (cross-sectional) lifetime, is sometimes reported. This rate, in the same manner as the total fertility rate or the total first marriage rate, sums the age-specific divorce rates (divorces per woman, either married or unmarried) at a given time. This measure is informative but, like the general divorce rate, can be influenced by variations in the population at risk.

In the United States the collection of detailed divorce certificate data was discontinued by the federal government as a cost-savings measure and because the information provided by reporting states was incomplete. Thus, apart from the aggregate rates, most of what is known about divorce differentials and trends is inferred from sample surveys with retrospective marital histories, like the Census Bureau's Current Population Survey or the Survey of Income Program Participation.

As long-term cohabitation increases, which is the case especially in Western Europe, divorce rates alone give an increasingly incomplete picture of actual separation levels.

See also: *Cohabitation; Family: Future; Family Demography; Marriage.*

BIBLIOGRAPHY

Becker, Gary. 1991. *A Treatise on the Family,* enlarged edition. Cambridge, MA: Harvard University Press.

Cherlin, Andrew J. 1992. *Marriage, Divorce, Remarriage,* 2nd edition. Cambridge, MA: Harvard University Press.

Clarke, Sally C. 1995. "Advance Report of Final Divorce Statistics, 1989 and 1990." *Monthly Vital Statistics Report* 43(9).

Goldstein, Joshua R. 1999. "The Leveling of Divorce in the United States." *Demography* 36(3): 409–414.

McLanahan, Sarah, and Gary Sandefur. 1994. *Growing Up with a Single Parent.* Cambridge, MA: Harvard University Press.

Preston, Samuel H., and John McDonald. 1979. "The Incidence of Divorce within Cohorts of American Marriages Contracted since the Civil War." *Demography* 16: 1–25.

Schoen, Robert, and Nicola Standish. 2001. "The Retrenchment of Marriage: Results from Marital Status Life Tables for the United States, 1995." *Population and Development Review* 27(3): 553–563.

United States Census Bureau. 2001. *Statistical Abstract of the United States: 2001.* Washington, D.C.: US Government Printing Office.

JOSHUA R. GOLDSTEIN

DUMONT, ARSÈNE

(1849–1902)

Arsène Dumont studied law and, after reading the results of the 1880 French census, resolved to devote his life to the study of the causes of low fertility, or, in his preferred formulation, depopulation. Dumont never married or held an official position and supported his research with personal resources in the forlorn hope of obtaining a university position. His closest professional affiliation was with the French anthropological society. When his wealth was exhausted, he committed suicide.

Although Dumont resorted to official statistics to describe fertility and mortality as immediate causes of low population growth, his originality consisted in using an ethnographic approach to probe for its psychological and social causes. His method involved evaluating the moral climate of village communities in various regions of France rather than looking at individual behavior. He would describe features of the environment, local production and occupations, and the appearance and lifestyle of the inhabitants and use that information to interpret their reproductive behavior and test various theories. The village ethnologies thus assembled served as raw material for three books in which Dumont presented his theory on the causes of fertility decline. The best known of these works was *Dépopulation et Civilisation* (1890).

Dumont rejected the eugenic theories of his day, which attributed low fertility to biological mechanisms. The pursuit of "individual idealism" in democratic societies, in which men could climb the social ladder and improve their standard of living, was the mechanism leading to fertility decline. Dumont used the arresting metaphor of "social capillarity" to describe that phenomenon. In the same way that oil ascends the wick of a lamp, molecule by molecule, to burn and produce light, the social matter climbs, individual by individual, toward the higher life of art, politics, and science, and in this process children represent an impediment. If democratic societies wanted to survive, they had to control this socially destructive process.

Dumont was visualizing a balance between the benefits of modern life and their deleterious effects on reproduction. An objective of policy would be a birthrate of twenty-five per thousand and three births per marriage, close to replacement-level fertility in the prevailing mortality conditions. Local economic development would stimulate fertility and discourage migration to the cities.

Although his views were not popular in his time, Dumont influenced subsequent demographers, including the British social historian Joseph A. Banks, who applied the notion of social capillarity to the tendency of the middle classes in Britain to reduce the size of their families so that their children could rise on the social scale.

See also: *Population Thought, History of; Social Mobility.*

BIBLIOGRAPHY

Banks, Joseph A. 1954. *Prosperity and Parenthood: A Study of Family Planning among the Victorian Middle Classes.* London: Routledge & Kegan Paul.

Dumont, Arsène. 1890. *Dépopulation et Civilisation: Étude Démographique.* Paris: Lecrosnier et Babé. Reissued, with a biographical and critical introduction by André Béjin. Paris: Economica, 1990.

———. 1898. *Natalité et Démocratie: Conférences Faites à l'École d'Anthropologie de Paris.* Paris: Schleicher.

———. 1901. *La Morale Basée sur la Démographie.* Paris: Schleicher Fréres.

Etienne van de Walle

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EASTERLIN, RICHARD A.

(1926–)

Born in Ridgefield Park, New Jersey, American economist, demographer, and economic historian Richard A Easterlin received a degree in mechanical engineering from the Stevens Institute of Technology in 1945, and a Ph.D. in economics from the University of Pennsylvania in 1953. He was drawn into demography through participation in a project conducted from 1953 to 1956 on population redistribution and economic growth with economist Simon Kuznets and demographer Dorothy Thomas. Easterlin's association with Kuznets was also the impetus for his interest in empirical research, and his concern with understanding real world situations, both of which are evident in all of his work.

Easterlin spent nearly 30 years as a faculty member at the University of Pennsylvania, where he was William R. Kenan Jr. Professor of Economics from 1978 to 1982, before moving to the University of Southern California to become University Professor in the department of economics. He is a Fellow of the American Academy of Arts and Sciences, and a member of the National Academy of Sciences. He has been president of the Population Association of America (PAA) (1978) and of the Economic History Association (1979–1980).

Easterlin's 1978 presidential address to the PAA, which was titled "What Will 1984 Be Like? Socioeconomic Implications of Recent Twists in Age Structure," was the first comprehensive presentation of what came to be known as the *Easterlin Hypothesis*—the proposition that the relative size of a birth cohort determines the labor market outcome of its members, which in turn has repercussions on a host of other socioeconomic characteristics including fertility, creating the potential for continuing fluctuations in the relative size of birth cohorts. The hypothesis has stimulated a large amount of empirical research both in the United States and Europe, in efforts to confirm or refute it. The results appear to provide some support for his hypothesis, but suggest that institutional factors and period effects might ameliorate the impact of changing relative cohort size, reducing the likelihood of continuing regular fluctuations. In addition, some work suggests that the mediating link between relative cohort size and income might be more complex than that envisioned in the original Easterlin hypothesis. In an extension of this work, Easterlin has made significant contributions to research on preference formation, suggesting that the life cycle trend in average happiness is flat because aspirations vary with level of income.

The possibility of fertility cycles deriving from the relative economic status of successive cohorts is of major interest to demographers. Easterlin is also well known in demography for developing, in collaboration with his wife, demographer Eileen Crimmins, a comprehensive framework for analyzing social and economic aspects of fertility transition in terms of the demand for children, the "supply" of children, and the cost of fertility control. This supply/demand or synthesis framework, often referred to as the Easterlin-Crimmins model, has become for many researchers an accepted way of categorizing fertility variables.

See also: *Cycles, Population; Economic-Demographic Models; Kuznets, Simon; Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY RICHARD A. EASTERLIN.

Easterlin, Richard A. 1968. *Population, Labor Force, and Long Swings in Economic Growth.* New York: Columbia University Press.

———. 1978."What Will 1984 Be Like? Socioeconomic Implications of Recent Twists in Age Structure." *Demography* 15: 397–432.

———. 1987. *Birth and Fortune: The Impact of Numbers on Personal Welfare,* 2nd edition. Chicago: University of Chicago Press.

———. 1987. "Easterlin Hypothesis." In *The New Palgrave: A Dictionary of Economics,* ed. John Eatwell, Murray Milgate, and Peter Newman. New York: The Stockton Press.

———. 1987. "Fertility." In *The New Palgrave: A Dictionary of Economics,* ed. John Eatwell, Murray Milgate, and Peter Newman. New York: The Stockton Press.

———. 1996. *Growth Triumphant: The Twentieth Century in Historical Perspective.* Ann Arbor, MI: University of Michigan Press.

———. 1999. "How Beneficent is the Market? A Look at the Modern History of Mortality." *European Review of Economic History* 3(3): 257–294.

———. 2001. "Income and Happiness: Towards a Unified Theory." *Economic Journal* 111(473): 465–484.

Easterlin, Richard A., and Eileen M. Crimmins. 1985. *The Fertility Revolution: A Supply-Demand Analysis.* Chicago: University of Chicago Press.

SELECTED WORKS ABOUT RICHARD A. EASTERLIN.

Blaug, Mark, ed. 1986. *Who's Who in Economics: A Biographical Dictionary of Major Economists 1700–1986,* 2nd edition. Cambridge, MA: MIT Press.

DIANE J. MACUNOVICH

ECOLOGICAL PERSPECTIVES ON POPULATION

Human population size profoundly influences the state of the environment, which in turn has sweeping effects on human vital rates, as well as on the health, standards of living, and personal satisfaction of individual human beings. For most of the approximately five million years of human history, populations exerted mostly local and reversible influence on the environment. But beginning with the agricultural revolution some 10,000 years ago, that changed dramatically.

Human Domination of the Biosphere

From about 1850 to 2002, the human population increased some five-fold and consumption per person about four-fold. The scale of the human enterprise, then, has expanded roughly twenty-fold; as a result, *Homo sapiens* has become a truly global ecological force.

There is no significant area of the biosphere that has not been altered by human activities. Synthetic pesticides and radioactive materials from nuclear weapons tests have been dispersed globally, and humans have dramatically altered the distribution of key elements such as carbon and nitrogen throughout the land, atmosphere, and oceans. Only a few extremely deep parts of the ocean may still be relatively pristine. More obviously, humans have cut down forests, plowed plains, exterminated many species and populations, paved over large areas, and otherwise transformed most of the land surface. People have released a great variety of novel poisons into the environment, and have degraded oceans and most freshwater bodies by overfishing and pollution.

Ecosystems, Ecosystem Services, and Natural Capital

An ecosystem is defined simply as the community of organisms (plants, animals, microbes) that reside in a given area and the physical environment with which they interact. Human beings are always elements of the ecosystems in which they live, be it the ecosystem of a village, a city, a watershed, a region, a country, or the entire planet. Ecosystems supply human beings with the material basis of life, including food, water, oxygen, wood, energy sources, and metal ores. They also supply an array of indispensable "ecosystem services." These services include climate stabilization; provision of fresh water; control of floods; generation and replenishment of soils essential to agriculture and forestry; detoxification and disposal of wastes; recycling of nutrients; control of the majority of potential crop pests; pollination of crops; provision of forest products and seafoods; and maintenance of a vast genetic library from which humanity has already drawn its crop plants, domestic animals, and a critical portion of its medicines. In extracting benefits from ecosystems, humans also inevitably modify those ecosystems.

The organisms, soils, aquifers, ores, and other features of ecosystems can be thought of as "natural capital": a more fundamental ingredient of economic well-being than the human-made physical and human capital that modern economies so carefully evaluate and husband. The loss of natural capital is all too often irreversible on a time scale relevant to human societies.

Human Impacts on Ecosystem Services

Humans alter ecosystems not only by extracting materials and services from them but also by returning materials and energy (e.g., carbon dioxide, heat, other wastes, synthetic chemicals) to them. In the course of becoming the dominant animal on Earth, human beings also have destroyed outright many natural components of ecosystems through habitat destruction, overexploitation, and depletion, reducing the ability of many natural systems to supply goods and services in the future. On the positive side, the goods and services that are being extracted sustain, at least for the present, a population of more than 6 billion individuals.

A trade-off that is often ignored is the cost in ecosystem degradation that is often a counterpart to the benefits people derive from ecosystem services. Locally, destruction of a wetland may damage its waste disposal service to the degree that artificial treatment is required to protect people from polluted water. Paving over recharge areas may disrupt the flow of clean water into local wells, and overexploiting a local fishery may drive the resource to economic extinction—that is, to the level where harvesting is no longer worth the effort.

Regionally, deforestation of a watershed that formerly discharged a relatively constant surface flow of water may lead to a series of alternating droughts and floods. In Honduras, a combination of population growth and inequitable land tenure arrangements led to forest loss and numerous people living in areas lacking natural protection from floods. In 1998 Hurricane Mitch, an unusually severe storm, killed thousands of people and left hundreds of thousands more homeless in Honduras—illustrating the ecological principle that high population density can produce disproportionate per-capita impacts of climatic and other factors that on the surface might seem independent of demography.

There is a small but growing trend toward investing in the restoration of ecosystem assets. In another regional example, New York City's population growth required it to seek more and more distant water sources, and the city eventually developed the Catskill/Delaware Watershed as its main source. The watershed is 100 miles to the north of the city, and it originally supplied water of fabled purity. By the late 1980s, though, water quality had declined to the point where it no longer met Environmental Protection Agency (EPA) standards. The cause was itself indirectly connected with the growth and affluence of New York's population: Suburban sprawl and rising demands for recreation and second homes placed higher demands on the watershed. The city was faced with the choice of building costly new treatment facilities or controlling development in the watershed ecosystem. Economic analyses showed that controlling development for improving water quality would cost far less, even without taking into account the other benefits of preserving the watershed, and that was the solution chosen.

Globally, climate change—traceable primarily to the anthropogenic injection of greenhouse gases into the atmosphere, itself strongly correlated with both human population size and consumption of fossil fuels for energy—threatens to damage agricultural production in many areas, inundate low-lying coastal areas, and spread tropical diseases into temperate regions. Population-related global warming also endangers coral reefs through bleaching, and threatens the persistence of ecologically and economically important tropical reef fisheries.

Loss of biodiversity—the plants, animals, and microorganisms with which humanity shares Earth—is an important element in the degradation of ecosystems related to increasing human numbers. It is especially critical because losses of species diversity, including genetically diverse populations of those species, are irreversible. In addition, it is often very difficult to find substitutes that can play the same roles as the organisms that are gone, so that restoration of certain ecological services may be difficult or impossible. Areas of high biodiversity and high human population density frequently coincide, which puts the living parts of local ecosystems at risk.

Overexploitation and resulting degradation reduce the productivity of ecosystems. Major fisheries such as cod and Atlantic swordfish are threatened with economic extinction by overharvesting in response to growing demand, especially from increasingly affluent consumers. In poor countries, tropical forests and their precious stores of biodiversity are threatened with destruction by overexploitation for timber, combined with the need for farmland to feed growing populations.

Generally, the more people there are the more they extract from, emit pollutants into, and disrupt ecosystems. But numbers of people alone do not tell the whole story; how they behave also contributes to the resultant loss of ecosystem products and services. Environmental scientists generally divide that behavior into two factors: affluence (how much each person consumes on average) and technology, a complex factor that includes both the technologies of production and the sociopolitical and economic arrangements necessary for production and distribution to take place. This is the basis of the $I = PAT$ equation: **I**mpact on life-support systems is the product of **P**opulation size, **A**ffluence, and **T**echnology. The equation suggests that, from an ecological viewpoint, the worst problems of overpopulation are likely to be found not in populous poor nations like India and China, but in populous rich ones like the United States because of the latter's high levels of per-capita consumption.

It is important to note that, although population growth is an important driver of environmental deterioration, in some cases it is possible to ameliorate its impact. For instance, growing populations contributed to an increasing flow of chlorofluorocarbons (CFCs) into the atmosphere, threatening the destruction of the important ozone layer. But technological changes, entailing substituting less destructive chemicals for CFCs, largely removed the threat. However, in many other areas such as the provision of water to homes, industry, and agriculture, opportunities for substitution are more limited and often involve high costs. Locally, environmental outcomes are complicated by the existence of positive feedback involving population growth. As a favorable example, additional people moving into a forested area may supply capital to provide jobs that do not depend on logging, to install sewage treatment plants, and to take other measures that help protect the environment. The better conditions that result in turn attract more people, who (up to a point) may further improve conditions.

The Epidemiological Environment

The human epidemiological environment determines susceptibility to disease. It is shaped by a complex of biophysical, economic, sociocultural, and political factors in which the size and structure of the population are key variables. Demographic factors have been important in increasing susceptibility to epidemic disease. Many diseases require a certain host population size in order to maintain themselves; for instance, measles requires agglomerations of 200,000 to 500,000 in order to persist. The growing world population brings ever larger groups into contact with the animal reservoirs of pathogens potentially able to colonize *Homo sapiens.* This increases the probability that more HIV-like or "killer flu"-type epidemics will occur in the future.

Factors contributing to higher risks to public health include greater geographic mobility, urbanization (especially the growth of urban fringe settlements), large numbers of malnourished (and thus immune-compromised) people, declining water quality, misuse of antibiotics (leading to increasing problems with resistant pathogens), widespread distribution of recreational intravenous drugs with sharing of needles, and bioterrorism. While these risks are relatively well understood and advances in molecular biology should strengthen the human drug and vaccine armamentarium, and there is little question that the present perilous state of the epidemiological environment could be substantially improved despite the opposing effects of demographic pressures and mobility. Substantial advances, however, will require intensification of medical effort, especially better provision of public health services in developing nations.

Defining Overpopulation

Overpopulation (or population overshoot) is much discussed but rarely defined. From an ecological standpoint, the biophysical carrying capacity—that is, the maximum population size that can be long sustained under given technological capabilities—

has no direct connection to population density. Overpopulation may best be defined as occurring when the number of people is larger than can be supported over the long term by the flow of income from natural capital, since depletion of that capital will constrain future generations. There are complexities in this definition, such as accounting for depletion of nonrenewable resources (economists generally do this by considering possibilities for substitution) or gauging overpopulation for countries heavily involved in international trade, but more precision is rarely required. The basic point is that remaining somewhat below carrying capacity is essential in order to avoid excessive damage to ecosystems and thus reduce negative feedbacks from ecosystems to human populations. Where no such margin for error exists, the result too often is a "natural disaster" as exemplified by Hurricane Mitch's devastation in Honduras.

Population Structure

Population growth is not the only demographic factor important in the human impact on ecosystems. The age structure of the population and its spatial distribution can also be important. With population aging, for example, there is often a rising proportion of single-person households, with greater per capita demands on fuel. In southwestern China, for instance, the aging population requires more home heating than was required when the average age was lower, increasing the consumption of fuel-wood from disappearing forests. In many countries there is steady migration into coastal areas with damaging consequences for the marshes and mangroves that serve as nursery areas for many marine fishes, and, in the longer run, where people are increasingly vulnerable to sea-level rise. Urbanization and international migration also have ecosystem effects, which can be very complex.

Ecological Sustainability and Environmental Ethics

An important ecological issue is that of sustainability: whether supporting the human population today might limit the ability of future generations to sustain themselves. This raises complex questions. Some are technical: How much reliance can be placed on technological progress to find substitutes for the natural capital now being depleted? Other, more contentious questions are ethical: What are a population's obligations to future generations, given that their reproductive decisions also influence the size of those generations? What duties of stewardship does the human population owe to other species and to the natural environment? Such questions are too rarely systematically explored.

The Scientific Consensus

The consensus of the scientific community on the interrelationship of demographics and the environment was well expressed in a 1993 statement by the world's scientific academies. This said, among many things:

> Throughout history and especially during the twentieth century, environmental degradation has primarily been a product of our efforts to secure improved standards of food, clothing, shelter, comfort, and recreation for growing numbers of people. The magnitude of the threat to the ecosystem is linked to human population size and resource use per person. Resource use, waste production and environmental degradation are accelerated by population growth. . . . As human numbers further increase, the potential for irreversible changes of far-reaching magnitude also increases. Indicators of severe environmental stress include the growing loss of biodiversity, increasing greenhouse gas emissions, increasing deforestation worldwide, stratospheric ozone depletion, acid rain, loss of topsoil, and shortages of water, food, and fuel-wood in many parts of the world. (National Academy of Sciences)

See also: *Carrying Capacity; Environmental Ethics; Environmental Impact, Human; Natural Resources and Population; Sustainable Development.*

BIBLIOGRAPHY

Daily, Gretchen C., ed. 1997. *Nature's Services: Societal Dependence on Natural Ecosystems.* Washington, D.C.: Island Press.

Daily, Gretchen C., and Paul. R. Ehrlich. 1996. "Global Change and Human Susceptibility to Disease." *Annual Review of Energy and the Environment* 21: 125–144.

Dasgupta, Partha. 2001. *Human Well-being and the Natural Environment.* Oxford, Eng.: Oxford University Press.

Ehrlich, Paul R., Anne H. Ehrlich, and John P. Holdren. 1977. *Ecoscience: Population, Resources, Environment.* San Francisco: W.H. Freeman and Co.

Ehrlich, Paul R., and John Holdren. 1971. "Impact of Population Growth." *Science* 171: 1212–1217.

Gleick, Peter H., ed. 1993. *Water in Crisis: A Guide to the World's Fresh Water Resources.* New York: Oxford University Press.

Heywood, Vernon H., ed. 1995. *Global Biodiversity Assessment.* Cambridge, Eng.: Cambridge University Press.

Holdren, John. 1991. "Population and the Energy Problem." *Population and Environment* 12: 231–255.

Holdren, John P., and Paul R. Ehrlich. 1974. "Human Population and the Global Environment." *American Scientist* 62: 282–292.

Jansson, AnnMari, Monica Hammer, Carl Folke, and Robert Costanza, eds. 1994. *Investing in Natural Capital: The Ecological Economics Approach to Sustainability.* Washington, D.C.: Island Press.

Liu, Jianguo, et al. 2001. "Ecological Degradation in Protected Areas: The Case of Wolong Nature Reserve for Giant Pandas." *Science* 292: 98–101.

McMichael, Anthony J. 2001. *Human Frontiers, Environments and Disease: Past Patterns, Uncertain Futures.* Cambridge, Eng.: Cambridge University Press.

Myers, Norman. 1991. *Population, Resources and the Environment: The Critical Challenges.* London: United Nations Population Fund.

National Academy of Sciences, USA. 1993. *A Joint Statement by Fifty-eight of the World's Scientific Academies. Population Summit of the World's Scientific Academies.* New Delhi, India: National Academy Press.

Pimm, Stuart L. 2001. *The World According to Pimm.* New York: McGraw-Hill.

Postel, Sandra L., Gretchen C. Daily, and Paul R. Ehrlich. 1996. "Human Appropriation of Renewable Fresh Water." *Science* 271: 785–788.

Vitousek, Peter M., Paul R. Ehrlich, Anne H. Ehrlich, and Pamela A. Matson. 1986. "Human Appropriation of the Products of Photosynthesis." *BioScience* 36: 368–373.

Vitousek, Peter M., Harold A. Mooney, Jane Lubchenco, and Jerome M. Melillo. 1997. "Human Domination of Earth's Ecosystems." *Science* 277: 494–499.

Paul R. Ehrlich
Anne H. Ehrlich

ECONOMIC-DEMOGRAPHIC MODELS

Economic-demographic models are designed to describe in formal terms the main effects of demographic change on economic activity and those of economic activity on demographic change. The goal of these models is to forecast how the linked population-economy system will evolve over time, provide insights into the effects of policy change, or both.

The attempt to understand how population processes interact with the economy was at the center of interest in the work of the classical economists, most notably T. R. Malthus (1766–1834), as well as Adam Smith (1723–1790), David Ricardo (1772–1823), and John Stuart Mill (1806–1873), although their theories seldom were expressed in terms of mathematical formulas. In the development of neoclassical economics through the first half of the twentieth century, consideration of such interactions was largely neglected. Subsequently, formal modeling of the mutual impact of demographic and economic variables received a strong impetus. This was in part the logical outcome of the novel ambition to construct comprehensive multivariate models of the workings of the economy and partly a result of the renewed post–World War II interest in the role of rapid population growth in the economic development of low-income countries. This entry discusses salient aspects of economic-demographic modeling efforts during the last few decades of the twentieth century.

Models of Developed Economies

Until the mid-1960s economic models were constructed principally to yield short-run forecasts. Because it was commonly believed that demographic effects were relatively unimportant in explaining variations in short-run economic activity, the models ignored demographic change, treating population as an exogenous variable. Similarly, economic effects were absent from demographic models because those models were concerned with long-run forecasts, time periods over which economic effects were considered unpredictable.

The first economic model to incorporate demography other than as an exogenous variable was the Brookings model of the U.S. economy, which was built in the 1960s. In this model population affected the labor market, which affected marriage and household formation, which in turn affected the economy through the nonbusiness construction sector. Population also affected government revenues and expenditures.

As described by Dennis Ahlburg, the next generation of models—mostly known by their abbreviated titles or institutional provenance, such as the Wharton, DRI, Chase, and Hickman-Coen models in the United States; the RDX and CANDIDE models in Canada; and the BACHUROO model in Australia—introduced fine-gauge age disaggregation in the production and consumption sectors. The DRI model introduced a highly elaborate demographic-economic system that forecast the size of consumer populations and the income available to those groups. The models also linked changes in age structure to changes in labor supply, unemployment, and wages.

In the late 1970s the Wharton model added an endogenous demographic sector that included births, marriage, divorce, work, and education as variables that affected and were affected by economic variables. The main linkages between the demographic sector and the economic model were income and labor force participation and household formation. Subsequently, the Wharton model introduced an endogenous demographic projection methodology so that it expressed the total fertility rate, migration rate, and life expectancy as functions of economic and demographic variables. These demographic variables in turn had effects throughout the economic model.

The main purpose of these models was short-run forecasting, but they also could give policymakers insights into the effects of policy changes without the need to carry out those changes. The usefulness of those simulations depended on the accuracy with which a model captured the economic and demographic structure of a country. Generally, demographic change in these models had only a relatively modest effect on the aggregate rate of economic growth.

Economic-demographic models of this type continue to be refined and applied widely. For example, the San Diego Association of Governments employs a simultaneous nonlinear model to produce medium- to long-term (20-year) forecasts of 700 economic and demographic variables. The Netherlands Interdisciplinary Demographic Institute is modeling economic-demographic scenarios for Europe at the national and regional levels. The International Institute for Applied Systems Analysis has developed a multiregional economic-demographic model to simulate various long-run economic growth scenarios for Europe and assess the economic impacts of population aging.

Models of Developing Countries

Formal economic-demographic models for developing countries were designed to illuminate the interaction between population and other variables in the development process and evaluate the consequences of various policies on economic and demographic variables. The best known of these models is the pioneering model by Ansley Coale and Edgar Hoover of the Indian economy, whose findings were cited widely to justify government interventions to limit fertility. In this model economic growth essentially depends on the resources devoted to productive investments. Population growth has a negative impact on economic growth because it increases current consumption and welfare-type outlays at the expense of savings and productive investments. Two shortcomings of the model are that it assumes costless fertility and mortality reduction and omits labor from the production function. This means that population growth adds consumers but does not add producers. Omitting labor is defensible only for medium-term calculations, the period of 15 to 20 years during which a decline in the birthrate leaves the size of the population of labor force age unaffected.

Almost all the other early economic-demographic models of low-income countries agreed with the Coale-Hoover conclusion that rapid population growth slowed the pace of economic growth, although the mechanisms yielding that outcome varied. An exception was the model proposed by Julian Simon. Simon's model assumed that relatively rapid population growth produces strong economic growth, at least in the long run. Output in the model is a positive function of "social overhead capital" (better roads and communication, economies of scale in production, improved government and organization, and better health services). Social overhead capital in turn is a costless function of population growth; this is an important and questionable assumption. The significance of Simon's model is that it suggests that although the short-term impact of population growth may be negative, there may be more than compensating positive effects in the future. Thus, the net impact of population growth for various specified time horizons is an open empirical question.

Later models became larger and more complex. As discussed by Dennis Ahlburg, the Bachue series of models developed by the International Labour Organization contained multisectoral input-output submodels and treated population in a highly disaggregated way (by age, sex, location, and education). Those models endogenized the components of population change and determined both the level of employment and the size distribution of incomes across households. The Bachue models are intended to be long-term policy-oriented simulation models rather than short-term forecasting models.

Models of this type have had only a limited impact on policy analysis and planning because of their complexity, the often conflicting specifications of key economic-demographic relationships, very different empirical estimates of those relationships, and the fact that a single equation (the production function) often has a dominant impact on the properties of the model regardless of the specification of the rest of the model. (The strengths and weaknesses of these models are discussed in Brian Arthur and Geoffrey McNicoll's, Warren Sanderson's, and Ahlburg's works.)

In the 1990s a series of country-specific models was constructed that added environmental interactions to the economic-demographic system to produce population-development-environment (PDE) dynamic simulations. Only sectors considered important to a particular country are modeled in detail, and simplicity of specification is emphasized to aid comprehension of the user. Wolfgang Lutz, Alexia Prskawetz, and Sanderson discuss examples of these models.

Economic Growth Models

Interest in the determinants of economic growth, which was the motivation for some of the earliest neoclassical growth theories, resurfaced in the late 1980s with simple single-equation models that tried to explain relative rates of economic growth across countries. Economic growth was expressed as a function of economic, demographic, institutional, and other variables.

The dominant model in this so-called new growth theory comes from the work of Robert Barro and is derived from an extended version of the neoclassical growth model. It embodies the idea of conditional convergence: The lower the starting level of real per capita gross domestic product in relation to its long-term or steady-state level, the higher the predicted growth rate. The significance for demography is that the long-term growth rate can be affected by the growth rate of population and by other factors, such as the savings rate, that may be affected by demographic change.

Capital had always played a critical role in models of economic growth, and the new growth models broadened the concept of capital to include education and health. Economic growth depended on the relationship between the initial and target levels of output. The target level of output depended on government policies (including not only spending and tax rates but also the rule of law, the protection of property rights, and political freedom) and household behavior (savings, labor supply effort, fertility, and health). Geographic endowments such as a temperate climate and ecological conditions that impede the spread of diseases or favor cash crops also can affect economic growth directly or through their impact on institutions.

Barro estimated the basic model with data on a panel of about 100 countries from 1960 to 1990. He found that economic growth was higher the lower the fertility rate, the longer the life expectancy, and the higher the level of education. These arguments are similar to those of Coale and Hoover. Other determinants of growth were the maintenance of the rule of law, lower levels of government consumption, lower inflation, and improved terms of trade.

Allen Kelley and Robert Schmidt and others have extended the demographic specification of the basic growth model and explored the adjustment or transition to the long-run equilibrium. Those researchers argued that the impact of demography on economic growth was a function of the levels of fertility and mortality rates, the timing of changes in fertility and mortality, and the sensitivity of the economy to those changes. Differences in levels and timing can create significant shifts in the age structure of the population that can affect economic growth in addition to the direct effect of births and deaths. Disaggregating population change into its components and more fully specifying the dynamics allow the effect on economic growth to be positive, negative, or zero. Many earlier models did not allow such flexibility. Population size and density also appear in some of those models. A larger population can lead to economies of scale in the provision of roads, communication systems, research and development, and markets and institutions. Higher population densities can lead to lower per-unit costs and increased efficiency of investments, particularly in agriculture. The effects of population size and density have been found to vary considerably across countries.

Kelley and Schmidt developed several extended growth models with data from a panel of 86 countries for the period 1960–1995. (A single model could not suffice because of disagreement among economists on structural details.) They reached the qualified conclusion that declining fertility and mortality reinforce each other in encouraging economic growth. Because fertility and mortality declines necessarily offset each other in their effect on population growth, this finding underscores the importance of distinguishing the components of population change rather than using population growth as a single variable. It also illustrates the importance of specifying the dynamics of the effect of demography on economic growth (current high fertility decreases growth, but fertility lagged by a generation increases growth). Kelley and Schmidt also found small positive effects of population size and density.

The "Demographic Gift"

The effect of changes in age structure on economic growth, a relationship treated in the Coale-Hoover model, was investigated further by researchers in the 1990s. Coale and Hoover had argued that high fertility resulted in a high youth dependency rate that depressed aggregate savings rates and thus economic growth. However, this is just the initial phase of the changes in age structure that accompany the demographic transition. The ratio of the population of labor force age to total population is low when fertility is high, rises as declining fertility lowers child dependency, and eventually falls as population aging sets in. The second phase of this shift is a period in which the demands the population makes on resources are relatively low but the economic contributions (through work, savings, and investments) are potentially great. The resulting (potential) impetus on economic growth has been referred to as the "demographic gift" or "demographic bonus."

David Bloom and Jeffrey Williamson found that the rate of economic growth rose faster as the ratio of the working-age population to the total population rose. Although the exact mechanisms by which this effect occurs are unclear, it seems that changes in the age structure are associated with shifts from unpaid work to paid work, increased health and education of workers, and increases in savings and capital accumulation.

Ronald Lee, Andrew Mason, and Tim Miller showed that during the demographic gift period savings and wealth can increase faster, spurring economic growth because of favorable shifts in the age structure and changes in life expectancy and total fertility. In a case study of Taiwan they found that as much as one-half of the increase in savings rates was due to demographic factors. Other studies investigated the influence of demographic change on the "economic miracle" of East Asia in the 1980s and early 1990s and concluded that the demographic gift caused one-quarter to one-third of the rapid economic growth that took place.

The conclusion that can be drawn from this event is that under the right conditions it is possible for a rapid demographic transition to generate large increases in savings and wealth that can stimulate economic growth. It appears that the "demographic gift" of rapidly falling fertility and mortality can translate into higher economic growth if there are supportive policies, markets, and institutions. The practical challenge indicated by the modeling is to bring about conditions that will convert the "gift" into the reality of economic growth.

See also: *Development, Population and; Intergenerational Transfers; Microeconomics of Demographic Behavior; Migration Models; Simon, Julian L.; Simulation Models.*

BIBLIOGRAPHY

Acemoglu, Daron, Simon Johnson, and James Robinson. 2001. "The Colonial Origins of Comparative Development." *American Economic Review* 91: 1369–1401.

Ahlburg, Dennis A. 1987a. "The Impact of Population Growth on Economic Growth in Developing Nations: The Evidence from Macroeconomic-Demographic Models." In *Population Growth and Economic Development: Issues and Evidence,* ed. D. Gale Johnson and Ronald D. Lee. Madison: University of Wisconsin Press.

———. 1987b. "Modeling Economic-Demographic Linkages: A Study of National and Regional Models." In *Forecasting in the Social and Natural Sciences,* ed. Kenneth C. Land and Stephen H. Schneider. Dortrecht, the Netherlands: D. Reidel.

Arthur, W. Brian, and Geoffrey McNicoll. 1975. "Large-Scale Simulation Models in Population and Development: What Use to Planners?" *Population and Development Review* 1: 251–265.

Barro, Robert J. 1997. *Determinants of Economic Growth.* Cambridge, MA: MIT Press.

Bloom, David, and Jeffrey G. Williamson. 1998. "Demographic Transitions and Economic Miracles in Emerging Asia." *World Bank Economic Review* 12: 419–455.

Coale, Ansley J., and Edgar M. Hoover. 1958. *Population Growth and Economic Development in Low-Income Countries.* Princeton, NJ: Princeton University Press.

Kelley, Allen C., and Robert M. Schmidt. 2001. "Economic and Demographic Change: A Synthesis of Models, Findings, and Perspectives." In *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World,* ed. Nancy Birdsall, Allen C. Kelley, and Steven W. Sinding. Oxford: Oxford University Press.

Lee, Ronald D., Andrew Mason, and Tim Miller. 2001. "Saving, Wealth, and Population." In *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World,* ed. Nancy Birdsall, Allen C. Kelley, and Steven W. Sinding. Oxford: Oxford University Press.

Lutz, Wolfgang, ed. 1994. *Population-Development-Environment: Understanding Their Interactions in Mauritius.* Berlin: Springer-Verlag.

Lutz, Wolfgang, Alexia Prskawetz, and Warren C. Sanderson, eds. 2002. *Population and Environment: Methods of Analysis.* Supplement to *Population and Development Review,* Vol. 28.

MacKellar, Landis, and Tatiana Ermolieva. 1999. "The IIASA Social Security Reform Project Multiregional Economic-Demographic Growth Model: Policy Background and Algebraic Structure." Interim Report IR-99-007. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Sanderson, Warren C. 1980. *Economic-Demographic Simulation Models: A Review of the Usefulness for Policy Analysis.* Laxenburg, Austria: International Institute for Applied Systems Analysis.

San Diego Association of Governments. 1993. *DEFM Forecast 1993 to 2015.* Volume 1: *Model Overview.* San Diego, CA: San Diego Association of Governments.

Simon, Julian L. 1977. *The Economics of Population Growth.* Princeton, NJ: Princeton University Press.

Dennis Ahlburg

ECONOMICS OF POPULATION

See *Cost of Children; Development, Population and; Economic-Demographic Models; Family Allowances; Family Bargaining; Immigration, Benefits and Costs of; Microeconomics of Demographic Behavior.*

EDUCATION

In the last part of the nineteenth century, the enforcement of compulsory schooling laws in most countries of Europe and in North America made school participation universal for all children. Starting in the early twentieth century, the United States led the way towards mass schooling at the secondary level with roughly 50 percent of young people earning high school diplomas by the 1940s. Susan Cotts Watkins, an American sociologist, in her study of the demographic integration of Europe from 1870 to 1960, identifies schooling as the most important aspect of nation building, particularly because of the enforcement of a national language. Since the end of World War II and the subsequent transition to nationhood of many former colonies, the spread of mass formal schooling has become a global phenomenon.

Progress towards mass formal schooling can be measured by examining changes in the educational distribution of the adult population or by looking at trends in the enrollment and attainment of the current school-age population. Figure 1 depicts trends from 1960 to 2000 in the percent of the adult population completing at least primary school, and in the percent of the adult population completing at least some secondary education, by region, as calculated by Robert J. Barro and Jong-Wha Lee in 2000, using data from censuses with intercensal adjustments based on net enrollment data. Dramatic progress has been recorded in all regions from a very low base in most of the developing world. As of 2000, while only 43 percent of the population in developing countries had completed at least a primary education, over 70 percent of these go on to attain some secondary education, which represents roughly one-third of the adult population. By contrast roughly 85 percent of adults living in advanced or transitional economies have completed primary school and the vast majority of these go on to at least some secondary education. Accompanying this growth in educational attainment has been a narrowing of the gender gap.

Despite progress, large gaps remain in primary and secondary enrollment rates both between regions and within regions of the developing world. In some cases past rates of growth have declined or been reversed in recent years. Sub-Saharan Africa remains a conspicuous laggard. Despite impressive growth in the early post-colonial period, as of 2000, no more than a quarter of the adult population in sub-Saharan Africa had completed primary school. Economic slowdowns in many countries of that region in the 1980s and 1990s have been linked with a stalling of past economic growth and in some cases actual declines in enrollments among the current school age population. Boys have been particularly affected.

Trends in the enrollment among school age populations are more difficult to measure and compare because of the well known inaccuracies of United Nations Educational, Scientific and Cultural Organization enrollment data that are based on Ministry of Education reports that are often exaggerated. Figure 2, which is based on 1990s household survey data from 41 developing countries participating in the Demographic and Health Surveys, the majority in Sub-Saharan Africa, shows the range of primary completion rates currently prevalent within each of the developing regions for young people aged 20 to 24. In all regions, there are some countries that have achieved close to universal primary completion rates. However the ranges are wide in each region and especially so in Africa. Among the 24 sub-Saharan African countries with data for the 1990's, the median value for primary completion rates is no more than one-third of the population aged 20 to 24.

The Consequences of Education for Demographic Outcomes

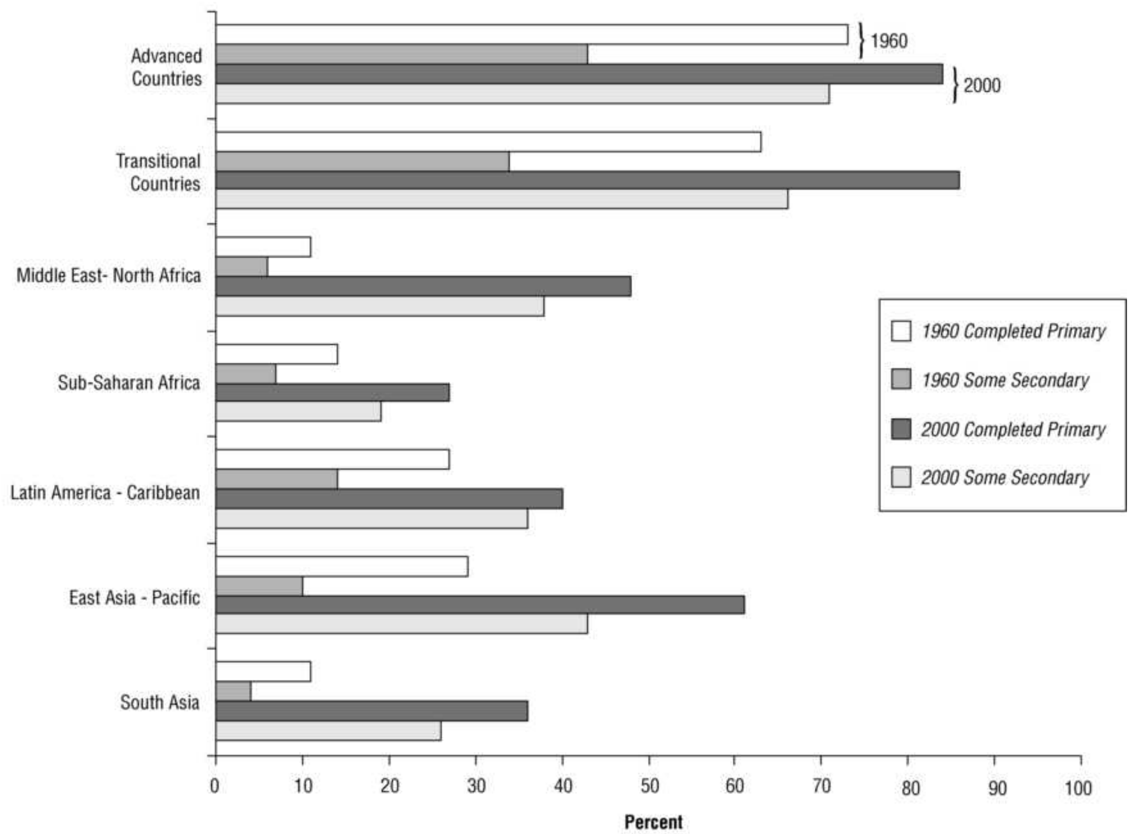
A great amount of empirical evidence, reviewed by Shireen Jejeebhoy in 1999, has documented the strong statistical association at the individual level between the number of grades (or levels) of schooling attained (particularly for women) and various subsequent demographic outcomes including the age of marriage, the number of births, child health and mortality, and children's educational attainment. There are various hypotheses as to the causal forces underlying this relationship but no definitive findings. The relationship could be explained by the following:

1. The increased knowledge and skills acquired in school;
2. The status it confers on those who receive it;
3. Its effect on participation and on potential earnings in the labor market (and by extension the opportunity costs associated with high fertility); and/or
4. By its effects on personal autonomy and agency, particularly in the case of girls and young women.

A 1999 U.S. National Research Council report, *Critical Perspectives on Schooling and Fertility in the Developing World*, found no clear answers. Indeed, with reference to hypothesis 4 above, other research points to the conservative nature of schooling as a socializing agent, particularly for girls, suggesting the possibility that schooling could reinforce existing

FIGURE 1

Change in Educational Attainment of the Adult Population Ages 15 and Over from 1960–2000, by World Region



SOURCE: Barro and Lee (2000).

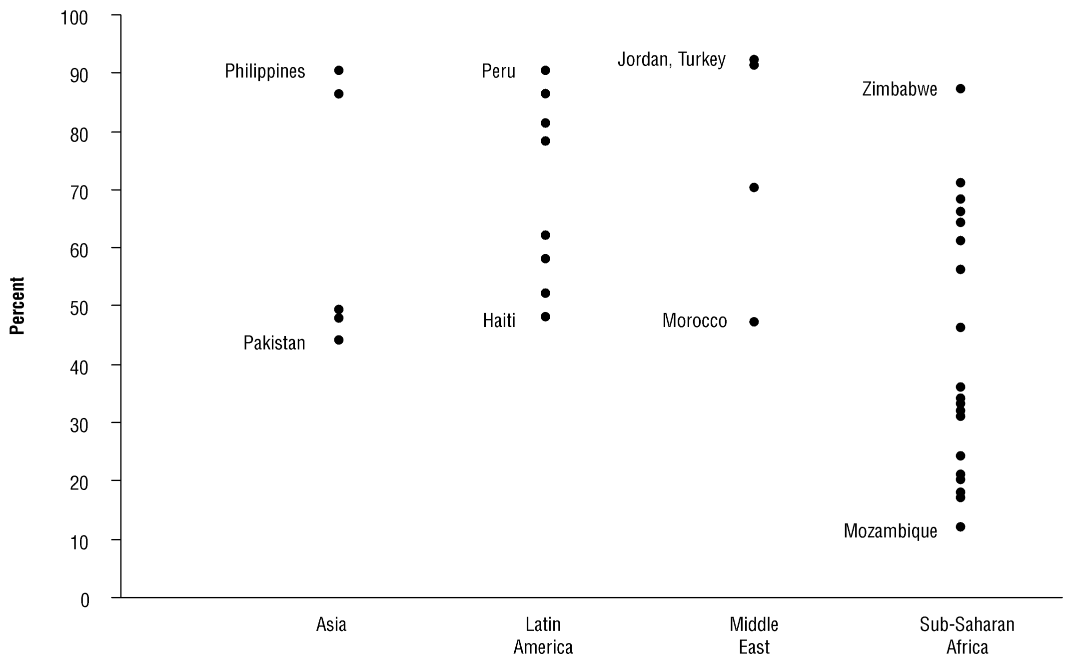
gender hierarchies rather than enhancing gender equity. Nonetheless, policy makers have concluded from the empirical evidence that investments in girls' schooling have high social and economic returns.

A different interpretation of the relationships between schooling and demographic outcomes is based on exploring the societal forces that trigger the fertility transition, or what some economists call the *quantity-quality transition* during which families decrease fertility and increase their investments in children. There is clear historical evidence that the enforcement of compulsory schooling laws and the spread of state power through national schooling systems using a common language and curriculum were key forces in reducing the demographic diversity prevalent in Europe in the mid-nineteenth century and in triggering the onset of European fertility transitions. In 1980, Australian demographer John C. Caldwell theorized that the arrival of mass formal schooling in developing countries would also serve as a trigger for the demographic transition, particularly if it involved both boys and girls and particularly if it involved socialization in Western middle class values. A recent review of the evidence in Africa by Lloyd, Kaufman and Hewett (2000) provides strong empirical support for this relationship. Further evidence at the country level comes from in-depth case studies in Nepal and Pakistan in which data collected at the community level show the positive effect of school availability on contraceptive use, even when the parents themselves have no formal education.

Once begun, the quantity-quality transition can be self-propelling. Although there is a natural tendency for rates of return to education to decline as

FIGURE 2

Percent of Population Aged 20–24 with Completed Primary Schooling in 41 Developing Countries, by Region, 1990s



SOURCE: DHS Survey Data from 1990s.

more children are educated, evidence from many Asian countries examined by Mark R. Montgomery, Mary Arends-Kuenning and Cem Mete in 2000 shows that this effect can be counteracted by beneficial macroeconomic changes resulting from increases in trade, physical capital, and technology, thus sustaining the quantity-quality transition.

Policy Implications

Educational opportunities of children are harmed by having many siblings in the home. The evidence for this, reviewed by economist Cynthia B. Lloyd in 1994, shows the disadvantage to children from large families to be greater in contexts where schooling is available but not fully subsidized by the state and where family support networks are confined to biological parents and their children. Furthermore, the negative consequences are particularly felt by girls, leading to intra-familial inequality in schooling levels among children in the same family.

Further research has explored the effects of unwanted fertility on investments in children's schooling in a range of developing country settings and has found that in the "middle to latter phases of a fertility transition, the positive effects of mother's education on children's education are likely to be reinforced by reductions in the incidence in unintended or excess fertility" (Montgomery and Lloyd, p. 249). Thus differences between families in their ability to achieve their fertility preferences will lead to intra-familial as well inter-familial inequalities in schooling outcomes.

Evidence of significant differences in enrollment rates across income or socioeconomic groups in a variety of different settings lends support to a variety of anti-poverty policy interventions in developing countries to reduce the costs to parents of sending their children to school as a means of increasing enrollments and achievement. Preliminary evidence suggests very positive short-term effects of such interventions.

While much has been learned about the familial determinants of enrollment and attainment, much less is known about the school factors—quality and content of instruction, degree of crowding, character of physical plant—that may also play a role. In 1996, David Card and Alan Krueger suggested this as a promising avenue for future research. They contend that it is "unclear whether this relationship [between school quality and educational attainment] results because students respond to the economic incentives created by a rise in the return to schooling [because of better quality] or because they find it more enjoyable to attend schools with smaller classes or better-paid teachers" (Card and Krueger, p. 123). Thus, they hint at the possibility that attitudes towards school and schooling may be another pathway of influence between school quality and grades attained besides cognitive competencies—a pathway that has been shown in numerous studies on school effectiveness to be positively affected by certain school quality factors such as time to learn, material resources, and the quality of teaching.

In less-developed countries where enrollment even at the primary level is far from universal, the potential implications of school quality for educational attainment are profound. Indeed, a major vehicle through which school quality may affect cognitive competencies, earnings and subsequent demographic outcomes is through its impact on retention and educational attainment. Only a few studies in Ghana, Kenya, and Egypt have explored this relationship. There is some intriguing evidence that parents may be highly sensitive to visible changes in school quality in choosing between schools when school choice is available.

A review of the large and growing body of literature indicates various gaps in data and research: (1) comparable population-based data on enrollment, progression, and grade attainment by age and sex for all countries in the world; (2) longitudinal studies of the pathways through which educational attainment affects subsequent adult decisions relating to the timing of marriage, the size of the family, and investments in children as well as child rearing practices that affect children's health and mortality and their subsequent progress in school; and (3) longitudinal studies of the effect of specific elements of school quality on progression to higher levels of schooling, transitions into the labor market and into marriage, and subsequent parental decision-making about fertility, childrearing, and investments in children's education.

Study of the education-demographic nexus is also becoming of increasing relevance in the high-income countries. Rising rates of return in the labor market to higher education (not only in absolute terms but also differentially) for both men and women have resulted in a steady rise in the proportion of the population with post-secondary schooling. For example, the 2000 U.S. census results show that the percentage of people 25 to 29 years old completing college has risen to 29 percent—its highest level ever—with the completion rates of young women now slightly exceeding those of young men. The resulting increases in labor force participation of women even after marriage and childbearing in response to rising rates of return in the labor market have led to dramatic changes in the family, including delayed child bearing, increasing rates of childlessness, higher divorce rates, greater rates of female hardship, and larger proportions of dual career couples observed in most industrialized countries.

See also: *Adolescent Fertility; Fertility, Below-Replacement; Fertility Transition, Socioeconomic Determinants of; Literacy.*

BIBLIOGRAPHY

Barro, Robert J., and Jong-Wha Lee. 2000. "International Data on Educational Attainment: Updates and Implications," CID Working Paper No 42. Cambridge, MA: Center for International Development, Harvard University.

Bledsoe, Caroline H., John B. Casterline, Jennifer A. Johnson-Kuhn, and John G. Haaga, eds. 1999. *Critical Perspectives on Schooling and Fertility in the Developing World.* Washington, D.C.: National Academy Press.

Caldwell, John C. 1980. "Mass Education as a Determinant of the Timing of Fertility Decline." *Population and Development Review* 6(2): 225–255.

Card, David, and Alan Krueger. 1996. "Labor Market Effect of School Quality: Theory and Evidence." In *Does Money Matter? The Effect of School Resources on Student Achievement and Adult Success,* ed. G. Burtless. Washington, D.C.: Brookings Institution.

Filmer, Deon, and Lant Pritchett. 1999. "The Effect of Household Wealth on Educational Attainment: Evidence from 35 Countries." *Population and Development Review* 25(1): 85–110.

Jejeebhoy, Shireen J. 1995. *Women's Education, Autonomy and Reproductive Behaviour; Experience* *from Developing Countries.* Oxford, Eng.: Clarendon Press.

Kremer, Michael, Sylvie Moulin, David Myatt, and Robert Namunyu. 1997. "Textbooks, Class Size and Test Scores: Evidence from a Prospective evaluation in Kenya," IPR Working Paper Series.

Lloyd, Cynthia B. 1994. "Investing in the Next Generation: The Implications of High Fertility at the Level of the Family." In *Population and Development: Old Debates, New Conclusions,* ed. Robert Cassen. Washington D.C.: Overseas Development Council.

Lloyd, Cynthia B., Carol E. Kaufman, and Paul Hewett. 2000. "The Spread of Primary Schooling in Sub-Saharan Africa: Implications of Fertility Change." *Population and Development Review* 26(3): 483–515.

Meyer, John W., Francisco O. Ramirez, and Yasemin N. Soysal. 1992. "World Expansion of Mass Education, 1987–1980." *Sociology of Education* 65(2): 128–149.

Montgomery, Mark R., Mary Arends-Kuenning, and Cem Mete. 2000. "The Quantity-quality Transition in Asia." *Population and Economic Change in East Asia,* ed. C.Y. Cyrus Chu and Ronald Lee, Supp. to *Population and Development Review* 26: 223–256.

Montgomery, Mark R., and Cynthia B. Lloyd. 1999. "High Fertility, Unwanted Fertility, and Children's Schooling." In *Critical Perspectives on Schooling and Fertility in the Developing World,* ed. Caroline Bledsoe, John B. Casterline, Jennifer A. Johnson-Kuhn, and John G. Haaga. Washington, D.C.: National Academy Press.

Summers, Lawrence H. 1994. "Investing in All the People; Educating Women in Developing Countries." EDI Seminar Paper No 45.

Watkins, Susan Cotts. 1991. *From Provinces into Nations: Demographic Integration in Western Europe, 1970–1960.* Princeton, NJ: Princeton University Press.

CYNTHIA B. LLOYD

EMERGING INFECTIOUS DISEASES

Emerging infectious diseases are those that have newly appeared in the human population or are rapidly increasing in incidence (number of cases) or geographic range. As with the periodically reported outbreaks of Ebola (a viral hemorrhagic fever with high mortality) in Africa, emerging infectious diseases may seem mysterious and dramatic, but in fact specific factors responsible for their emergence can be identified (Table 1). The emergence of an infectious disease can be seen as a two step process—introduction and establishment/dissemination—that these factors precipitate or promote in one, or both, phases. HIV/AIDS, Ebola, and hemolytic uremic syndrome (caused by certain strains of the bacterium *Escherichia coli* in food or water) are among the notable infectious diseases that were first identified in the latter decades of the twentieth century. Others, such as influenza, reappear periodically causing major epidemics or even pandemics (epidemics that affect the entire world). With increasing globalization and geographic mobility of populations, each part of the world is now vulnerable to infections that might first arise in any other part.

Introduction of Infectious Disease

In analyzing infections that have emerged, it is apparent that many diseases existed in nature before gaining access to the human population, often as a result of changed ecological or environmental conditions that placed humans in contact with previously inaccessible pathogens or the natural hosts that carry them. The term *viral traffic* (or, more generally, microbial traffic) was coined to represent processes involving the access, introduction, or dissemination of existing pathogens to new host populations. Ecological changes and major demographic changes (such as population migrations) often precipitate emergence. Many of these changes are anthropogenic. Infections transmitted by mosquitoes, which include malaria, dengue, yellow fever, West Nile fever, Rift Valley fever, and many others, are often stimulated by the presence of dams, irrigation projects, or open water storage since mosquitoes breed in water.

In terms of the introduction phase, examples of infections originating as zoonoses (infections transmissible from animals to humans) suggest that the *zoonotic pool*—introductions of pathogens from

TABLE 1

Factors in the Emergence of Infectious Diseases

Factor	Examples of specific factors	Examples of diseases
Ecological changes (including those due to economic development and land use)	Agriculture; dams, changes in water ecosystems; deforestation/reforestation; flood/drought; famine; climate changes	Schistosomiasis (dams); Rift Valley fever (dams, irrigation); Argentine hemorrhagic fever (agriculture); Hantaan (Korean hemorrhagic fever) (agriculture); Hantavirus pulmonary syndrome, southwestern US, 1993 (weather anomalies)
Human demographics, behavior	Societal events: Population growth and migration (movement from rural areas to cities); war or civil conflict; economic impoverishment; urban decay; factors in human behavior such as: sexual behavior (including urban prostitution and "sex-for-drugs"); intravenous drug use; diet; outdoor recreation; use of child care facilities (high-density settings)	Introduction of HIV; spread of dengue; spread of HIV and other sexually transmitted diseases
International travel and commerce	Worldwide movement of goods and people; air travel	Dissemination of HIV; dissemination of mosquito vectors such as Aedes albopictus (Asian tiger mosquito); ratborne hantaviruses, intoduction of cholera into South America, dissemination of O139 (non-O1) cholera organism (ships)
Technology and Industry	Food production: Globalization of food supplies; changes in food processing and packaging; Health care: New medical devices; organ or tissue transplantation; drugs causing immunosuppression; widespread use of antibiotics	Food processing: Hemolytic uremic syndrome (E. coli contamination of hamburger meat), bovine spongiform encephalopathy; Health care: Contaminated injection equipment (Ebola, HIV); Transfusion associated hepatitis (hepatitis B, C); opportunistic infections in immunosuppressed patients; Creutzfeldt-Jakob disease from contaminated batches of human growth hormone (medical technology)
Microbial adaptation and change	Microbial evolution, response to selection in environment	Changes in virulence and toxin production; development of drug resistance (antimicrobial resistant bacteria, chloroquine resistant malaria); "antigenic drift" in influenza virus
Breakdown in public health measures	Curtailment or reduction in prevention programs; lack of, or inadequate, sanitation and vector control measures	Resurgence of tuberculosis in United States; cholera in refugee camps in Africa; resurgence of diphtheria in former Soviet republics

Note: Categories are not mutually exclusive; several factors may contribute to emergence of a disease.

SOURCE: Morse, S.S. (1995).

other species—is an important and potentially rich source of emerging pathogens or their precursors, some of which might become successful under conditions that favor transfer to human hosts. HIV is a possible case of such transfer. Although the original ancestors of HIV-1 are not known with certainty, the best current evidence suggests that HIV-1 originated as a zoonotic introduction, possibly from chimpanzees; this may have occurred several times. There is somewhat better evidence for a probable zoonotic origin as regards HIV-2 (another lentivirus that causes AIDS), with the sooty mangabey monkey the likely source. As an illustrative example, an infected man, identified in rural Liberia, had a strain of HIV-2 that closely resembled viruses taken from the sooty mangabey monkey, the presumed reservoir of a virus with a close ancestral connection to HIV-2. That such individuals can be identified suggests that zoonotic introductions of viruses such as HIV may well occur from time to time in isolated populations, and probably often escape notice. In the case of HIV-1, key factors in its success after introduction were the social and demographic changes in the last half of the twentieth century (such as migration to cities) that gave the virus access to a larger population, and other social changes (e.g., drug-related use of contaminated injection equipment, growth of the commercial sex trade) that allowed more facile transmission of the virus to new individuals despite its relatively low natural transmissibility.

Although it is common to think of infectious diseases as causing acute outbreaks, at the beginning of the twenty-first century there is increasing recognition that infections can also be the cause of chronic diseases. Hepatitis B is responsible for many cases of liver cancer worldwide. Recent pioneering work by gastroenterologist Barry Marshall implicated the bacterium *Helicobacter pylori* in gastric ulcers and cancer. Molecular biologists Yuan Chang and Patrick S. Moore, of Columbia University, identified a novel herpesvirus (now known as human herpesvirus 8) as the likely cause of Kaposi's sarcoma.

Establishment and Dissemination

Once introduced, the success of the pathogen in a new population depends on its establishing itself and then disseminating within the population. Many zoonotic introductions are highly virulent but not readily transmissible from person to person, thus preventing their establishment. Both chance and the evolutionary potential of the pathogen play a role in determining whether the infection will establish itself.

Human intervention and social change, in addition to providing opportunities for the introduction of pathogens, also provide increasing opportunities for dissemination. Ebola in Africa is usually introduced into humans by contact with its still unknown natural host in the forest, but most of the subsequent cases of the disease occur in hospitals through use of contaminated injection equipment. A number of factors have led to the resurgence in tuberculosis worldwide: HIV infection increases susceptibility to tuberculosis, while high density settings such as day care centers, homeless shelters, and prisons enhance the probability of transmission. Human migration from rural areas to cities, especially in areas with a high degree of biodiversity, can introduce remote pathogens to a larger population. HIV is the best known beneficiary of introduction by migration, but many other diseases may proliferate in this way. After its likely first move from a rural area into a city, HIV-1 spread via highways to other regional cities. Later, by long distance routes including air travel, it progressed to places even further away than the initial site of the infection. The increasing volume of air travel affords pathogens vast opportunities for globalization.

The globalization and industrialization of the food supply and other goods also offer pathways for microbial traffic. The strains of *Escherichia coli* that cause hemolytic uremic syndrome were probably once limited to a few relatively isolated populations of cattle, but have spread as cattle are collected into large central processing facilities. Bovine spongiform encephalopathy (BSE, so-called mad cow disease), which has been identified in Britain since the 1980s, may have been an interspecies transfer of scrapie from sheep to cattle. Widespread use of animal byproducts as feed supplements, in combination with changes in rendering processes that allowed the scrapie agent in sheep byproducts to contaminate the feed, may have been responsible for its introduction and spread in cattle and eventually, in a variant form, to the human population.

Basic public health measures, including clean water and immunization, and improving nutrition have made major contributions to the relative decline of infectious diseases, and remain essential. Reemerging diseases are those that were previously decreasing in the human population but are again on the upswing. Usually the diseases are those that were once controlled but are staging a comeback due to breakdowns in public health or control measures. The resurgence of diphtheria in the former Soviet Union in the 1990s (as immunization programs lapsed due to lack of resources) is an example. Reemerging diseases should be a reminder that complacency can lead to the resurgence of many infectious diseases that were once thought to be vanquished.

Infectious diseases have a long history, and are likely to remain significant causes of illness and death in the foreseeable future. Some emerging diseases, like HIV/AIDS, have become worldwide public health crises (there were an estimated 40 million HIV infected individuals at the end of 2001, and according to the World Health Organization, an annual death toll of about 3 million.) Other diseases, such as Ebola, are dramatic but fortunately have remained localized, with limited public health impact.

Biowarfare and Bioterrorism

At the beginning of the twenty-first century, biowarfare and bioterrorism have emerged as related concerns. While nature has been the main source of emerging infections, humans have also on occasion attempted to introduce or disseminate disease intentionally. Historians have suggested that the Tatars catapulted dead bodies into the Crimean city of Kaffa (present day Feodossiya in Ukraine) during a siege in 1346, possibly starting the Black Death (bubonic plague). Smallpox, a dreaded natural scourge since ancient times, was declared conquered in 1980 after a major, and successful, eradication campaign. As a result, control measures were ended, and most of world population is now vulnerable to reintroduction, raising concerns in the event that terrorists succeed in obtaining samples of the virus. In autumn 2001, anthrax letters—envelopes containing a powder of highly concentrated anthrax spores enclosed in a letter—were sent to media and Senate offices in the United States. By the end of the outbreak in late November, there had been 23 cases of anthrax, with 5 deaths; none of the victims were themselves the actual addressees of the letters. Both emerging infectious diseases and bioterrorist attacks can be viewed as involving unexpected outbreaks of infectious disease (although, in the case of biowarfare or bioterrorism, introduced through direct human intervention rather than by the other, usually incidental, means described for natural outbreaks). Conceptually, many of the steps that need to be taken to avoid both types of introduction are similar, beginning with effective public health surveillance to detect and respond to unexpected infectious disease outbreaks.

Detection and Prevention

Fortunately, since most new natural infections have limited ability to establish themselves or disseminate, public health catastrophes like the AIDS pandemic are rare. But which infection will be the next smallpox or AIDS, or even the next pandemic influenza, and how can one prevent it? Global events such as AIDS will occur from time to time, and the risk may well be increasing as factors favoring emergence increase worldwide. Many, although not all, of the facilitating factors for infectious disease emergence are anthropogenic. And though early warning and detection are prerequisite to an effective response, public health infectious disease surveillance remains fragmented and incomplete. An enhanced global system, with the capability to recognize both common and novel infectious diseases, is both possible and necessary.

See also: *AIDS; Disease and History; Diseases, Infectious; Mortality Reversals; Tuberculosis.*

BIBLIOGRAPHY

Haggett, Peter. 2000. *The Geographical Structure of Epidemics.* Oxford: Oxford University Press/ Clarendon Press.

Hahn, Beatrice H., George M. Shaw, Kevin M. De Cock, and Paul M. Sharp. 2000. "AIDS as a Zoonosis: Scientific and Public Health Implications." *Science* 287: 607–614.

Lederberg, Joshua, Robert E. Shope and Stanley C. Oaks, Jr. eds. 1992. *Emerging Infections: Microbial Threats to Health in the United States.* Washington, D.C.: National Academy Press.

Morse, Stephen S. 1990. "Regulating Viral Traffic." *Issues in Science and Technology* 7: 81–84.

———. 1991. "Emerging Viruses: Defining the Rules for Viral Traffic." *Perspectives in Biology and Medicine* 34: 387–409.

———. ed. 1993. *Emerging Viruses.* New York and Oxford: Oxford University Press.

———. 1995. "Factors in the Emergence of Infectious Diseases." *Emerging Infectious Diseases* 1: 7–15.

———. 2002. "The Vigilance Defense." *Scientific American* 28 (No. 4, October): 88–89.

Morse, Stephen S., Barbara Hatch Rosenberg, and John P. Woodall.1996. "Global Monitoring of Emerging Diseases: Design for a Demonstration Program." *Health Policy* 38: 135–153.

Webster, Robert G. 1998. "Influenza: An Emerging Microbial Pathogen." In *Emerging Infections,* ed. Richard M. Krause. San Diego, CA: Academic Press.

INTERNET RESOURCES.

Centers for Disease Control and Prevention. "Emerging Infectious Diseases." <http://www.cdc.gov/ncidod/eid/>.

———. "CDC Bioterrorism Preparedness and Response." <http://www.bt.cdc.gov/>.

International Society for Infectious Diseases. "ProMED-mail." <http://www.promedmail.org/>.

STEPHEN S. MORSE

EMPLOYMENT

See *Labor Force*

ENERGY AND POPULATION

How significantly does the size and growth of world population affect the demand for energy? The short answer: possibly less than one might expect. Whatever the extent of the population-energy connection, the concern that growing energy use threatens the sustainability of the underlying energy resource base is understandable, but perhaps unwarranted.

To address the issue of the effect of population size and growth on energy demand, the fact that the link between population and energy involves two intermediate connecting elements must be recognized. The first link relates to levels and changes in economic development, approximated by income or gross domestic product (GDP) per capita. (The two terms are used interchangeably throughout this article.) Typically, the greater a region's per capita income, the greater its per capita consumption of energy: The average per capita GDP and energy consumption of the world's developing countries are, respectively, only about one-seventh and one-eighth those of industrial areas. Notwithstanding this marked per capita disparity, given the sheer population size of developing regions—over three-quarters of the world total—the absolute amount of energy consumption and of GDP are relatively large: one-third of world energy use and about two-fifths of world GDP.

What is true of prevailing levels in the relationship between per capita income and energy is also true of rates of change over time since as income per capita rises, so does per capita energy use. The reason is evident. Energy—electricity to run motors, fuels for transport, and hundreds of other applications—is a vital complement to other investments for boosting productivity and stimulating economic growth. In turn, that very growth gives rise to acquisition of household necessities and creature comforts associated with increased energy usage.

Even though income and energy use are conspicuously correlated, the degree of the relationship is by no means perfect and unvarying, which raises the second point to consider in linking population and energy. Even at comparable levels of per capita GDP, the volume of energy use will differ among countries and regions, depending on structural characteristics of the economy, spatial features, climate, fuel and power prices, government conservation policies, and other factors. Similarly, changes in per capita income need not signify commensurate rates of energy use; for example, shrinkage of energy-intensive manufacturing and expansion of lower energy-use service activities can contribute to de-coupling growth of GDP and energy use.

Such de-coupling has manifested itself in a number of advanced countries, and may, in time, manifest itself in the world's poorer countries as they continue to develop. In the United States, a plot of energy use per unit of GDP from the third quarter of the nineteenth century and well into the greater part of the twentieth century shows what is basically a bell-shaped curve, in that there was a rise in energy intensity peaking in the 1920s and falling steadily thereafter. In the first half of this period, greater energy use per unit of GDP was associated with the growth of large-scale manufacturing and energy-associated infrastructure. As that process of heavy industrialization began to taper off towards the last several decades of the twentieth century, a growing relative role of non-manufacturing activity meant a commensurate slowdown in the growth rate of energy consumption, although continuing, of course, its steady growth in absolute terms. That slowdown, it should be added, benefited as well from certain non-structural factors, such as energy and economic efficiency improvements in electricity generation and other sectors.

Quantifying the Linkage

With this background, consider Table 1 as a way of highlighting, for recent years and the projected near term, the complex interrelationships among changes in population, economic development, and energy consumption. Its aggregated and simplified layout notwithstanding, the table is instructive in identifying the three broad factors that go into the determination of changes in total energy use. (Strictly speaking, the change in energy use is the *multiplicative product* of the three factors; but, when relatively small numbers are involved, as here, it is effectively the *sum of additive* items.) The items in this decomposition, expressed in terms of percentage changes, are:

$$\textit{Population} + \textit{GDP per capita} \\ + \textit{Energy per unit of GDP} = \textit{Energy}$$

The decade of the 1990s saw economic growth (i.e., GDP per capita) dominating population growth as a factor in energy consumption growth in

TABLE 1

Decomposing the Population-Energy Link: Major World Regions

(AVERAGE ANNUAL PERCENTAGE RATES OF CHANGE)

	1990-1999 (actual)	1999-2020 (projected)
Population		
Industrial	0.6	0.4
EE/FSU	0.0	0.0
DC	1.7	1.3
World	1.4	1.1
GDP per capita		
Industrial	1.6	2.2
EE/FSU	-3.4	4.3
EE/DC	3.2	3.9
World	1.3	2.8
Energy per unit of GDP		
Industrial	-0.6	-1.4
EE/FSU	-1.1	-2.5
DC	-1.1	-1.4
World	-1.7	-1.6
Energy consumption		
Industrial	1.6	1.2
EE/FSU	-4.5	1.7
DC	3.8	3.8
World	1.1	2.2

Note: EE/FSU=Eastern Europe and the former Soviet Union; DC=developing countries. "Energy" refers to the sum of the different energy sources, aggregated according to their respective calorific properties.

SOURCE: Historic population and energy data and all projections from U.S. Department of Energy, Energy Information Administration, *International Energy Outlook 2001*(March 2001), Tables A2, A3, and A16. Historic GDP data from United Nations Development Programme, *Human Development Report 2001* (New York/Oxford: Oxford University Press for UNDP, 2001), p. 181.

both industrialized and developing regions. (Worldwide rates were strongly influenced by developments in the former Soviet Union/Eastern Europe, here included for completeness; but their erratic record for the greater part of the decade hampers meaningful analysis.) Even if population growth had been less than estimated, it is conceivable—though by no means assured—that offsetting economic performance would have accelerated the growth in energy use above that shown in the table.

An important step in this de-composition exercise is to flag the contribution of the changing relationship between energy and GDP, often referred to as changing "energy intensity." Interestingly, in both industrial and developing regions, its (negative) role in dampening the growth in energy use was vastly greater than the growth of population in stimulating it.

The framework employed in Table 1 is easily augmented to indicate the extent to which energy growth compounded or attenuated certain environmental problems. For example, with respect to the problem of greenhouse warming, a worldwide degree of *de-carbonization*—through, among other ways, limited substitution of (carbon-lean) natural gas for (carbon-rich) coal—which allowed carbon dioxide emissions to rise considerably less than energy consumption, can be demonstrated. In the future, that process of de-carbonization—aided by gradual introduction of (zero-carbon) renewable resources—is likely to endure, though not sufficiently to preclude an absolute, and perhaps dangerous, rise in carbon dioxide emissions.

Table 1 includes the U.S. Department of Energy's 20-year "business as usual" projections, showing a doubling in the annual rate of worldwide energy consumption growth, and reflecting—at least over that time span—the credible assumption of ample supply and relatively level prices into the future. For developing regions, the effect of an 0.4 percentage point reduction in the population growth rate is more than offset by a 0.7 percentage point increase in per capita economic growth. That observation is not meant to assert a demonstrated inverse trade-off between population growth and per capita income growth—a matter that remains elusive after many years of study and, in any case, demands a more in-depth analysis than that provided by the macro indicators employed here. Thus, a 1994 World Bank assessment—in line with other expert studies—notes that "[a]ttempts to demonstrate consistent cross-national macroeconomic effects of high rates of population growth have, for the most part, been inconclusive" although suggesting "that rapid growth (above 2 percent a year) inhibits efforts to raise incomes in poor countries with high fertility and youthful age distributions" (World Bank, pp. 36–37).

The Longer-Term Picture

The 20-year time horizon sketched out above provides no reassurance that demographic-economic pressures building in the coming decades of the twenty-first century might not begin to put pressure on availability of the energy resources to which successful development prospects around the world are importantly tied. However, before turning to the question of the longer-term adequacy of exploitable energy resources, researchers should consider the plausible longer-term evolution of the demographic and economic factors underlying changes in energy use. To a degree greater than the 1990 to 2020 trend depicted in the table, growing energy requirements over the longer-term future will almost surely reflect the consequence of rising income to a significantly greater degree than the effect of population growth. The 2000 United Nations projections attest dramatically to decelerating population growth: The *medium* projections show world population rising from 6.06 billion in 2000 to 9.32 in 2050—a number that is 1.5 billion less than that projected just four years earlier. Looked at in another way, the *low* projection for 2050, issued in 2000, approximates the medium projection issued in 1996. Successive reductions like these are due in large part to strikingly lower fertility experience in a number of major developing countries. As a result, population growth between 2000 and 2050 is currently projected to grow at an average annual rate of 0.86 percent, in contrast to the 1.77 percent rate between 1950 and 2000.

Although long-term GDP per capita growth involves its own degree of uncertainty and conjecture, the range of possibilities considered in numerous analyses cluster around a mid-point of around 1.6 percent per year in the period 2000 to 2050. Coupling 0.86 percent population growth with 1.6 percent GDP/capita growth signifies total GDP growth of around 2.5 percent. There will, of course, be wide regional and national disparities around these worldwide averages. The implication for developing countries—with a prevailing per capita GDP of roughly $3500 (1999 price level) becomes especially important. A rough breakdown of the 1.6 percent per capita growth rate worldwide could mean a rate of around 2.2 percent for developing countries, which would yield per capita GDP of approximately $10,600 in 2050. This would represent a solid gain in living standards, although that income level is still well below the per capita GDP in industrial countries of about $22,000 in 2002. Nevertheless, compared with the prevailing disparity in per capita GDP (the one-seventh ratio mentioned above), the gap by 2050, implied by the assumption as stated, would narrow to a ratio of around one-fourth.

If worldwide GDP growth can reasonably be projected at a yearly rate of 2.5 percent, it also seems reasonable, in turn, to view 2.5 percent as the *upper* bound to long-term energy growth because, particularly in an era focused on technologies and practices that promote economically more efficient energy usage, a time trend of declining energy intensity can be taken as virtually certain. (To cite just one of many examples of such technological changes: A newly commissioned power plant can generate a kilowatt hour of electricity at less cost and using half the raw energy input than a plant built a mere dozen years ago.) These considerations and a review of various studies support the position that, with worldwide GDP growth over the next 50 years proceeding at an average annual rate of around 2.5 percent (that is, somewhat below the long-term historical trend), a *best guess* for the concomitant increase in energy use is an annual rate of approximately 1.3 percent, the difference reflecting an assumed annual energy intensity improvement factor of around 1.2 percent, is about as large a reduction as can be defended on the basis of historical and empirical grounds.

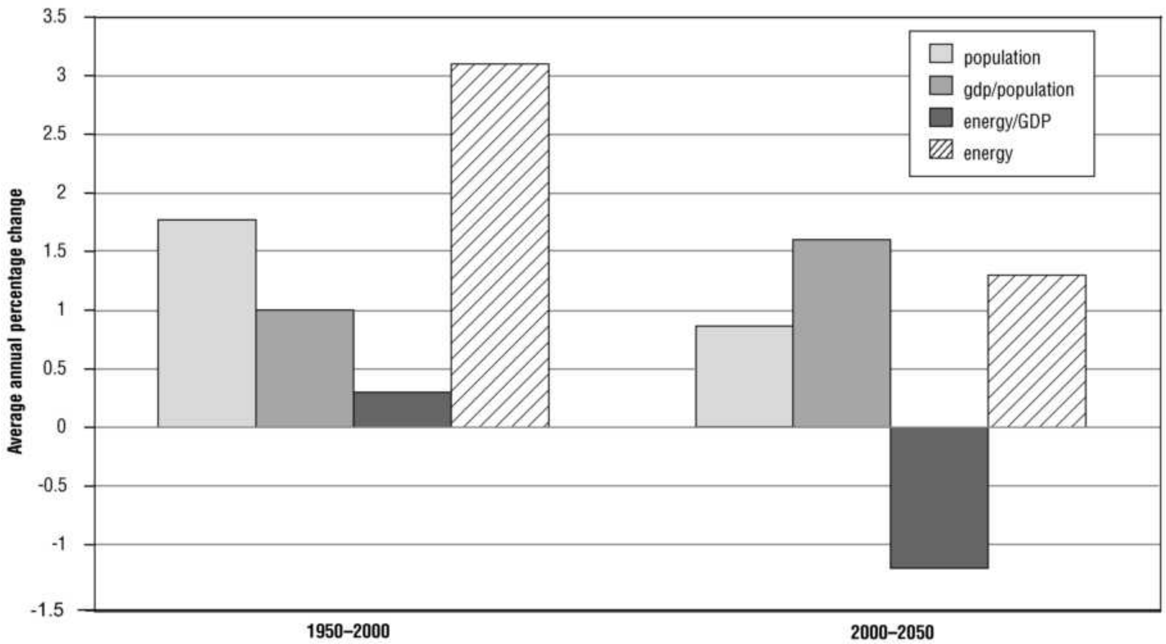
If a yearly energy consumption growth rate of 1.3 percent seems strikingly below historical experience, it still implies that, compared to the year 2000, by the year 2050 the world will see a near-doubling in its annual level of energy consumption. It is widely expected that a disproportionately large share of the 2000 to 2050 increment will originate in developing countries, with China and India leading the demand. Figure 1 shows long-term historic trends and plausible projections in world population, per capita GDP, energy intensity, and energy use, using the de-composition elements introduced earlier. A conspicuous difference between the long-term past and long-term future clearly relates to the changing relative importance of population growth and per capita income growth combined with decreasing energy intensity in driving energy demand. The last two factors seem certain to be much more decisive in the decades ahead than population growth—a trend already foreshadowed in the near-term forecast shown in the table.

The Energy Resource Base

The extent to which the rate of energy growth falls below the rate of economic growth will remain a matter of unusually spirited debate. One important reason for the debate is that as the fall in energy intensity continues, the threat from climate change and other sorts of environmental deterioration, particularly if declining energy intensity is also accompanied by a shift toward non-fossil energy sources, will become more attenuated. On the other hand, as long as fossil fuel combustion remains a major part

FIGURE 1

Long-Term Historical and Projected Change in World Population, GDP, and Energy Use, 1950–2000 and 2000–2050



SOURCE: Population from UN, *World Population Prospects–The 2000 Revision* (2001); historical GDP from N. Nakicenovic *et.al., Global Energy Perspectives*, Cambridge Press, 1998, p. 30, updated on the basis of information from US DOE, Energy Information Administation; historical energy estimate based on UN World Bank and DOE/EIA data and checked against chart in Nakicenovic, p. 66. GDP and energy projections are discussed in accompanying text.

of the energy system, the challenge of mitigating climate consequences remains less tractable.

The last discussion leads to the *running out* question: Whatever the way population growth interacts with economic development to spur increased demand for energy, will the identified and likely discoverable resources of fossil energy be adequate to accommodate such future demands? There is no certain answer to that question. However, the fact that fossil fuel resources are finite in the earth's crust has little practical bearing on the answer since, over many decades, new discoveries and innovations in exploration and extraction technology have more than offset rising consumption, with the result that the long-term trend in the real price of energy—the most critical measure of scarcity—has barely changed.

Those facts, although they are often overlooked, deserve brief amplification. Consider, for example, that in 1967, the world's proven oil reserves were estimated at around 418 billion barrels. At then prevailing levels of consumption, projections were that that supply would last some 31 years. By the year 2000, notwithstanding a vast amount of cumulative consumption in the interim, proven oil reserves had risen to 1.05 trillion barrels, equivalent to approximately 40 years of reserves at current consumption levels. Aided by such exploratory breakthroughs as *3-D seismic* and enhanced production capabilities through deep-sea and horizontal drilling, the inflation-adjusted price of crude oil has, notwithstanding periodic volatility, remained virtually stable over the long run. In fact, between the 1950s and the 1990s, the price recorded an inconsequential increase, averaging around 0.3 percent yearly. Similar technological advances can be noted regarding natural gas deposits. Moreover, since natural gas is a geologically young resource, worldwide exploration has yielded many successful discoveries. Exploitable coal deposits exist in such vast abundance that declining use, when it occurs, is much more likely to be due to environmental considerations rather than scarcity factors. In short, while history is an imperfect guide to the future, it seems highly probable that energy scarcity will not manifest itself for decades to come.

One caveat deserves to be added to this somewhat optimistic assessment. It has to do with energy security concerns arising from the concentration of petroleum resources in limited parts of the world. Their abundance notwithstanding, access to these resources could be jeopardized by political turmoil or the exercise of market power. That possibility could reinforce the impetus for a more broad-based energy portfolio, including a progressive shift to renewables, and, conceivably, a revived interest in nuclear power to smooth the longer-term energy transition, which both environmental concerns—especially global warming—and rising prices for conventional energy may in time dictate.

Beyond an Aggregative Perspective

Much of the preceding exposition has been framed in highly aggregated or stylized terms. Even if valid for the world as a whole or for broad regions, such generalized treatment says little about the subtleties, exceptions, and counterfactual experience of individual countries. Forming deeper insights on energy use therefore depends on what can be learned from conditions—not merely economic, but institutional and structural—characterizing populations in different countries.

A few examples suggest the type of considerations involved. People in rural areas of many developing countries gather and use energy, often inefficiently, in the form of firewood or dung for meeting basic needs of cooking and heating. Inevitably, this contributes to erosion and loss of soil fertility and, due to poor combustion, to a widespread incidence of indoor air pollution. While poverty is the primary cause of this practice, limited access to information and the absence, or lax enforcement, of property rights—which might limit such exploitation of the commons—are factors as well. Thus, an early-twenty-first century visitor to Bhutan—an extremely low income country by World Bank standards—will note that the country's farmers receive permanent property rights to small woodlots as a source of firewood and to meet other basic needs. This policy provides farmers with both the responsibility and incentive for adopting and maintaining sustainable forest practices. In particular circumstances, therefore, income is not the sole mediator connecting population and energy.

Energy use in densely-populated urban areas, both in developed and developing societies, exhibits its own unique characteristics. Greater density improves the economics of public transport systems, thereby achieving lower energy use per passenger-kilometer of travel in such places. Multi-family housing, another attribute of high population density, allows for more efficient energy use than single-family homes. It is not surprising that, relative to income, energy use in places like New York City or Philadelphia is significantly less than that in Dallas or Phoenix, which have dispersed settlement patterns.

These findings do not imply that crowding is good, for many things enter into decisions about where to live. Indeed, depending on local conditions, including deficient regulatory policies, higher population density can aggravate energy-producing pollution. Mexico City, for example, illustrates how a crowded metropolitan area, traffic congestion, and a substantial volume of industrial activity lacking effective pollution controls all combine with weather inversions to pose serious environmental and public health problems. And, as in numerous other developing-country cities, significant continuation of urban in-migration, coupled with natural population growth, make the search for solutions more challenging. Even in very large cities that have achieved, or are approaching, middle-income rank—for example, Bangkok or Sao Paulo—it is not clear that political processes and governance are as yet up to the task of managing the intertwined challenges of pollution, congestion, and the provision of adequate municipal services. Specifically with respect to energy use, these qualitative dimensions of rising demand, as much as any demographic pressures on resource availability, will require the prime attention of both researchers and policy-makers in the years ahead.

See also: *Climate Change and Population: Future; Disease and History; National Security and Population; Natural Resources and Population.*

BIBLIOGRAPHY

Birdsall, Nancy. 1992. *Another Look at Population and Global Warming,* Working Paper WPS 1020. Washington D.C.: World Bank.

Darmstadter, Joel. 2001. "The Energy-CO_2 Connection: A Review of Trends and Challenges." In

Climate Change Economics and Policy, ed. Michael A. Toman. Washington, Resources for the Future.

———. 2001. "On Population and Resources," An Exchange Between D. Gale Johnson and Partha Dasgupta. *Population and Development Review.* 27(4): 739–754.

United Nations. 2001. *Population, Environment and Development.* New York: Department of Economic and Social Affairs, Population Division.

World Bank. 1994. *Population and Development: Implications for the World Bank.* Washington D.C.: World Bank.

Joel Darmstadter

ENVIRONMENTAL ETHICS

Unqualified references to "population" typically refer to the human population. This is no doubt true of the vast majority of entries in this encyclopedia, which thus might more accurately be titled *The Encyclopedia of Human Population.* As things stand, however, species-specific references to the particular kind of "population" under discussion typically occur only in the context of specialized discussions in biology and ecology, especially the field of population biology.

These observations indicate a morally relevant point: The implicit understanding that the term *population* typically refers, unless otherwise specified, to the human population both reflects and reinforces the implicit assumption that human populations are the ones that really matter, the ones that, morally speaking, really count. There is of course a legitimate place for the widespread discussion of issues relating to human population, but why are these discussions not explicitly referred to as discussions relating to the human population so as to acknowledge the basic fact that humans live on this planet alongside a great many other, nonhuman kinds of populations to which humans are evolutionarily related?

Anthropocentrism

Acknowledging the ongoing human-centered (anthropocentric) nature of people's thinking, including the empirical and moral distortions that this introduces, has been a central motivating factor in the development of the field of inquiry that has become known as environmental ethics or, more generally, environmental philosophy. These empirical and moral distortions have included claims (in the Western tradition at least) along the lines that "we" (meaning the human population) dwell at the center of the universe; that humans and humans alone possess a soul and are created in the image of God, to whom they have a privileged personal relationship; that humans occupy the highest (and therefore most perfect) position in a scale of nature (Aristotle's influential *scala naturae*); that humans occupy the highest earthly position in a great chain of being that stretches all the way up to God (a view that permeated medieval thinking); and that humans are essentially and uniquely rational (a view that runs from the early Greek philosophers through the greatest thinkers up to the present yet is called into question by what has been learned from Sigmund Freud and the developments in clinical psychiatry and psychology since Freud as well as from human cognitive psychology, comparative psychology, and cognitive ethology).

As John Passmore argues, the history of ideas reveals that these kinds of anthropocentric views have been employed in varying forms to underpin the morally charged conclusion that humans are either exclusively or overwhelmingly valuable relative to all other earthly kinds and that these other earthly kinds are therefore people's to do with as they will. Indeed, as Passmore notes, throughout the history of Western philosophical thinking, "It is constantly assumed that whatever else exists does so *only for the sake of* the rational"(p. 15) (emphasis added). This sort of thinking has patently obnoxious upshots.

To take just one kind of example, Passmore states: "In so far as cruelty to animals was wrong, this was only because, so it was argued by [Thomas] Aquinas, by [Immanuel] Kant, and by a multitude of lesser thinkers, it might induce a callousness towards *human* suffering. There was nothing wrong with cruelty to animals *in itself*" (p. 113). It seems almost inconceivable today that highly intelligent thinkers of any period could maintain that nonhuman animals were not capable of suffering (a view to which René Descartes, the father of modern philosophy, was committed) or that they could suffer but that their suffering was of no direct moral consequence. However, up until at least Kant's time the most influential thinkers in the Western tradition believed precisely this.

The Argument against Anthropocentrism

Correcting anthropocentrically fueled intellectual distortions—or undermining them by showing their irrelevance to defensible moral conclusions—has been one of the central theoretical motivating factors for environmental ethicists. The central practical motivating factor has been the increasing sense, especially since the 1960s and the birth of the modern environmental movement, of a number of gathering ecological crises. It is the conviction of environmental ethicists that these theoretical and practical factors are directly related: that how people think about—or fail to think about—the value of the world around them has a direct connection with the ecological crises that people are experiencing today. Things might have turned out otherwise: People might have had a set of views that resulted in a far more ecologically respectful approach to the world around them yet still suffer from a range of ecological crises resulting from, say, an asteroid impact. However, it seems that the current ecological crises are largely anthropogenic, that is, of human origin. If it is true that there is a direct connection between these anthropogenic crises and the ways in which people think about and value the world, then environmental ethics must be thought of as a discipline that carries profound significance for the future of habitable life on Earth. Thus, Edward O. Wilson concluded a 1989 paper with the reflection that

> Environmental ethics, still a small and neglected branch of intellectual activity, deserves to become a major branch of the humanities during the next hundred years. In the end, when all the accounting is done, conservation will boil down to a decision of ethics based on empirical knowledge: how we value the natural world in which we evolved and now, increasingly, how we regard our status as individuals. (p. 7)

Environmental ethics did not arise as a formal field of inquiry until the 1970s. Its official birth—after a period of gestation during the 1970s that saw the publication of a number of influential papers and books—perhaps can be dated to 1979 with the publication of *Environmental Ethics,* the first refereed journal in the field. Echoing the point made at the beginning of this entry about the term *population,* environmental ethicists have been unrelenting in pointing out that the discipline of ethics, and of philosophy generally, has been directly responsible for introducing and defending profoundly anthropocentric biases into Western thought.

A significant upshot of these biases is that the subject area known as ethics (or moral philosophy) has been focused almost exclusively on humans for the 2,500 years from the time of the Greek founders of this area of inquiry until at least the 1970s. Yet when people today hear the term environmental ethics, they think of it as a minor, specialized offshoot of a "main game" that is known purely and simply as ethics, when in fact environmental ethics represents a vast enlargement of the traditional boundaries of that main game. This is the case because it is the environmental ethicists who have deliberately and systematically criticized the traditional restriction of moral status to human beings on scientific, pragmatic, logical, moral, and even experiential grounds and at the same time have opened up the issue of moral status in order to address the question of what kinds of entities ought to be granted moral status and why. This means that it would be more logical, informative, and intellectually honest to change the name of what traditionally has been referred to as *ethics* to *human ethics* and to change the name of *environmental ethics,* which can mistakenly suggest a more specialized area of inquiry, to *general ethics.*

Ethical arguments that extend moral status beyond the human sphere typically begin by making two critically damaging points against the restriction of moral status to humans. The first is the logical point that it is not possible to identify a single morally relevant characteristic that distinguishes all humans from all nonhumans. For example, even if one accepted the idea that rationality (or the abilities that follow in its wake, such as the capacity to act as a moral agent) should be the criterion for moral status, one would find that there is a now standard objection to this view: the argument from marginal cases. This is the objection that such a view would not even include all humans, since some humans have not yet developed this capacity (infants), some have lost it and will never regain it (e.g., the senile, people in a persistent vegetative state), and some will never develop it (e.g., people who are profoundly retarded or brain damaged). Should it be permissible to do anything to these people, for example, experiment on them, as can be done to other animals, including other primates, humankind's closest evolutionary cousins, who can often lay more claim to rationality than can these "marginal cases"? However, if one tries to come up with a morally relevant characteristic that will include all humans, including these marginal cases, one will find that one is employing a criterion of moral status that also includes a great many nonhuman beings.

The second argument against the restriction of moral status to humans is the moral point that the traditional criteria that have been advanced for moral status—such as those of rationality or actual or potential moral agency and those that rest on highly contested religious assumptions—are irrelevant to the basic reason why most people think it is categorically wrong, say, to torture a baby. The basic reason most people think that this is categorically wrong is not because the baby is actually or even potentially rational, capable of moral agency, or endowed with a soul but simply that the baby will suffer if this is done and that there is no justification for inflicting that suffering. However, if this is the basic reason, consistency of reasoning—or what might simply be called intellectual honesty—demands that one should not inflict unnecessary suffering on any being that is capable of suffering (i.e., any sentient being).

This essentially is the argument that was advanced by the philosopher Jeremy Bentham (1748–1832), the founding father of utilitarianism, and later was taken up and elaborated by Peter Singer. For Singer and other animal liberationists, consistency requires that equal consideration be given to equal degrees of pain no matter who the bearer of that pain is; to say that one should be concerned about pain only when it occurs in humans and not when it occurs in other primates, cats, birds, or fish is akin to saying that one should be concerned about pain only when it is experienced by men or whites. It amounts, in other words, to a morally indefensible form of discrimination, which Singer refers to as speciesism.

Nonanthropocentric Arguments

Other thinkers have developed different arguments for attributing moral status to nonhuman animals. These arguments range from Tom Regan's "subject-of-a-life" approach to animal rights, which would attribute the same degree of moral status to many nonhuman animals that is attributed to humans, to Richard Ryder's "painism" approach, which Ryder argues combines the best of Singer's and Regan's approaches, to R. G. Frey's "unequal value thesis" and Charles Birch and John Cobb's "richness of experience" approach, both of which only go halfway toward accepting Singer's argument in that they accept the moral significance of sentience but attribute different degrees of moral status to nonhuman animals—and people—on the basis of their overall capacity for richness of experience.

If one accepts any of these arguments even partially, one has attributed at least some degree of moral status to the members of a great many kinds of populations other than human populations. The implications of this for human action, including the incursion of human populations on nonhuman populations, are potentially immense.

However, that is just the beginning of the nonanthropocentric argument. Other thinkers go even further and argue that living things per se (such as plants) embody certain kinds of interests (such as the need for light and water) whether these living things are sentient or not. For example, physician Albert Schweitzer advanced a "reverence for life" ethic that has found more contemporary and perhaps more philosophically rigorous statement in the work of both Kenneth Goodpaster and Paul Taylor. Other environmental ethicists have noted that all the approaches discussed so far—anthropocentric, zoocentric, and biocentric—focus on individual entities: humans, nonhuman animals (or at least some nonhuman animals), and living things (including plants), respectively.

For these thinkers, there is something that is even more radically different about environmental ethical thought than its rejection of anthropocentrism: its questioning of any ethic, no matter how nonanthropocentric, that confines itself to an individualistic moral focus. In their view, what is profoundly revolutionary about environmental ethical questions is that they force people to take seriously the idea that certain kinds of complex wholes—paradigmatically, ecosystems and the ecosphere itself—may be proper foci of moral concern in their own right.

This idea was first seriously advanced in an ecological context by the American forester and conservationist Aldo Leopold in the culminating section ("The Land Ethic") of *A Sand County Almanac,* originally published in 1949. Contemporary environmental ethicists such as J. Baird Callicott and James Heffernan have drawn different kinds of inspiration from Leopold's pioneering Land Ethic in elaborating more philosophically rigorous versions of ecological holism. Other environmental philosophers, such as the advocates of "deep ecology" and "ecofeminism," are impatient with formal philosophical arguments about moral status per se and want instead to construct a type of ecological virtue ethics in which the point of the ethical enterprise would be to cultivate a wider and deeper sense of identification with the world around humankind in the case of deep ecology or a more caring attitude toward that world in the case of ecofeminism. Again, the implications of these nonanthropocentric views —biocentric, ecocentric, deep ecological, and ecofeminist—for the scale and rate of human impact on the natural world are potentially immense. This realization raises significant ethical questions about the built environment—both how people build and how people live in built environments—that are just beginning to be explored from an environmental ethical perspective.

However, lest these approaches (or at least those which are explicitly concerned with questions of moral status) sound like a simple continuum—a kind of linear bus ride in which different people who consider these issues get off at stops labeled anthropocentrism, zoocentrism, biocentrism, and ecocentrism (or ecological holism), depending on how far they feel the arguments oblige them to go—it must be pointed out that there are some very sharp turns and even disjunctions along this path.

To start with, nonanthropocentric environmental ethicists in general have an argument with the whole Western ethical tradition, which has systematically excluded and even denigrated the moral status of all members and aspects of the nonhuman world. However, even within the nonanthropocentric environmental ethical fold there are major divisions and disagreements. One of the most theoretically difficult and practically urgent is the argument between those who adopt an individualistic focus and those who adopt a holistic focus. Recent research suggests that the second leading cause of loss of biodiversity in the world today is introduced species that have become invasive and outcompeted indigenous species. What to do? In the case of invasive (nonhuman) animals such as feral cats and foxes in Australia, the animal liberationist—and certainly the animal rights advocate—is committed to saying in effect, "Leave the invasive animals alone; they have as much right to live as any other animals," whereas the ecocentrist is committed to saying, "Do whatever is necessary to get rid of the invasive animals; we have a duty to preserve the characteristic diversity of this region." There are real-world examples of precisely this sort of confrontation. Thus, Callicott once characterized the argument about animal liberation as a "triangular affair," a three-way argument between anthropocentric ethicists, animal welfare advocates, and ecocentrists.

The Future of Environmental Ethics

These kinds of debates are both important and overdue. Environmental ethics or, more logically, general ethics is overturning the Western ethical tradition, is still in its infancy, and both promises and needs to become, as Wilson said, a major branch of intellectual inquiry in the next hundred years.

See also: *Animal Rights; Ecological Perspectives on Population; Future Generations, Obligations to; Sustainable Development.*

BIBLIOGRAPHY

Birch, Charles, and John Cobb. 1981. *The Liberation of Life.* Cambridge, Eng.: Cambridge University Press.

Callicott, J. Baird. 1980. "Animal Liberation: A Triangular Affair." *Environmental Ethics* 2: 311–338.

———, ed. 1987. *Companion to a Sand County Almanac: Interpretive and Critical Essays.* Madison: University of Wisconsin Press.

Cohen, Carl, and Tom Regan. 2001. *The Animal Rights Debate.* Lanham, MD: Rowman and Littlefield.

Fox, Warwick. 1995a. *Toward a Transpersonal Ecology: Developing New Foundations for Environmentalism.* Albany: State University of New York Press, and Totnes, Devon, Eng.: Green Books.

——— 1995b. "Anthropocentrism." In *Conservation and Environmentalism: An Encyclopedia,* ed. Robert Paehlke. New York and London: Garland Publishing.

———, ed. 2000. *Ethics and the Built Environment.* London: Routledge.

Heffernan, James. 1982. "The Land Ethic: A Critical Appraisal" *Environmental Ethics* 4: 235–247.

Johnson, Lawrence. 1991. *A Morally Deep World: An Essay on Moral Significance and Environmental Ethics.* Cambridge, Eng.: Cambridge University Press.

LaFollette, Hugh. 1997. *Ethics in Practice: An Anthology.* Malden, MA, and Oxford: Blackwell.

Passmore, John. 1980. *Man's Responsibility for Nature: Ecological Problems and Western Traditions.* 2nd edition. London: Duckworth & Co.

Ryder, Richard. 2001. *Painism: A Modern Morality.* London: Centaur Press.

Singer, Peter. 1990 (1975). *Animal Liberation,* 2nd edition. London: Jonathan Cape.

Warren, Mary Anne. 1997. *Moral Status: Obligations to Persons and Other Living Things.* Oxford: Oxford University Press.

Wilson, Edward O. 1989. "Conservation: The Next Hundred Years." In *Conservation for the Twenty-First Century,* ed. David Western and Mary Pearl. New York and Oxford: Oxford University Press.

Zimmerman, Michael, general ed. 2001. *Environmental Philosophy: From Animal Rights to Radical Ecology.* Upper Saddle River, NJ: Prentice Hall.

WARWICK FOX

ENVIRONMENTAL HEALTH

The word environment as applied to health is elastic in use. Conventionally it refers to the external factors—physical, chemical, and microbiological—that impinge on human health, usually through shared exposures among members of communities or whole populations, and that therefore are not under the control of individuals. A broader definition embraces the social environment, including the aspects of social capital that influence health within the community at large. Indeed, in the early twenty-first century about half of all people live in urban environments as *Homo sapiens* becomes an urbanized species. The urban environment is essentially a habitat: a system of interacting physical, demographic, social, and cultural environments. These wider dimensions of the environment necessitate a more ecological, systems-based approach.

External environmental exposures can be either natural or human-made and have a local, regional, or global scale. The modern preoccupation is with human-made environmental hazards. Historically, however, concerns focused on aspects of the natural environment, including weather extremes, infectious agents, physical disasters, and local micronutrient deficiencies. For example, one-fifth of the world population lives on ancient, leached, and often mountainous iodine-deficient soils. This puts many populations at risk of iodine deficiency disorders, including goiter, reproductive impairment, and congenital disorders, including cretinism (Hetzel and Pandav 1994).

The environmental health agenda also must encompass the risks to population health that result from humankind's larger-scale disruption of the planet's ecological and geophysical systems. These are the systems that provide nature's "goods and services": climatic stability, food yields, the supply of clean fresh water, and the healthy functioning of biotically diverse natural ecosystems that recycle nutrients, cleanse the air and water, and produce useful materials. This disruption or depletion of the biosphere's life support systems can affect health through pathways that are less direct and sometimes less immediate than the effects of specific traditional hazards.

In industrialized countries attention has been directed predominantly to the plethora of chemical contaminants entering air, water, soil, and food, along with physical hazards such as ionizing radiation, nonionizing radiation, urban noise, and road trauma. In the popular understanding prototypical environmental health events include the disasters of Chernobyl, Bhopal, Seveso, Minamata Bay, and the Great London Smog of 1952. As technologies evolve and as levels of consumption rise, the list of candidate hazards lengthens: In the late 1990s questions arose about the cancer hazard of electromagnetic radiation from mobile phones, the risk to a fetus from chlorinated organic chemicals in chlorine-treated water supplies, and the possible toxicity and allergenic and other consequences of genetically modified foods. In low-income countries the major environmental concerns continue to be the microbiological quality of drinking water and food, the physical safety of housing and work sites, indoor air pollution, and traffic hazards.

The relative importance of environmental exposures as a cause of human disease and premature death remains a matter of contention. Depending on definitions and assumptions, estimates of the environmental contribution to the global burden of disease and premature death vary. The World Health Organization has estimated that about 25 percent of the global burden, as measured in disability-adjusted life years (DALYs), is caused by environmental hazards, along with around one-sixth of the total burden in children. Kirk Smith and colleagues (1999), in an analysis that encompassed disease initiation, progression, and case outcome, estimated that 25 to33 percent of the global burden of disease and premature death is attributable to direct environmental risk factors.

Relationships between Environment, Population, Poverty, and Health

The relationships among ambient environmental conditions, socioeconomic circumstances, demographic change, and human health are complex and multidirectional. Some of the relationships are immediate; for example, poverty today causes malnutrition today. Other relationships involve long time lags; for example, current poverty contributes to the need to clear local forests for fuel and to farm marginal lands, inducing ecological attrition and hunger in the future. Time lags aside, there is not a simple linear causal chain connecting these variables. Population pressure and poverty in rural populations often lead to land degradation, with consequences for supplies of food and materials. Meanwhile, poverty influences fertility rates, and vice versa. Environmental degradation often causes further impoverishment and also may impair health through increases in infectious disease, nutritional deficiencies, and toxic environmental exposures.

In many African, Asian, and Latin American countries life expectancy is 20 to 30 years less than it is in rich Western countries. Infectious diseases remain the main killer, particularly of children below five years of age. Much of this health deficit reflects the widespread poverty, adverse social consequences of export-oriented economic development, and environmental adversity caused by the exploitation of natural resources.

Some larger-scale environmental stresses may heighten social tensions, leading to conflict and adverse health consequences. For example, Ethiopia and the Sudan, upstream of Egypt, increasingly need the Nile's water for their crops. Worldwide, approximately 40 percent of the world's population, living in 80 countries, now faces some degree of water shortage. The prospect of international conflict caused by environmental decline, dwindling resources, and ecological disruption enlarges the shadow over the prospects for human health.

It is difficult to confirm or refute the widely assumed linkage between poverty, environment, and health. Both poverty and environmental degradation, through independent pathways, increase risks to health. There is also a strong but complex relationship between income level and environmental quality. For many important environmental pollutants, as average incomes rise, the effect on environmental quality can be represented by an inverted U-shaped curve. Initially the pollutant loads increase; then, as wealth, literacy, and political liberalism increase, negative feedback processes emerge and societies act to reduce those pollutants. However, the indexes of several larger-scale sources of environmental degradation, such as emissions of the greenhouse gas carbon dioxide, display a continuing increase. These are "global commons" problems for which there is not yet sufficiently clear evidence of adverse social, economic, or health consequences to generate negative feedback responses through the policy process. Humankind has not yet learned how to mitigate, with international cooperation, these large-scale threats.

Conclusion

Throughout history human communities have depleted natural resources and degraded local ecosystems. Often the consequences have been a recession in local human numbers and impairment of nutrition, health, and social viability. Demographers have long debated the classic Malthusian problem in which local population needs exceed the local environmental carrying capacity. In the early twenty-first century that postulated process of ecological deficit budgeting has become global, an unprecedented development for humankind with significant implications for human population health.

For the last two centuries environmental health concerns in the industrializing world have focused mainly on toxicological or, less often, microbiological risks to health from specific agents in the local environment. In low-income countries the traditional hazards from infectious agents in air, food, and water, along with malnutrition and the physical hazards of living environments, have predominated. The escalating impact of human numbers and economic activity has begun to alter some of the major global biophysical systems that underpin the health of humans and all other species. Humankind is at risk of incurring global ecological deficits as, increasingly, people live beyond the planet's overall environmental carrying capacity.

See also: *Climate Change and Population: Future; Disease and History.*

BIBLIOGRAPHY

Diamond, Jared. 1998. *Guns, Germs and Steel. The Fate of Human Civilizations.* London: Jonathan Cape.

Gleick, Peter H. 2001. *The World's Water 2000–2001.* Washington, D.C.: Island Press.

Grossman, G. 1995. "Pollution and Growth: What Do We Know?" In *The Economics of Sustainable Development,* eds. I. Goldin, and L. A. Winters. Cambridge, Eng.: Cambridge University Press.

Hetzel, Basil S., and C. S. Pandav. 1994. *SOS for a Billion: The Conquest of Iodine Deficiency Disorders.* Bombay, India: Oxford University Press.

Homer-Dixon, T. F. 1994. "Environmental Scarcities and Violent Conflict: Evidence from Cases." *International Security* 19: 5–40.

Logie, Dorothy E., and Solomon R. Benatar. 1997. "Africa in the 21st Century: Can Despair Be Turned to Hope?" *British Medical Journal* 315: 1444–1446.

McMichael, Anthony J. 2001. *Human Frontiers, Environments and Disease: Past Patterns, Uncertain Futures.* Cambridge, Eng.: Cambridge University Press.

McMichael, Anthony J., and John W. Powles. 1999. "Human Numbers, Environment, Sustainability and Health." *British Medical Journal* 319: 977–980.

Smith, Kirk, Carlos Corvalan, and Tord Kjellstrom. 1999. "How Much Global Ill Health Is Attributable to Environmental Factors?" *Epidemiology* 10: 573–584.

World Health Organization. 1997. *Health and Environment in Sustainable Development: Five Years after the Earth Summit.* Geneva: World Health Organization.

A. J. McMichael

ENVIRONMENTAL IMPACT, HUMAN

Since the late nineteenth century, changes to the global environment have been profound—and mostly in the direction of degradation. Such changes include ozone destruction, widespread smog, devastating erosion, river blockages and channelization altering water flow and preventing nutrients from reaching deltas and seas, the frenzied clearing of tropical forest for timber and arable land, the collapse of ocean fisheries and other common-access resources, and heightened extinction rates. As the historian John McNeill chronicles, humans, propelled by population growth, migration, and urbanization, and by the worldwide drive for development with its penchant for the industrial "Motown cluster" of automobiles, oil, chemicals, and plastics, have powerfully transformed the planet.

But as the cultural geographer David Lowenthal once astutely pointed out, "the acceleration of environmental transformations blinds us to their antiquity." Antiquity is the focus here: Did human hands aggressively shape the environment prior to the modern or industrial era? Did indigenous people walk lightly on the land? People in preindustrial times surely possessed comprehensive environmental knowledge and were ecologists in the sense of thinking about the environment and its components in interrelating, systemic (but always culturally specific) fashion; some were environmentalists in their expressed concern for the state of the environment. But what counts when considering the human impact on the environment is how people behaved. Did they conserve resources—that is, intentionally use them wisely to maintain their future availability, and avoid waste, despoliation, and the like—or did they take quite different action with other ends in mind, leading rapidly or ultimately to depleted resources and unsustainable futures?

Despite widespread infatuation with the late-twentieth-century image of indigenous people living lives consistently in balance and harmony with nature, the answers to these questions are complex. They can be sought in the scientific, archaeological, and historical record, as well as in ethnographies of nineteenth- to twentieth-century indigenous people living traditional lives. The latter offer useful ways to imagine preindustrial times with respect to the use of fire, animal extinctions, food production and village life, and extirpations linked to the emergence of market economies. Special attention is given here to the North American case.

Fire

Human-induced fire is as old as our species, Homo sapiens, and might have evolved as long as one-half to one million years ago as one of the earliest hominid tools. The evidence of fire is in the archaeological and historical record on all continents and innumerable islands. Because fire has transformative effects on ecosystems, landscape—that is, culturally modified environment—is as ancient as humankind. Wilderness, defined as territory untrammeled by humankind, became increasingly uncommon after humans began using fire.

North America, for example, was far from the pristine, primeval land the Europeans imagined it to be when they arrived. Instead the continent, as noted by an early-seventeenth-century Dutch mariner off the East Coast, was "smelt before it is seen." Everywhere, the Native American Indians torched the land. They burned to improve subsistence, to create favorable ecological niches, to drive animals from one place to another, to increase production of crops or berries and other gathered foods, to set the stage for new plant growth that would attract herbivores and, in turn, carnivores in another season. They knew what would happen to the land and to plants and animals as a result of their burns. Their use of fire revealed keen awareness of the systemic interrelationships that are at the core of the conception of an ecosystem. Indians possessed their own theories of animal behavior (ethnoethology) and gave ecosystems cultural definition with spaces and links that would not necessarily appear in a Western conservation biologist's depiction of the ecosystem. They were ecologists, if ecology also can be ethnoecology. But these first North Americans did not always burn with ecological consequences in mind. Some often used fire as an offensive or defensive weapon, to drive enemies before them or to cover their own escape. Many lit fires to send signals to each other, communicating a variety of desires and plans. Others who lived in forests set them ablaze to ease travel. Many of these fires, as well as others, raged beyond control, deeply scorching the land beyond short-term utility, killing animals, and burning until extinguished by rain or halted by rivers.

Determining the precise ecological consequences of long-past fires can be daunting because archaeologists cannot always know whether fires were natural (caused by lightning) or anthropogenic. Yet in North America certain ecosystems are fire-succession ecosystems in which human hands were present in their maintenance if not at their inception. For example, widespread ponderosa pine forest requires periodic fire to eliminate competing understory, and in the absence of fire these pines grow so densely that the forest stagnates or changes to one dominated by shade-tolerant species. Chaparral, a scrub community in the North American West, is fire-induced and will endure as a robust ecological community only if managed by fire (which many Indians did, to the benefit of useful plants and the animals attracted to them). Longleaf pine forests in the Southeast require regular fires to remove competing plants and destructive fungus. Longleaf pines are fire-adapted in growth and in fire's absence fail to reproduce or survive, and the forest changes to one dominated by other pines and deciduous trees. Finally, the eastern sections of the vast North American plains and prairies, where moisture allowed natural succession by oaks, aspens, and willows, were maintained and quite possibly induced by human-originated fires.

In short, when Europeans gazed upon North America for the first time and many imagined an untouched Edenic wilderness, they actually were looking in large part upon a cultural, anthropogenic landscape produced and maintained by fire. Many landscapes in other regions of the world had similar pyrogenic histories.

Animal Extinctions

Humans are implicated in animal extinctions long before the highly publicized ones of the modern period. One episode occurred at the end of the era known as the Pleistocene in North America, where the destruction of numerous species of animals followed closely on the heels of the initial arrival of hunting-gathering Paleoindians some 13,000 to 14,000 years ago (Australia has a similar history at an earlier time). The Pleistocene extinctions were remarkable. At least 35 mammalian genera disappeared, many in the millennium beginning 11,000 years ago. Animals familiar and unfamiliar, widespread and local, and large and small vanished. Many were large animals, the so-called megafauna: hulking, tusked mammoths and mastodons; slow-moving giant ground sloths; the armored 2,000-pound, six-foot long glyptodonts, a kind of giant armadillo; single-hump camels; 300-pound giant beavers; hyena-like dire wolves; short-faced bears; scimitar-toothed and great saber-toothed cats, and others.

Debate is sharp over why these animals became extinct. Some researchers point to climate, which can be linked to six other extinction episodes in the last ten million years in North America. The climate was in the throes of significant change at the end of the Pleistocene, when temperatures warmed markedly, and winters became colder and summers hotter. Entire habitats changed overnight. Grasses, plants, and invertebrate and vertebrate organisms flourished or died. Were the consequences dire for key herbivores with the potential to transform the environment, and therefore for species linked to them? There are more questions than answers about the consequences of climatic and vegetational changes on specific species, and about the precise mechanisms involved in the impact of climate on particular species.

Moreover, unlike earlier extinctions in North America, during the Pleistocene extinctions there existed men and women with a distinctive hunting technology and definite taste for species now extinct. Humans' likely role in the extinctions is argued by the other protagonists in the debate. Perhaps climate change left certain animals susceptible to a Paleoindian *coup de grace.*

One way to think about what happened in North America is to consider the large island of Madagascar, where, in the wake of human arrival some 1,500 years ago, large flightless birds, giant tortoises, hippos, more than 15 species of lemurs, and other animals became extinct. They vanished after people appeared during a long dry spell in an oscillating (wet to dry) climate. This coincidence doomed more species than either humans, desiccation, or vegetation changes alone could have.

Yet even in the absence of such coincidence, preindustrial humans were highly efficient predators who, under the right conditions, were fully capable of depleting faunal resources. For example, as people colonized the Pacific (1600 B.C.E. to 1000 C.E.), they induced widespread environmental change and exterminated thousands of species of birds. In Hawaii, colonizers cleared land with fire, diverted streams for irrigation, transformed forested coastal areas into farms and grasslands, changed mudflats into fishponds, and introduced animals. Birds vanished with their habitats or were overwhelmed by their utility as food or commodities (for example, feathers to ornament clothing); over one-half of endemic avian species were extinct when Europeans arrived. This pattern was repeated on other islands. Birds and some other animals almost completely disappeared from small islands like Easter Island, Mangaia, and Tikopia. Even on the large island of New Zealand, Polynesian colonizers deforested vast sections of the land and hunted 13 species of moas—ostrich-like flightless birds, one of which towered over men and women—to extinction before turning their attention to the small birds, shellfish, fish, and seals that remained.

Food Production, Population Size and Density, and Village Life

The extinction of birds in the Pacific is just one example of environmental change caused by food producers. From 8500 to 2500 B.C.E., a potent combination of forces for change emerged independently in Southwest Asia, China, Mesoamerica, the Andes, and what is now the eastern United States: permanent villages occupied by more people living more densely than before, with economies based on domesticated plants and animals. This way of life, anchored in food production, spread to other parts of the globe. It supported population densities 10 to 100 times as great as in most foraging societies (even as such crowding left people susceptible to diseases originating in domesticated animals and unsanitary conditions). Demography was not the only important determinant in this changing relationship between humans and the land—acquisitive intentions, resource abundance, impact of technology, and precise environmental understandings played important roles—but it was nevertheless significant. Everywhere it was practiced, this new way of life contained potential for significant environmental change—in villages and especially in the most densely settled areas where urbanism emerged.

In America north of the Rio Grande, where there were probably no more than 4 to 7 million people on the eve of European arrival (equal to the 2000 population of Colorado or Virginia), the pressures could be sensed in the Southwest and along the Mississippi, where densely-settled societies emerged, flourished, and (from the eleventh through fourteenth centuries C.E.) disappeared. These changes happened because the settlers' demand for wood for fuel, construction, and other purposes overtaxed forests; because they did not foresee the long-term consequences of delivering, through irrigation canals, saline waters to salt-sensitive crops planted in salty fields where the water table was high; or for other reasons. Farther south and centuries earlier, the Maya had degraded and deforested their own terrain, which with other factors set the stage for the abandonment of their striking ceremonial centers by 900 C.E..

These events repeat the pattern established earlier in the Old World. Canal siltation, waterlogging, and salinization doomed urban life in Mesopotamia, despite the shift from wheat to salt-resistant barley. People in the Near East denuded forests to satisfy the demand for wood, especially for use as household fuel and to prepare lime plaster. Domesticated animals (not an environmental problem in the Americas) were an important part of the production mix and were clearly linked, through heavy grazing, to defoliation and erosion. In ancient Greece and Rome, deforestation and erosion, which were prominent environmental problems, were caused by clearing lands for cultivation; grazing by cattle, sheep, goats, and pigs; and the demand for charcoal for domestic fuel and lumber for building construction and shipbuilding. Deforestation was extensive in many parts of the classical Mediterranean world. Permanently eroded and degraded, these lands were subject to flooding, siltation, desiccation, and disease—all clearly worrisome to some contemporaries who remarked upon man's effects on nature. As the archaeologist Charles Redman suggests, productive strategies often seem to have undermined whatever balance might fortuitously or deliberately have existed in cycles of decline and recovery, and to have left societies vulnerable to the unexpected—like adverse climate change.

On the eve of the transformations leading to the modern era, fifteenth-, sixteenth-, and seventeenth-century Europeans profoundly altered entire portions of their continent. Woodcutters in search of fuel, iron and other mineral smelters on the make for charcoal, and farmers seeking new arable land all assaulted forests on a broad front. Naval and merchant interests could never get enough timber for ships. Hunters systematically killed wolves and other predators. In England, marshes were drained for conversion to arable land. People engaged in brewing, brick making, dyeing, and other industries oblivious to the environmental consequences. Urban skies were darkened by the pollution from burning sulfur-laden coal. Some fled to the countryside as an escape from modern ills, but many went about their lives seemingly without regard for the wastes that fouled water and air.

Commodity-Linked Extirpations

From ancient times, as production rose above subsistence levels, the development of trade and markets increased the pace of environmental exploitation. In ancient Greece and Rome, for example, the demand for wildlife products in household and military subsistence, the commercial marketplace, private sport, and the arena led to the widespread decline of animal stocks and extirpations both on islands and the mainland. The need to protect domesticated crops from competing grazers and domesticated animals from predators also contributed to extirpations.

Environmental destruction reached a new level with the rise of capitalism in seventeenth-century Western Europe. The subsequent global spread of Europeans affected the environmental history of all continents. In North America, Europeans arrived along with microbes that were harmless to them, inadvertently unleashing horrific epidemic diseases among the Indians. These diseases killed great numbers of indigenous people and in the short run lessened pressures on ecosystems. But the Europeans also came with an unrelenting and expansive belief that environmental goods were commodities for exploitation. This commodification of the environment, together with increasingly capital-intensive industrial designs, ultimately proved profoundly transformative. Indigenous people responded by becoming primary suppliers of environmental goods such as animal pelts and skins in exchange for a variety of desired, highly valued consumer goods. The two most famous commodities from the sixteenth through the nineteenth centuries were deerskins and beaver pelts, willingly supplied by indigenous people to the point of extirpation of white-tailed deer and beaver populations.

It is often assumed that indigenous people like the Native Americans possessed a primordial conservation ethic that they abandoned as they participated in Western systems of commodification. If the global ethnography of hunting and foraging people in modern times is any guide, this assumption is erroneous. Restraint in harvesting wildlife is rare among such people, who instead make choices that maximize efficiency or promise high yields. Moreover, in the case of the North American Indians, the hunt was ruled by culturally defined respect for prey species which, properly approached in thought and deed, gave themselves up for sustenance and use and thereby gained the opportunity to be reborn to be killed another day. For restraint to be practiced, this indigenous belief in reincarnation had to be reconciled with Western-style conservation.

Conclusion

Neither the antiquity of environmental change nor the enormous scale of transformation in the modern global environment should be in dispute. In some cases, ancient and modern behavior produces similar results: Extinction of a species is forever, whether at the end of the Pleistocene, on a Polynesian island 500 years ago, or in twentieth-century North America. Moreover, some small-scale modern environmental changes at least superficially mimic ancient ones associated with the emergence of densely settled village life based on domestication. The major difference is one of scale, linked to population size and technology: In the past, the changes were local or regional; in the early twenty-first century they have global potential. The tempo of change has also risen markedly. Yet one should be humbled by the fact that the consequences of ancient destructive practices are often visible today—although noting the irony that, in places like Greece, the long history of environmental degradation produced the aestheticized landscapes that many now admire, in ignorance of their origin.

See also: *Biogeography; Carrying Capacity; Ecological Perspectives on Population; Hunter-Gatherers; Prehistoric Populations; Sustainable Development.*

BIBLIOGRAPHY

Diamond, Jared. 1997. *Guns, Germs, and Steel: The Fates of Human Societies.* New York: W. W. Norton.

Goudie, Andrew. 1990. *The Human Impact on the Natural Environment,* 3rd edition. Cambridge, MA: MIT Press.

Hughes, J. Donald. 1994. *Pan's Travail: Environmental Problems of the Ancient Greeks and Romans.* Baltimore, MD: Johns Hopkins University Press.

Kirch, Patrick V. 1997. "Microcosmic Histories: Island Perspectives on 'Global' Change." *American Anthropologist* 99(1): 30–42.

Krech, Shepard, III. 1999. *The Ecological Indian: Myth and History.* New York: W. W. Norton.

Krech, Shepard, III; Carolyn Merchant; and J. R. McNeill, eds. 2003. *Encyclopedia of World Environmental History.* New York: Routledge.

Lowenthal, David. 1990. "Awareness of Human Impacts." In *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 Years,* ed. B. L. Turner II, W. C. Clark, R. W. Kates, J. F. Richards, J. T. Matthews, and W. B. Meyer. Cambridge, Eng.: Cambridge University Press.

McNeill, John R. 2000. *Something New Under the Sun: Environmental History of the Twentieth Century.* New York: W.W. Norton.

Redman, Charles L. 1999. *Human Impact on Ancient Environments.* Tucson: University of Arizona Press.

Shepard Krech III

EPIDEMICS

Epidemic diseases break out, reach a peak, and subside; endemic diseases cause a relatively constant amount of illness and death over time (see Figure 1). Epidemic diseases can be new or normally endemic to a community. They break out on a local level and remain localized, or spread out in diffusion waves to surrounding communities. Very large-scale epidemics that strike several continents or the entire globe are called pandemics. Although relatively infrequent, pandemics are exceptionally disruptive; the economic, social, and demographic damage they do insures that they receive the lion's share of attention from both contemporaries and historians.

Defining Epidemics

The most familiar epidemic diseases are propagated by direct contact between infected and uninfected persons, as is the case with tuberculosis, smallpox, measles, polio, syphilis, and AIDS, among others. But some of the most devastating epidemic diseases were and are transmitted to human beings by insect vectors, such as bubonic plague, malaria, typhus, and yellow fever. Among the epidemic diseases spread by water-borne pathogens are cholera, typhoid, and dysentery. Some epidemic outbreaks do not involve microorganisms at all; these common vehicle epidemics can be caused by food-borne or other toxins (e.g., ergotism). Under certain circumstances, even vitamin deficiency diseases like scurvy (Vitamin C) or night blindness (Vitamin A) can break out suddenly in certain populations. Every epidemic disease has its own distinctive etiology, and its own complex relationship with both natural and social environments.

Epidemiologists identify epidemic outbreaks by observing the statistical behavior of a specific disease over time, based on the number of reported cases and/or deaths the disease causes. In theory, if zero cases of a specific disease are expected in a normal year, then even one observed case can signal an epidemic and call for a public health response. This reasoning was used in 1976 to declare a national public health emergency in the United States, based on a single unexpected death from a type of influenza that seemed similar to the 1918 outbreak.

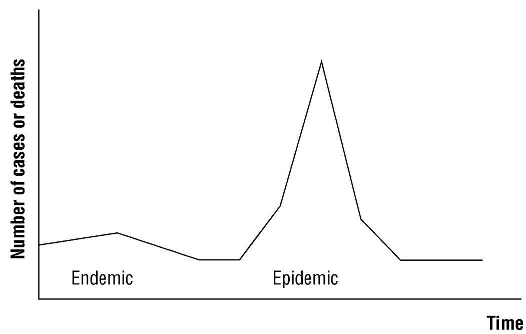
By using statistical criteria alone, more and more diseases have been perceived as taking epidemic form. Around 1950, several chronic diseases were classified as epidemics, including lung and breast cancer and ischemic heart disease. Some slowly-developing "social" diseases—like alcoholism and drug addiction—and a few mental diseases like depression have also been described as epidemics. But instead of erupting and subsiding in a year or less, chronic-, social-, or mental-disease epidemics rise and fall over several decades. As a consequence, they can only be observed by experts with access to high quality morbidity and/or mortality data.

History of Epidemics

The existence of epidemics has been recorded since the beginning of written history, and in all probability they predate it. Just as epizootics (epidemic animal diseases) have always been part of the demography of animal populations, epidemics were part of the evolution of human populations. It is widely supposed that during the transition from hunting and gathering to agriculture, when human beings began to live in larger groups and at higher densities, the frequency—and possibly the severity—of epidemics increased. Subsequently, the development of cities made epidemic disease an even greater threat to human life.

FIGURE 1

Endemic and Epidemic Disease



SOURCE: Based on a graph in Gordis, *Epidemiology* (1996).

But knowledge about epidemics and mortality in history is necessarily limited by the relative absence of reliable quantitative data. Although the Black Death is one of history's most famous and well-researched epidemics, data problems have kept everything about the epidemic controversial, except for the fact that it arrived in Southern Europe in 1347 and spread to Northern Europe by 1352. Historians continue to disagree on whether or not the "plague" was one disease or several. (Before the seventeenth century, plague was still a generic concept used in connection with any sudden outbreak of disease.) Accounts from the time often describe the plague as killing the majority of the living. Most historians, however, believe that about one third of Europeans died in the first outbreak, although estimates range from less than a fifth to more than two thirds. Subsequently, major epidemics seem to have erupted with sufficient frequency and intensity in Europe that the continent's population was cut in half. Demographic recovery took two centuries or more.

It was the continuing social and economic disruption caused by recurrent outbreaks of plague that led city officials in Europe, particularly in Renaissance Italy, to develop novel measures of disease management, including the formal surveillance of mortality. By 1500, several cities in Italy were tracking deaths on a week-by-week basis, and trying to distinguish between those that were and were not caused by plague. These data have been used to estimate that, on average, plague outbreaks in the 1400s and 1500s multiplied the normal number of urban deaths by a factor of four to seven (Del Panta and Livi Bacci 1979, p. 72). In Sienna, when the normal death rate was about 35 per 1,000 per year, mortality increased by a factor of five to ten during a plague year (Livi-Bacci 2001, p. 39). In Florence, it has been estimated that epidemic disease caused 38 percent of the total number of deaths among girls under age 15 in the two centuries after the first outbreak of bubonic plague (Morrison, Kirshner and Molho 1985, p. 531).

The ancient Greek concept of *epidemic* was revived in connection with increasingly sophisticated disease surveillance systems, and was used by leading physicians to speculate on the natural causes of any sudden outbreak of disease. (Outbreaks of "influenza" received that name because university-educated physicians once thought they were caused by astral influences). Eventually all the other diseases thought to be causes of death were tracked as well.

London followed the example of cities in Italy, and by the early 1600s its officials had institutionalized the continuous surveillance of death and its causes. Thus, when John Graunt (1620–1674) published demography's founding text in 1662 (*Natural and Political Observations Made Upon the Bills of Mortality*), he could draw on more than a half-century of annual data on about 70 diseases that were thought to be causes of death. The data made it very clear that, while bubonic plague remained the most lethal epidemic disease, smallpox epidemics seemed to be getting worse. In 1665, London, with a population of about 500,000, could still lose some 80,000 lives to plague, while Copenhagen lost 20,000 people out of its total population of 60,000 in 1711.

There were no more major outbreaks of bubonic plague in Europe after the 1720s. Historians still disagree about the relative importance of human agency (particularly in the form of public health measures) versus exogenous natural causes in its disappearance. The evidence is inconclusive for Europe, but it is worth noting that outside Western Europe, in countries such as Russia, Turkey, Egypt, China, and India, bubonic plague continued to erupt on a large scale long after 1720. It ceased to do so only after European-style public health measures were adopted and enforced.

When T. R. Malthus published the first edition of his essay on population in 1798, there was enough mortality data—both urban and rural—to hypothesize about the role played by more ordinary epidemics in the regulation of population growth. To Malthus, sudden outbreaks of disease were just one of a set of four mortality-related positive checks on growth, the others being poverty, war, and famine (which he regarded as the last and most deadly positive check). Subsequent historical research suggests that before the twentieth century most deaths that occurred during wars and famines were caused by epidemic disease, not by battle casualties or starvation. Since the poor are often (but not always) hardest hit by epidemic disease, there seems limited value in distinguishing between poverty, war, famine, and epidemic disease as separate checks on population growth, at least before 1900.

Modern Study of Epidemics

Modern demographic historians tend to study epidemic disease as part of "crisis mortality," those sudden increases in deaths or death rates that were a general feature of pre-modern mortality patterns. In theory, mortality crises can be caused by natural disasters as well as by wars, persecution, genocide, and famine; but in practice most crises were caused by epidemics, at least before the early twentieth century. Using historical data, demographers have attempted to gauge how much death rates must rise above some "normal" or background level of mortality in order to constitute a mortality crisis. No agreement has been reached on how to measure either "normal" or "crisis" mortality—especially in cities, where death rates were exceptionally volatile. Thus the relative importance of crisis mortality, and by implication, epidemic disease, in keeping life expectancy levels low (below 40 years) before the modern era remains a matter of controversy.

In theory, the extent to which epidemics as mortality crises can regulate population growth depends on their frequency, amplitude, and duration. But with respect to amplitude, using a high threshold to identify a mortality crisis (for example, requiring that the crisis death rate must be at least five times the "normal" level) would mean that mortality crises (and, by implication, major epidemics) were too infrequent to check population growth in most places and times. In contrast, if death rates must only exceed normal levels by 10 percent, then frequent mortality crises (caused mostly by epidemics) would clearly have been the major brake on population growth in the past. In general, the importance of mortality crises, or epidemics, cannot be assessed independently of the demographic criteria used to identify them.

The uncertainties connected with crisis mortality stimulated demographic research on all short-term fluctuations in pre-modern populations, including marriages and births as well as deaths. In some localities, harvest failures could cause grain shortages, rising prices, and (with a lag) rising death rates, mostly in connection with epidemic disease. But in other cases, a steep rise of grain prices has been observed to lag behind the sharp rise in death rates associated with an outbreak of epidemic disease. Historical research suggests that up to half of all epidemics in early modern Europe broke out and caused mortality crises for reasons unconnected to harvest failures, high prices, or food shortages. The implication is that some epidemics were Malthusian—meaning that they were related to increasing poverty and malnutrition—while others were not.

From a biological standpoint, this conclusion is not surprising, since those diseases that take epidemic form are differentially, not equally, sensitive to the nutritional status of the individuals exposed. This observation is relevant to the study of economic development, where it is still widely but mistakenly assumed that whenever per capita incomes rise, nutrition will improve and death rates will fall automatically without public health reforms. This overlooks the extent to which economic development stimulated urbanization, and thus the frequency with which density-dependent, air- and water-borne diseases broke out. The empirical evidence is that death rates rose during Europe's development, despite rising income levels, until effective measures were taken to control infectious diseases that often took epidemic form.

During the twentieth century, the same story can be told on a global scale: it is primarily the decline of the infectious and parasitic diseases as leading causes of death that produced the global rise of life expectancy. These diseases were first targeted for control through public health measures because of their close connection to epidemic outbreaks of disease and death. Wherever common epidemics were prevented by effective measures of disease control, death rates declined and remained relatively flat from year to year.

The last traditional mortality crisis in the developed countries occurred in 1918 as part of a worldwide pandemic of influenza. This one outbreak was estimated to have caused more deaths in one year than World War I did in several years. (Estimates range from 20 to 40 million deaths caused by influenza, versus 15 million for war-related losses). Nevertheless, in America and Europe influenza was not particularly lethal; many more people were infected than died. In the United States, although one-third of the population is estimated to have developed the symptoms of influenza, at most less than 3 percent of the infected died (Davies 1999, p. 219). Even so, the influenza epidemic produced at least 500,000 excess deaths; as many as 650,000 if pneumonia cases are included. Had death rates prevailing during the epidemic continued, life expectancy levels in the United States would have dropped by 12 years (Noymer and Garenne 2000, p. 568). Instead, death rates quickly returned to normal levels, and subsequently resumed their decline.

Despite the relative absence of mortality crises in the last half of the twentieth century, new pathogenic diseases (newly discovered, newly reportable, or newly resurgent) have continued to turn up at the rate of six to seven per decade (Karlen 1996, p. 6). Most of these new epidemics caused few cases and fewer deaths. Indeed, in most modern epidemics, even those producing hundreds of thousands of cases, so few die that life expectancy levels are not affected. For example, an epidemic of dengue fever broke out in Brazil in 2002. In the Rio de Janeiro area alone, over 400,000 cases were reported. There were fewer than 20 deaths.

While the twentieth century saw undeniable progress in disease control, the twenty-first century began in the shadow of an unusually deadly epidemic disease. HIV-AIDS was discovered in the United States; based on 31 suspicious deaths, it was declared a new epidemic in 1981. Subsequently hundreds, then thousands, of Americans began to die from the disease. But unlike a classic epidemic disease, AIDS fatalities in the United States took more than a decade to reach their peak. By 1995 AIDS was causing

50,000 deaths a year, but even this carnage was insufficient to appreciably increase the death rate at the national level. With respect to the developed countries (and many developing ones), AIDS has not been sufficiently deadly to prevent the continued rise in life expectancy at birth.

In Sub-Saharan Africa, however, the scale of HIV-AIDS deaths has been compared to that of the bubonic plague. Because the data are often defective or incomplete, it is hard to estimate the impact. Nevertheless demographers have made valuable contributions to the estimation of the impact of AIDS on Africa's future population growth, age-structure, and fertility, as well as on mortality. United Nations estimates for 1995 through 2000 indicate that in 35 highly-affected African countries, life expectancy at birth is about 6.5 years lower than it would have been in the absence of AIDS. In the 11 worst-affected countries, life expectancy at birth may drop to 44 years by 2005–2010, instead of reaching 61 years.

As the tragic social and economic implications of the HIV-AIDS epidemic unfold in the twenty-first century, demographers reflect that epidemic disease has long been a major force in human demographic history. It is possible that research on earlier epidemics may offer valuable insights into the continuing threat posed by both epidemic disease and mortality crises to human welfare.

Further Reading

Epidemics in Europe have received the most historical attention. L. Del Panta (1980) has reconstructed major epidemics in various Italian cities over five centuries. J. Biraben (1975) studied epidemics in early modern France. English epidemics are the subject of C. A. Creighton's classic, mostly descriptive, two volume history (1891). E. A Wrigley and R. Schofield's *Population History of England* (1981: Part 2, Sections 8 and 9) takes a more quantitative approach, and focuses on smaller-scale outbreaks in England, as do S. Scott and C. Duncan (1998). Recently, more research has been done on epidemics outside Europe: China (C. Benedict, 1996); Japan (A. Janetta, 1987), India and the Near East (S. Watts, 1997). For China, traditional sources have been used to compile a list of hundreds of major epidemics occurring between 243 B.C.E. and 1911 C.E. (W. McNeil, 1976). But the data available are not sufficiently accurate or detailed to permit detailed comparative work until the late nineteenth and early twentieth centuries (P. Cliff, P. Haggett, and M. Smallman-Raynor, 1998).

See also: *AIDS; Black Death; Disease and History; Epidemiological Transition; Famine, Concepts and Causes of; Health Transition; Influenza; Mortality Decline.*

BIBLIOGRAPHY

Benedict, C. 1996. *Bubonic Plague in Nineteenth Century China.* Stanford, CA: Stanford University Press.

Biraben, J. 1975. *Les hommes et la peste.* The Hague: Mouton.

Charbonneau, H., and A. Larose, eds. 1979. *The Great Mortalities: Methodological Studies of Demographic Crises in the Past.* Liège: Ordina Editions.

Cliff, P., P. Haggett, and M. Smallman-Raynor. 1998. *Deciphering Global Epidemics.* Cambridge, Eng.: Cambridge University Press.

Creighton, C. 1891. *A History of Epidemics in Britain from AD 664 to the Extinction of the Plague,* 2 vols. Cambridge, Eng.: Cambridge University Press.

Del Panta, L. 1980. *Le epidemie nella storia demografica Italiana (secoli XIV-XIX)* Turin.

Easterlin, R. 1999. "How Beneficent is the Market? A Look at the Modern History of Mortality." *European Review of Economic History* 3: 257–294.

Flinn, M. 1981. *The European Demographic System 1500–1820.* Baltimore: Johns Hopkins University Press.

Haggett, P. 2000. *The Geographical Structure of Epidemics.* Oxford, Eng.: Oxford University Press.

Jannetta, A. 1987. *Epidemics and Mortality in Early Modern Japan.* Princeton, NJ: Princeton University Press.

Johansson, S., and C. Mosk. 1987. "Exposure Resistance and Life Expectancy: Disease and Death during the Economic Development of Japan, 1900–1960." *Population Studies* 41: 207–235.

Karlen, A. 1996. *Plague's Progress: A Social History of Disease.* London: Indigo Edition.

Kiple, K. 1993. "The Ecology of Disease." In *Companion Encyclopedia of the History of Medicine,* Vol. 1. London: Routledge.

Lee, J., and Wang Feng. 1999. *One Quarter of Humanity: Malthusian Mythology and Chinese Realities, 1700–2000.* Cambridge, Eng.: Harvard University Press.

Livi Bacci, M. 2001. *The Population of Europe: A History,* 3rd edition. Oxford, Eng.: Blackwell Publishers.

McNeil, W. 1976. *Plagues and Peoples.* Garden City, NY: Anchor Press.

Mosk, C., and S. Johansson. 1986. "Income and Mortality: Evidence from Modern Japan." *Population and Development Review* 12: 415–440.

Noymer, A., and M. Garenne. 2000. "The 1918 Infuenza Epidemic's Effects on Sex Differentials in Mortality in the United States." *Population and Development Review* 26: 565–581.

Omran, A. 1971. "The Epidemiologic Transition: A Theory of the Epidemiology of Population Change." *Milbank Memorial Fund Quarterly* 49: 509–538.

Palloni, A. 1988. "On the Role of Crises in Historical Perspective: An Exchange." *Population and Development Review* 14: 145–158.

Preston, S. 1976. *Mortality Patterns in National Populations.* New York: Academic Press.

Preston, S., N. Keyfitz, and R. Schoen. 1972. *Causes of Death: Life Tables for National Populations.* New York: Seminar Press.

Riley, J. 2001. *Rising Life Expectancy: A Global History.* Cambridge, Eng.: University of Cambridge Press.

Scott, S., and C. Duncan. 1998. *Human Demography and Disease.* Cambridge, Eng.: Cambridge University Press.

Spielman, A., and M. D'Antonio. 2000. *A Natural History of Our Most Persistent and Deadly Foe.* London: Hyperion.

Timæus, I. 1997. "Mortality in Sub-Saharan Africa." In *United Nations Symposium on Health and Mortality.* Brussels: United Nations.

United Nations (UNAIDS and WHO). 1998. *Report on the Global HIV/AIDS Epidemic.* Geneva: United Nations.

Watts, S. 1997. *Epidemics and History: Disease, Power, and Imperialism.* New Haven, CT: Yale University Press.

Wrigley, E. A., and R. Schofield. 1981. *The Population History of England 1541–1871: A Reconstruction.* Cambridge, MA: Harvard University Press.

S. Ryan Johansson

EPIDEMIOLOGICAL TRANSITION

The term *epidemiological transition* refers to the shift in cause-of-death patterns that comes with the overall decline of death rates. In European countries the fall in death rates, which began after the middle of the eighteenth century, came about because of a decline in infectious disease mortality (chiefly from cholera and tuberculosis). The victory over infectious diseases allowed people to live longer and hence to develop the chronic degenerative diseases that became the main causes of death during the twentieth century: heart disease, cardiovascular disease, and malignant tumors.

Before the eighteenth century the epidemiological pattern was far from stable but the shifts that occurred had no significant effect on the level of mortality: Some infectious diseases diminished in lethality, but other diseases replaced them. In the 1960s it was thought that increases in life expectancy in the most advanced countries were nearing completion, but from the 1970s a major decline in cardiovascular disease allowed new progress. (The fall of cardiovascular mortality began earlier in a number of countries—dating back to at least 1925 in France.) Under the double effect of the continuation of the decline in infectious disease mortality, now largely eliminated, and the decline in cardiovascular mortality, it is the weight of mortality due to cancers that has been increasing.

The epidemiological transition is one component of a series of concurrent changes in population health. Running parallel to it is a functional component, referring to change in functional health status of the population (that is, abilities and disabilities), and a gerontological component, referring to the increasing proportion of the old and very old age groups in the population, with their distinctive health problems. The term *health transition* is used to describe these various components in combination.

A Theory of Epidemiology of Population Change

The characterization of long-run changes in cause of death as an epidemiological transition was first made by the public-health physician Abdel R. Omran in 1971 in a paper that became a classic in the literature of public health. "During the transition," Omran wrote, "a long shift occurs in mortality and disease patterns whereby pandemics of infection are gradually displaced by degenerative and man-made diseases as the chief form of morbidity and primary cause of death" (Omran, p. 516). He distinguished three stages:

1. The stage before the transition, "*The Age of Pestilence and Famine* when mortality is high and fluctuating, thus precluding sustained population growth" (Omran, p. 516). Average life expectancy at birth is low and variable, in the range of 20 to 40 years.
2. The transitional stage, "*The Age of Receding Pandemics* when mortality declines progressively and the rate of decline accelerates as epidemic peaks become less frequent or disappear. The average life expectancy at birth increases steadily from about 30 to 50 years. Population growth is sustained and begins to describe an exponential curve" (Omran, p. 517).
3. The stage after the transition, "*The Age of Degenerative and Man-Made Diseases* when mortality continues to decline and eventually approaches stability at a relatively low level. The average life expectancy at birth rises gradually until it exceeds 50 years. It is during that stage that fertility becomes the crucial factor in population growth" (Omran, p. 517).

Omran proposed three basic patterns of epidemiological transition: the classical (Western) pattern, the accelerated pattern (represented by Japan), and the contemporary or delayed pattern followed by most developing countries in Latin America, Africa, and Asia. He argued that the reduction of mortality during the nineteenth century in Western countries was determined primarily by ecobiologic and socioeconomic factors, the influence of medical factors being largely inadvertent until the twentieth century.

What should be retained from this schematic picture formulated in the early 1970s? Not a lot, according to the demographer John C. Caldwell. In 2001 Caldwell wrote, "What happened in the mortality transition was the conquest of infectious disease, not a mysterious displacement of infection by degeneration as the cause of death. The resulting demographic transition with its changing age of death and the existence of large numbers of people afflicted with chronic degenerative disease (rather than life-threatening infectious disease) is important for planning health services and medical training, which is the current focus of the burden of disease approach" (p. 159). Other criticisms of Omran's account are that he suggested that the mortality decline would stop during the Age of Degenerative and Man-Made Diseases and that the epidemiological transition is universal, even if delayed for less-developed countries.

A Fourth Stage of the Transition

In a later contribution to the subject, S. Jay Olshansky and A. Brian Ault described the third stage of the transition as a plateau in epidemiological history where mortality once again attains an equilibrium, with a life expectancy at birth reaching into the 70s. This value was believed in the 1970s to be close to the biological limit to the average length of human life. As Olshansky and Ault noted, however, a few years prior to the publication of Omran's theory, the United States and other Western nations began to experience a rapid decline in death rates, mainly due to a decline in mortality from cardiovascular disease. To take into account this unexpected change, Olshansky and Ault proposed adding a fourth stage to the transition, the Age of Delayed Degenerative Diseases. During this stage the ages at death increase because the decline in mortality is concentrated at advanced ages. The age pattern of mortality by cause of death remains largely the same as in the third stage, but the age distribution of deaths from degenerative causes shifts progressively toward older ages. Such a transition is likely to have a significant effect on the size of the population at advanced ages and on the health and the vitality of the elderly. All sections of the elderly population grow markedly, particularly the numbers of the oldest old. (A critical question raised by such a development is whether declining mortality at advanced ages will result in additional years of health or additional years of senility.)

How long can this fourth stage of the epidemiological transition last? Olshansky and Ault inquired whether more debilitating conditions would replace heart disease and cancer as the main killers or whether people would die a non-disease-related "natural death" as James Fries suggested in 1980. But Olshansky and Ault contended that the shift to the fourth stage is the last of the transitions, given the likelihood that the human lifespan is finite.

The Cardiovascular Revolution

During the fourth stage proposed by Olshansky and Ault, the cause-of-death pattern continues to be modified because deaths are postponed toward older ages and the relative incidence of degenerative causes of death, cardiovascular diseases, and cancers varies by age. Thus the concept of a distinct fourth stage being added to Omran's three stages is debatable. An alternative description would show a lengthened third stage characterized by shifting proportions of degenerative and human-made diseases, thus preserving a pattern of epidemiological transition with three "ages." According to France Meslé and Jacques Vallin, however, this would not take into account the major epidemiological change represented by the "cardiovascular revolution." These authors divide the transitional stage into a first phase characterized by the decline in the infectious diseases and a second phase led by the decline in cardiovascular diseases, with possible additional phases to come. The study of mortality levels and cause-of-death patterns are of little practical help in assessing exact dates for the change from Omran's second stage to his third stage (around the 1960s) and even less for dating the change from Omran's third stage to the Olshansky and Ault's fourth stage (around the 1970s). The number of years separating the second and the fourth stages appears to vary across countries. But in reality the cause-of-death pattern exhibits a more or less smooth modification over time rather than discontinuous change.

The Dispersion of Individual Lifespans

According to Jean-Marie Robine, the study of the dispersion of individual lifespans provides support for the existence of only three stages:

1. The reference stage that precedes the fall in mortality—Omran's Age of Pestilence and Famine—which came to an end during the eighteenth or nineteenth centuries, depending on the country.
2. A first stage of transition, when the level of mortality fell and tended to stabilize as a consequence of the decline in infectious diseases affecting mainly children, resulting in a very large reduction in the disparities of individual lifespans around the mode. This Age of Receding Pandemics came to an end in the 1950s in the countries that had gone furthest in the transition, such as northern and western Europe, North America, and Japan.
3. A new stage of transition (represented by these same regions) in which the mortality decline at adult ages, including the very old, becomes relatively larger than at younger ages and where the increase in life expectancy is no longer associated with a significant reduction in the dispersion of individual lifespans.

This new stage corresponds less to Omran's third stage—which in the early twenty-first century appears to have a weak empirical foundation—and more to the fourth stage proposed by Olshansky and Ault. It could be labeled the Age of the Conquest of the Extent of Life. This is the age when humans, having finally been liberated from the great epidemics, are increasingly able to experience the full extent of the potential duration of life. This stage too may eventually come to an end, perhaps to be succeeded by a further stage. Whether this will be the Age of Limits or something else is not known. But at present, in exploring their potential longevity, humans are making unexpected discoveries—such as finding that it is possible to live well beyond 100 years.

Deviations from the Epidemiological Transition

For a period after World War II, all developing countries seemed to be moving through an epidemiological transition; since the 1960s, that was no longer the case. Some countries, most notably those of eastern Europe, failed to experience the cardiovascular revolution, thus deviating from the pattern described above. And a number of African countries, such as Nigeria, Zambia, and Zimbabwe, were struck by AIDS epidemics or by the resurgence of earlier diseases, without having completed the second stage of the transition. In the middle of the 1960s, life expectancies in the countries of eastern Europe and the Soviet Union entered a period of stagnation or regression resulting from the combined effects of increased cardiovascular mortality, violence, and alcoholism.

See also: *Disease, Burden of; Diseases, Chronic and Degenerative; Diseases, Infectious; Health Transition; Mortality Decline; Mortality Reversals; Oldest Old.*

BIBLIOGRAPHY

Caldwell, John C. 2001. "Population Heath Transition." *Bulletin of the World Heath Organization* 79: 159–160.

Caselli, Graziella, France Meslé, and Jacques Vallin. 2001. "Les entorses au schéma de la transition épidémiologique." Paper presented to the general conference of the International Union for the Scientific Study of Population, Salvador, Brazil, August 2001.

Frenk, Julio, José Luis Bobadilla, Claudio Stern, Tomas Frejka, and Rafael Lozano. 1991. "Elements for a Theory of the Health Transition." *Health Transition Review* 1: 21–38.

Meslé, France, and Jacques Vallin. 2000. "Transition sanitaire: Tendances et perspectives." *Médecine/science* 16: 1,161–1,171.

Meslé, France, and Vladimir M. Shkolnikov. 2000. "Russie: Une crise sanitaire sans précédents." *Espace, populations, sociétés* 2: 253–272.

Myers, Georges, Vicki Lamb, and Emily Agree. 2002. "Patterns of Disability Change Associated with the Epidemiologic Transition." In *Determining Health Expectancies.* Chichester: John Wiley & Sons, Ltd.

Olshansky, S. Jay, and A. Brian Ault. 1986. "The Fourth Stage of the Epidemiologic Transition: The Age of Delayed Degenerative Diseases." *Milbank Quarterly* 64: 355–391.

Omran, Abdel R. 1971. "The Epidemiologic Transition: A Theory of the Epidemiology of Population Change." *Milbank Memorial Fund Quarterly* 29: 509–538.

Robine, Jean-Marie. 2001. "Redefining the Stages of the Epidemiological Transition by a Study of the Dispersion of Life Spans: The Case of France." *Population: An English Selection* 13(1): 173–194.

Jean-Marie Robine

ESTIMATION METHODS, DEMOGRAPHIC

Demographic estimation methods have been developed to cope with inadequacies frequently found in standard demographic data. In settings where population statistics are of good quality, key descriptive demographic measures are calculated as occurrence/exposure rates, with occurrences recorded by a vital statistics system and exposure time obtained from population estimates, the latter typically census-based. In many developing countries, data from these sources may simply not be available, or may be affected by systematic errors that bias the resulting measures.

An Overview of Estimation

Improvements in demographic data have reduced the need for demographic estimation. For example, the birth histories widely collected in sample surveys in developing countries provide adequate measures of fertility and child mortality from occurrence/exposure data. However, measures for small areas and of other population parameters, such as adult mortality and migration, still often require estimation. Even when population statistics are generally adequate, estimation methods have proved useful for tracing historical trends in demographic parameters, and are also helpful for estimating some parameters of current population dynamics that are particularly hard to measure, such as migration.

Demographic estimation methods can be broadly categorized into three groups: those that estimate rates from *changes in stocks,* those that are based on *consistency checks,* and those that are based on *indirect estimation.* The ideas underlying the three groups are illustrated below with examples.

Changes in Stocks

Stocks, such as the number of people in a population over age 50 or the number of children ever born to a cohort of women, change as a result of demographic events. Changes in stocks can therefore be used to draw inferences about underlying demographic rates. In situations where demographic events are not directly recorded, or are recorded with unacceptable levels of error, changes in population aggregates between two observations can be used as a basis to estimate the number of events between the two observations. Estimation methods based on changes in stocks are all residual methods, so results are sensitive to even quite small errors in the components.

The estimation of mortality through intercensal survival provides a simple example. Suppose that population censuses have been held in 1990 and 2000 in a population that has experienced negligible migration. The population aged 30–34 in 2000 represents the survivors of the population aged 20–24 in 1990. If the data are accurate, the survivorship ratio approximates a standard life table function:

$$\frac{{}_5L_{30}}{{}_5L_{20}} \approx \frac{{}_5P_{30}^{2000}}{{}_5P_{20}^{1990}}$$

where ${}_5L_x$ is the life table person-years lived between ages x and $x+5$, and ${}_5P_x^y$ is the population aged x to $x+5$ in year y. Thus, in principle, a life table after early childhood can be derived for any population with two census age distributions that has experienced little migration, though in practice, the method is adversely affected by age misreporting errors, particularly at older ages, and possibly by age-differential under- or over-count.

Fertility can be estimated from changes in the average parity (or average number of children ever borne) of a cohort of women between two observations. The change in average parity measures their cumulative fertility between the two observations, if selection effects through attrition—by death or migration—are negligible. A cumulative fertility distribution for a hypothetical cohort experiencing the fertility rates of the period between the two observations can then be obtained by summing the cohort changes. Period age-specific rates can be estimated from the hypothetical cohort parities in a number of ways, perhaps the simplest of which is fitting of the relational Gompertz fertility model proposed by British demographer William Brass in 1981.

If accurate population estimates—such as from successive census counts—are available for two points in time, net migration can be estimated as a residual from the Demographic Balancing Equation, which expresses the identity that population change during the time interval between the two population counts must be equal to the difference between the additions to the population (births and in-migrants) and the losses (deaths and out-migrants). Thus

$$NM^{t_1-t_2} = P^{t_2} - P^{t_1} - B^{t_1-t_2} + D^{t_1-t_2}$$

where NM is the number of net migrants between t_1 and t_2, P is the population at time t_1 or t_2, and B and D are the numbers of births and deaths respectively between t_1 and t_2. Applying this method to the United States, with a 1990 population count of 248.710 million, a 2000 population count of 281.421 million, and 39.837 million and 22.775 million intercensal births and deaths, net migration between the two censuses is estimated as 15.649 million.

Consistency Checks

Consistency checks seek to compare two or more measures of the same demographic parameter. Consistency between two measures is a necessary, but not sufficient, condition of their validity. If they are found to differ, assumptions about patterns of error can under certain circumstances provide a basis for adjustment, to obtain unbiased measures of the parameter in question even if both data sources are themselves biased. Brass proposed two consistency checks that have been widely used in demographic estimation.

The P/F Ratio Method (Brass 1964) compares current and lifetime measures of fertility. Current fertility estimates for developing countries with weak statistical systems may be in error for a number of reasons: births may not all be registered, and responses to survey questions on both recent births and birth histories may suffer from omission or misreporting of date of occurrence. Brass suggested a simple consistency check for situations in which fertility is not changing rapidly and additional information is available on each woman's lifetime fertility. Age-specific fertility rates can be cumulated from the start of childbearing to obtain measures equivalent to lifetime fertility (for a hypothetical cohort) at exact ages. Measures F comparable to average parities P for five year age groups can then be obtained by interpolating between the point values using standard fertility models (for instance, the relational Gompertz fertility model mentioned above). Consistency is assessed by calculating ratios of average parity P to interpolated, cumulated age-specific fertility F' for each age group.

Brass then goes further to argue that typical errors in the age-specific fertility rates, for example omission of births from registration, may not vary by age, therefore all the F' values will be incorrect by a constant factor, whereas the reporting of children ever born, the basis of the *P*'s, may be most accurate for younger women. Thus, when the *P/F* ratios indicate inconsistency, the ratios for younger women may provide appropriate adjustment factors for the age-specific fertility rates at all ages. A simple assumption about error patterns turns a consistency check into an adjustment method.

In practice the simple assumptions just stated may be incorrect: current and lifetime fertility may be inconsistent because fertility is changing, rather than because of data errors. Changing fertility can be accommodated if information on lifetime fertility is available for two time periods, allowing the calculation of lifetime fertility for a hypothetical cohort.

Brass (1975) proposed a way to use the Demographic Balancing Equation to evaluate information on deaths by age. The equation can be written in terms of rates, and also for age groups. In a population experiencing negligible migration, the open-ended age group x and over $(x+)$ experiences exits only through deaths at ages x and over, and entries only through birthdays at age x. Thus

$$b(x+) = r(x+) + d(x+)$$

where $b(x+)$, $r(x+)$, and $d(x+)$ are the entry (birthday), growth, and death rates for the age segment $x+$. $b(x+)$ can be estimated from an age distribution as $N(x)/N(x+)$, where $N(x)$ is an estimate of the population passing through age x in a year and $N(x+)$ is the population aged $x+$. Similarly, $d(x+)$ can be estimated as $D(x+)/N(x+)$, where $D(x+)$ is deaths in a year at ages x and over. If deaths are reported with completeness c, constant at all ages relative to the population numbers, then $d(x+) = (1/c)D^o(x+)/N(x+)$, where $D^o(x+)$ is observed deaths x and over. If the population is then assumed to be demographically stable, the growth rate $r(x+)$ is constant for all x. Thus

$$N(x)/N(x+) = r + (1/c)D^o(x+)/N(x+)$$

If the assumptions are correct, the birthday rates and the observed death rates over a range of ages x should be linearly related; the intercept estimates r, the stable growth rate, and the slope estimates $(1/c)$, the reciprocal of the completeness of death registration. Once again, by making simplifying assumptions, the consistency check (of death rates based on recorded deaths against death rates computed from the difference between entry rates and growth rates) provides a basis for adjustment.

If information is available about the population age distribution at two points in time, the assumption of stability can be relaxed, and the last expression can be written as

$$b(x+) - r^o(x+) = k + (1/c)d^o(x+)$$

where $r^o(x+)$ is the observed growth rate of the population $x+$, and k can be interpreted as the error in the growth rate due to change in enumeration completeness.

Indirect Estimation

Indirect estimation seeks to estimate a demographic parameter that is difficult to measure directly from some indicator that can be accurately recorded and is largely, but not exclusively, determined by the parameter of interest. The effects of confounding variables on the indicator are then allowed for, so that the parameter of interest can be estimated.

The most widely used example, due to Brass, estimates infant and child mortality from the proportion dead among children ever borne by women classified by age. Prior to the widespread use of birth histories in countries with deficient demographic statistics, infant and child mortality were especially hard to measure because of omission of early infant deaths from registers or retrospective reports. Brass realized that the proportion dead among children ever born was largely determined by the level of child mortality, but was also affected by the time location of the women's births prior to the survey and by the age pattern of mortality risk in childhood. The older the women, the longer on average their children would have been exposed to mortality risk and hence the higher, other things being equal, would be the proportion dead. However, controlling for women's ages, exposure would also be longer in a population of early childbearers than a population of late childbearers, and hence the former would have a higher proportion dead than the latter. Brass used simple fertility and child mortality models to simulate proportions dead for different fertility patterns to develop conversion factors to adjust an observed proportion dead for the effects of the age patterns of childbearing. His initial method has been extended by several authors, increasing the range of model patterns, extending the technique to data classifying women by duration of marriage, and placing reference dates on the estimates in order to estimate trends.

The Brass method and its successors greatly increased knowledge of levels and trends in childhood mortality in the developing world. Although the widespread use of birth histories in surveys has reduced the need to apply the method for national level estimates, the simplicity of the questions needed, and hence the ability to include them in population censuses, makes the method ideal for small area estimates of levels and trends of child mortality.

Indirect methods have also been developed to estimate demographic parameters from population age distributions assuming stability, to estimate adult mortality from proportions of respondents with surviving mother or surviving father and from proportions of brothers and sisters surviving. A method based on survival of sisters has been developed to measure maternal mortality, which is difficult to measure because the events are relatively rare and cause of death is often misclassified. Wendy Graham and colleagues suggest asking female respondents about the survival of their ever-married sisters, and identifying presumed maternal deaths by whether a dead sister was pregnant, delivering, or within two months of delivery at the time of death. Arguing that maternal deaths would follow approximately the pattern of overall fertility, except for rather higher numbers at young and old ages to reflect higher risks, the authors developed a method for estimating the lifetime risk of maternal death by extrapolating from the partial experience of each age cohort. An estimate of total fertility was then used to convert the measure of lifetime risk into the more widely used indicator, the Maternal Mortality Ratio. The indirect estimate obtained from this method refers to a time point at least 12 years before the survey, and the indirect approach has been largely superseded by the use of direct measurement based on a complete sibling history.

See also: *Actuarial Analysis; Brass, William; Data Assessment; Fertility Measurement; Life Tables; Mortality Measurement; Population Dynamics.*

BIBLIOGRAPHY

Arretx, Carmen. 1973. "Fertility Estimates Derived from Information on Children Ever Born Using Data from Censuses." International Population Conference, Liège 1973, Vol. 2: 247–261.

Brass, William. 1964. "Uses of Census or Survey Data for the Estimation of Vital Rates." Paper presented to the African Seminar on Vital Statistics, Addis Ababa, December 1964.

———. 1975. *Methods for Estimating Fertility and Mortality from Limited and Defective Data.* Chapel Hill, NC: University of North Carolina.

———. 1981. "The Use of the Gompertz Relational Model to Estimate Fertility." *International Population Conference, Manila 1981,* Vol. 3. Liège: International Union for the Scientific Study of Population.

Brass, William, and Kenneth Hill. 1973. "Estimating Mortality from Orphanhood." *International Population Conference, Liège 1973,* Vol. 3. Liège: International Union for the Scientific Study of Population.

Coale, Ansley, and Paul Demeny. 1968. *Methods for Evaluating Basic Demographic Measures from Limited and Defective Data.* New York: United Nations.

Feeney, Griffith. 1980. "Estimating Infant Mortality Trends from Child Survivorship Data." *Population Studies* 34: 109–128.

Graham, Wendy, William Brass, and R. W. Snow. 1989. "Estimating Maternal Mortality: The Sisterhood Method." *Studies in Family Planning* 20: 125–135.

Hill, Kenneth. 1987. "Estimating Census and Death Registration Completeness." *Asian and Pacific Population Forum* 1: 8–24.

Hill, Kenneth, and James Trussell. 1977. "Further Developments in Indirect Mortality Estimation." *Population Studies* 31: 313–334.

Sullivan, Jeremiah. 1972. "Models for the Estimation of the Probability of Dying Between Birth and Exact Ages of Early Childhood." *Population Studies* 26: 79–97.

Timæus, Ian. 1992. "Estimation of Adult Mortality from Paternal Orphanhood: A Reassessment and a New Approach." *Population Bulletin of the United Nations* 33: 47–63.

Timæus, Ian, Basia Zaba, and Mohamed Ali. 2001. "Estimation of Adult Mortality from Data on Adult Siblings." In *Brass Tacks: Essays in Medical Demography,* eds. Basia Zaba and John Blacker. London: The Athlone Press.

Trussell, James. 1975. "A Re-estimation of the Multiplying Factors for the Brass Technique for Determining Childhood Survivorship Rates." *Population Studies* 33: 97–107.

United Nations. 1983. *Manual X: Indirect Techniques for Demographic Estimation.* New York: United Nations.

Kenneth Hill

ETHICS, POPULATION

See *Animal Rights; Asylum, Right of; Data Collection, Ethical Issues in; Environmental Ethics; Euthanasia; Future Generations, Obligations to; Genetic Testing; Reproductive Technologies: Ethical Issues*

ETHNIC AND NATIONAL GROUPS

The term *ethnic group* has no single agreed-on definition in English. Its Greek origins refer to a nation or a people, but by the fifteenth century the word "ethnic" had a connotation of "heathen." A typical modern American definition (Merriam-Webster's Collegiate Dictionary) is "a: of or relating to large groups of people classed according to common racial, national, tribal, religious, linguistic, or cultural origin or background; b: being a member of an ethnic group; c: of, relating to, or characteristic of ethnics." However, if "religious," "racial," and "national" groups are included under the general rubric of "ethnic," what explains the common usages "ethnic and national groups," "ethnic and religious groups," and "racial and ethnic groups"? Such linguistic ambiguities cannot be resolved easily; therefore, the use of the term in this article is broad and inclusive.

The Use of Classifications

Governments around the world routinely collect demographic data classified according to ethnic, national, tribal, racial, linguistic, cultural, and other categories. The categorizations are typically country-specific—deemed to be suitable to their particular circumstances—thus, cross-country comparisons are difficult and can be misleading. As an example, although some states collect detailed data on the national origins or religions of their residents, others consider these categories improper in official statistics.

Classifications of ethnic and national groups within a country often are linked to sensitive political issues of power, control, and contested territorial boundaries. Therefore, they typically are determined by political rather than scientific or technical decisions.

Overall, the distinguishing quality of data on ethnic and national groups is variability. Even states with otherwise similar recent histories, cultures, political structures, and economic systems (e.g., the liberal democracies of Europe, North America, Asia, and Oceania) demonstrate marked differences in the manner in which they collect, classify, and report data on ethnic and national groups. Moreover, even within a state attitudes toward parallel categories of data are often inconsistent, applied differentially depending on the degree of historical and political sensitivity.

For example, in the U. S. censuses conducted from 1790 through 2000 more or less detailed data have been collected on race, national origin, ethnic origin, and ancestry. However, over the same period of more than two centuries essentially no official U.S. data have been collected on religion.

Changes in the U.S. Census

Early U.S. racial categories were simple—white, Negro, and Indian—but there have been numerous subsequent revisions, mostly in the direction of greater complexity. Until 1960 a respondent's "race" was determined by census interviewers; since that time it has been based on self-identification on a mailed questionnaire. As a result of pressure from a few influential members of Congress, the 2000 U.S. Census "race" classifications had no fewer than sixteen categories, with most of the new categories identifying a substantial number of distinct "races" in the Asian and Pacific regions. Many of these categories (e.g. "Samoan," "Guamanian or Chamorro," "Asian Indian," "Filipino," "Korean," and "Vietnamese") would more commonly be treated as national rather than racial categories.

After a political debate involving vociferous lobbying by interest groups for and against the change, the U.S. Census Bureau decided that a respondent should be allowed to select more than a single race.

In addition to race, the 2000 U.S. Census contained additional and often overlapping questions on "Hispanic origin" and "ancestry." These questions produced many statistical anomalies. Although the Census Bureau considers that any person self-identified as Hispanic to also have a race, about 40 percent of Hispanic respondents in both the 1980 and 1990 censuses reported no racial or other ethnic identity. Furthermore, in studies in which Hispanic respondents were re-interviewed, about 10 percent of the respondents did *not* identify themselves as Hispanic in the second interview.

The "ancestry" question that was sent to a 17 percent sample of households also produced responses generally considered highly subjective and variable. Changes in a "for example" list intended solely to illustrate by example what is meant by "ancestry" produced dramatic numerical changes in responses. Apparently, the mere mention or lack of mention of "German" or "Cajun" as examples of "ancestry" leads to dramatic changes in the numbers reporting such an ancestry, making tabulations of U.S. data by ancestry highly unreliable.

Despite the enormous effort by the U.S. government to collect detailed (if sometimes noncredible) data on race, Hispanic origin, and ancestry, essentially no data have been collected on one of the other main cultural markers of societies: religion.

Censuses Elsewhere

Other countries have different sensitivities about ethnic groups and different data-collecting strategies. In France there have been passionate debates about the acceptability of collecting any official data on "race," "ethnic origin," "national origin," or "ancestry." The French republican concept of the *citoyen* is seen by some as forbidding the government from collecting any information on such matters, and under the *jus soli* principle the national origin of any child born within French borders is "French." Others argue (on much the same grounds as do civil rights groups in the United States) that it is essential to have such data to determine the extent of, and correct problems caused by, discrimination against racial, ethnic, national, linguistic, and religious minorities.

In the neighboring country Germany, which together with France forms the fulcrum of the European Union, wholly different concepts prevail. The German state has long followed the opposing nationality principle of *jus sanguinis,* that is, nationality by "blood" rather than by place of birth. Thus, in Germany there are large numbers of persons classified as "foreigners" ("non-Germans") who were born and have lived the whole of their lives in Germany. Meanwhile, hundreds of thousands of *aussiedler*—populations of German ethnic extraction that have lived for generations in Russia and the former Soviet republics—have been preferentially admitted to Germany for permanent residence and upon admission are automatically classified as "Germans." Current legislation has somewhat modified these traditional concepts of German nationality.

Similar policies are in place elsewhere. The term *patrial* is used in some countries to describe persons who were born and raised elsewhere and have the nationality of other countries but who by dint of cultural and historical family ties (often limited to the origins of grandparents) are granted special access and residence permits and frequently expedited paths to citizenship in the "home country." Such practices are followed in a diverse range of countries in addition to Germany, including Italy, Spain, Israel, Japan, and the United Kingdom.

Categories Created by Governments

Official categories play a role in creating or solidifying ethnic categories and in eliminating or submerging categories that are considered politically problematic. The statistical and now ethnic concept of "Hispanic" was a creation of the U.S. Census Bureau. As was noted above, pressure from influential members of Congress led the Census Bureau to add numerous race categories, most of which involved people from Asia and the Pacific region. The Soviet Union under Stalin established over 100 "nationalities" for citizens of that country, with those designations taken as permanent and recorded prominently both in official statistics and in each individual's internal identification documents. Decisions by government political and statistical organs may have the effect of minimizing the importance of social-cultural-linguistic differences, as in the French government's position that the collection of data on national origins is inconsistent with French concepts of nationality.

Changes and Variations in Ethnic Identity

Ethnic and national groups may experience reduction or blurring of their distinct identities over time as they become integrated into the majority population. The most powerful source of such blurring is intermarriage because the ethnic and/or national identities perceived by the children of those marriages are commonly quite different from those of their parents. Intermarriage among established racial, ethnic, and linguistic groups has been rising in many settings, resulting in far more complex categories of identity in the succeeding generations.

Differing political traditions are also important in the emergence of ethnic categories. Four stylized types can be identified. The first are traditions in which ethnic commonalities are seen as defining the boundaries of the nation, as expressed in the German concept of the *Volk* (the people) and the Mexican concept of *la Raza.* (The term *raza*—literally "race" and colloquially "the people"—refers to the *mestizaje,* or mixed racial and ethnic identity of indigenous, European, and African heritage found in the former Spanish colonies of the Americas.) The second is the political tradition that defines national membership by religion, as in Israel's openness to Jews from all over the world (although native-born adherents of other religions also are defined by law as citizens of Israel). The third is the tradition in which persons from any national or linguistic background can become citizens if they assimilate culturally and linguistically, as in the French openness to naturalizing all types of foreign-born persons as long as they become fluent in French. The fourth is the tradition that defines membership in solely political terms, in which a foreign-born person may be naturalized with only minimal knowledge of the local language and culture, as in the United States, Canada, and Australia (what the French call, with a far-from-correct ethnic referent, the "Anglo-Saxon" notion of multiculturalism).

There are many circumstances in which ethnic bonds unite groups that straddle national boundaries but do not control their own national state. Several of these cases have presented long-standing problems of national and ethnic identity, resulting in persistent tensions and in some cases separatist or even violent movements. Examples include the cases of the Basque, Kurdish, and Roma groups. Less common are transborder ethnic groups that also identify with a state, (e.g., Hungarians in Romania and Slovakia and Russians in the former republics of the Soviet Union, such as Estonia, Latvia, Lithuania, and Kazakhstan).

See also: *Chinese, Overseas; Languages and Speech Communities; Racial and Ethnic Composition; Religious Affiliation; States System, Demographic History of.*

BIBLIOGRAPHY

Anderson, Benedict. 1984. *Imagined Communities.* London and New York: Verso.

Bissoondath, Neil. 1994. *Selling Illusions: The Cult of Multiculturalism in Canada.* Toronto: Penguin Books.

Brubaker, Rogers. 1992. *Citizenship and Nationhood in France and Germany.* Cambridge, MA: Harvard University Press.

Fuchs, Lawrence H. 1990. *The American Kaleidoscope: Race, Ethnicity, and the Civic Culture.* Hanover and London: Wesleyan University Press.

Glazer, Nathan. 1975. *Affirmative Discrimination: Ethnic Inequality and Public Policy.* New York: Basic Books.

Schuck, Peter H., and Roger M. Smith. 1985. *Citizenship Without Consent: Illegal Aliens in the American Polity.* New Haven: Yale University Press.

Skerry, Peter. 1993. *Mexican Americans: The Ambivalent Minority.* New York: Free Press.

Teitelbaum, Michael S., and Jay M. Winter. 1998. *A Question of Numbers: High Migration, Low Fertility, and the Politics of National Identity.* New York: Hill and Wang.

Thernstrom, Stephan, ed. 1980. *Harvard Encyclopedia of American Ethnic Groups.* Cambridge, MA: Harvard University Press.

U.S. Commission on Immigration Reform. 1997. *Becoming An American: Immigration and Immigrant Policy.* Washington, D.C.: Government Printing Office.

Michael S. Teitelbaum

ETHNIC CLEANSING

Ethnic cleansing, once a term of perpetrators, has become a term of art in the study of population movements. The term spread to English and other languages from Serbian in 1992, as the mass media broadcast a label that was borrowed from the lexicon of Serbian perpetrators. Although ethnic cleansing may be a new coinage, variants involving *cleansing* as the purification of the nation are not. In fact, similar language was used throughout the twentieth century, by Czechs, Poles, Ukrainians, and others. Indeed, Stalin's purges (*chystki*) could easily be translated as *cleansing*, as could Hitler's racial hygiene (*Säuberung*).

Although use of the term in scholarly discourse remains controversial, its function is fairly clear. The term is most often used to mean something like "coercive actions justified in national terms designed to clear territories of putatively undesirable populations without aspiring to their total physical extermination." It thus occupies some of the broad middle ground between voluntary migration and genocide. Part of the analytical value of the term is precisely that it captures a willingness to use force that need not include the willingness to exterminate the entire population.

Ethnic Cleansing and National Politics

Implicit in the idea of ethnic cleansing is a certain modern nationalist view of history and politics. In most, if not all, versions of modern nationalism, legitimate political power in a given territory is believed to be vouchsafed in a mass nation. According to certain important variants of modern nationalism, national identity is determined by ethnicity, which is connected to language and family origin. Ethnic cleansing connects these two ideas. Political legitimacy over territory rests with the nation; the nation is an ethnic group; therefore it is reasonable to expel other ethnic groups from desired territory. Since the political execution of ethnic cleansing involves the realization of a certain idea, the analytic use of the term ethnic cleansing involves a judgment about motives.

Such ideas are only one of a set of necessary conditions for the actual event. Most cases of ethnic cleansing involve the following conditions:

1. The prior collapse of state authority;
2. The cover of a larger war;
3. The practical anticipation of future states to be created;
4. Dedicated cleansers, with military or police training, at work far from home;
5. Historical propaganda that both requires cleansing to be plausible and justifies cleansing already underway;
6. A conscious escalatory push by dedicated elites and propagandists, allowing individual experiences to be understood as a national war; and
7. A motive for seizing property that implicates society after the cleansing has begun.

Ethnic cleansing has nothing to do with ancient hatreds. The idea that ethnic groups exist and are constitutive of national identity is modern. In recorded cases of ethnic cleansing, hostility did not simply express itself in violence. Rather, international and domestic political factors created a propitious moment for the expression of ethnic nationalism. Ethnic nationalists then seek to use existing institutions, such as armies, police forces, or partisans, for new purposes. The cover of war and the habit of military discipline often facilitates the commencement of ethnic cleansing.

Ethnic cleansing, once begun, tends to self-perpetuate. Some perpetrators acquire the habits of murder and rape, and many construe the reaction of victims as a reason to continue. While political circumstances create the opportunity for ethnic cleansers to begin their work, the social world they create then allows ethnic cleansing to continue. The initiation of ethnic cleansing usually requires the breakdown of international order and the rule of law; its progress usually brings the destruction of local norms and customs.

By murdering individuals in the name of the nation, ethnic cleansers in effect target their own group for revenge. Once vengeance is taken, survivors on both sides will see the other as the aggressor, and propagandists can present both sides as nations. What began as an attack by a small number of people against certain localities becomes a battle of nation upon nation. With time, the property motive tends to become increasingly important. Leaders are ideologically motivated; their first followers often seek revenge; but others soon realize that coveted property is there for the taking. These dynamics are most important in cases where there are, or come to be, two national sides. In some cases of ethnic cleansing, the state or another actor enjoys a monopoly or near-monopoly on force. Nazi and Soviet ethnic cleansing are the most important examples.

Ethnic Cleansing and International Politics

In many cases, ethnic cleansing is regulated by treaty, and comes to be seen as a matter of regulated population movements. Yet accords such as Lausanne (1923) and Potsdam (1945) serve to legitimize an ongoing practice. The first regulated the mutual expulsions of Greeks and Turks; the second the flight of Germans from Eastern Europe. Much the same can be said of the agreements between Turkey and Bulgaria (1913) and between the Soviet Union and communist Poland (1944). Although such agreements preserved the semblance of international order, they organized and legitimated ethnic cleansing that was already underway.

Because ethnic cleansing is associated with modern nationalism, it is a phenomenon of the twentieth century. Because it usually requires demanding permissive conditions, its main instances are associated with war, and especially world war. Major examples of ethnic cleansing include:

1. the Bulgarian-Greco-Turkish "exchanges" of 1913–1922;
2. the massacre of Armenians in Turkey in 1915–1922;
3. the deportation of "enemy nations" in Stalin's Soviet Union in 1935–1938;
4. the ethnic cleansing of Jews and Poles from Nazi Germany and occupied Poland in 1939–1941;
5. the mass murder of Poles by Ukrainian insurgents in 1943–1944 and the Polish response;
6. the forced mutual repatriations of Ukrainians from Poland and Poles from the Soviet Union in 1944–1946;
7. the expulsion of the Germans and Hungarians from Czechoslovakia in 1945–1946;
8. the expulsion of Germans from eastern Europe in 1945–1947; and
9. the murder of Bosnians, Kosovars, and others in the Yugoslav wars of 1992–1999.

It is impossible to rigidly separate ethnic cleansing from migration, on the one side, and genocide, on the other. Ethnic cleansing works in part by creating conditions in which people choose to leave a given territory. People need not have been coerced themselves to make such a decision. Ethnic cleansing in practice almost always involves acts of genocide, even if it falls short of the total destruction of a group. Ethnic cleansers may be indifferent to the survival of individuals; they may even wish to exploit them in some other locations, as with the resettlement of Ukrainians from Poland in 1947 or Stalin's pre-World War II cleansings. Yet ethnic cleansing may also provide a transition to full-scale genocide. In Hitler's Final Solution, policies of ethnic cleansing preceded a policy of total physical annihilation of Jews in Germany and the occupied territories. As the term ethnic cleansing has entered historical discussions, it has helped to shed light on the stages of Hitler's policy immediately antecedent to the Jewish Holocaust.

Soviet ethnic cleansing may be divided into two phases, before and after direct contact with German practices. Before and during World War II, Stalin deported all or part of nine "enemy nations" to the Soviet east. After World War II, Stalin deported all Poles west, across the newly expanded borders of the Soviet Union. In both cases, the motivation was the preservation of communist power and the creation of political calm, but the second involved accepting the need to remove groups not only from their homes but from the Soviet Union itself. The Soviet Union was not a national state, and neither were its constituent republics, but its leaders were aware of national questions, and sought to exploit or, at a minimum, defuse national questions. This new ethnic quality in postwar Soviet policy was part of a general trend, as the connection of homogeneity and stability came to be widely accepted.

After World War II, not only the Soviet Union but the United States and Britain accepted that ethnic homogeneity was needed for European peace. After the end of the Cold War, these perspectives changed. The United States, Britain, and their NATO allies prosecuted a war in Yugoslavia in 1999 with the express aim of bringing ethnic cleansing to a halt. Ethnic cleansing came to function as a term of both perpetrators and human rights activists, as a term of moral endorsement and moral opprobrium. The shock of the Yugoslav wars and the fact of a Western military response forced a reconsideration of the history of the twentieth century, in which ethnic cleansing as a social fact took a prominent place.

See also: *Communism, Population Aspects of; Forced Migration; Genocide; Refugees, Demography of.*

BIBLIOGRAPHY

Browning, Christopher. 2000. *Nazi Policy, Jewish Workers, German Killers.* Cambridge, Eng: Cambridge University Press.

DeZayas, Alfred M. 1977. *Nemesis at Potsdam: The Anglo-Americans and the Expulsion of the Germans: Background, Execution, Consequences.* London; Boston: Routledge & Kegan Paul.

Ladas, Stephen. 1932. *The Exchange of Minorities: Bulgaria, Greece, and Turkey.* New York: Macmillan.

Martin, Terry. 2001. *The Affirmative Action Empire: Nations and Nationalism in the Soviet Union.* Ithaca, NY: Cornell University Press.

Naimark, Norman. 2001. *Fires of Hatred: Ethnic Cleansing in Twentieth-Century Europe.* Cambridge, MA: Harvard University Press.

Renan, Ernest. 1996 (1882). "What is a Nation?". In *Becoming National.* trans. and ed. Geoff Eley and Ronald Grigor Suny. New York: Oxford University Press.

Snyder, Timothy. 2002. *The Reconstruction of Nations: Poland, Ukraine, Lithuania, Belarus, 1569–1999.* New Haven, CT: Yale University Press.

Ther, Philipp, and Ana Siljak. 2001. *Redrawing Nations: Ethnic Cleansing in East-Central Europe, 1944–1948.* Lanham: Rowman and Littlefield.

Weber, Max. 1996 (1914). "The Origins of Ethnic Groups" from *Economy and Society*. In *Ethnicity* trans. and ed. John Hutchinson and Anthony Smith. Oxford: Oxford University Press.

Timothy Snyder

EUGENICS

Eugenics, a term derived from the Greek for wellborn, is the science of improved breeding applied to humans. The eugenics movement was one of several initiatives that originated in the late nineteenth century, and which focused on the problem of the urban poor. The new Darwinian biology with its emphasis on evolutionary success and survival of the fittest was seen as providing an alternative ameliorative route to the efforts of the environmentalists, the sanitarians, and the public health movement. Fear of urban degeneration coincided with the beginning of the demographic transition with its sharply lowered fertility, especially marked in the upper socioeconomic classes.

The Early Movement

The eugenics movement began in Britain, but its appeal and its organization was international. It was particularly important in the United States and Germany. Francis Galton (1822–1911), explorer and amateur scientist, and cousin of English naturalist Charles Darwin, produced the founding documents, his *Hereditary Genius* of 1869 and *Natural Inheritance* of 1889. It was nature, not nurture, he claimed, that determined that eminent men were usually the sons of eminent fathers. The statistical methods he suggested—the normal curve, correlation, and regression—were developed by his admirer, the statistician Karl Pearson (1857–1936), working at University College, London, to measure the effect of heredity. Their work lent scientific support to the idea that class differentials represented levels of inherited natural ability and of civic worth. In this intellectual climate, the so-called professional model of class structure based on the occupation of male breadwinners, proposed by statistician William Farr (1807–1883) in 1851, reached its fully developed form in the British Census of 1911. It put the professional and intellectual groups in Class I, skilled labor in Class III, and unskilled and casual labor in Class V, with fill-in classes between. This classification scheme encouraged a linear view of society with the professional class as the most highly evolved. If indeed ability was inherited, and if classes corresponded to biological subtypes as Galton supposed, the differential decline in fertility in Class I was a national catastrophe. It was a catastrophe that the eugenists sought to publicize and to remedy.

As primary education became compulsory and the poorest and most deprived began to enter the new elementary schools in the last quarter of the century, children who could not keep up academically came to be seen as a compelling problem. Mary Dendy, secretary of the Lancashire and Cheshire Association for the Permanent Care of the Feebleminded, and Ellen Pinsent, chair of the Special Schools Subcommittee of the Birmingham Education Committee, founded the National Association for Promoting the Welfare of the Feebleminded in 1896. Their "welfare" entailed segregation and control of the children they selected as feebleminded for the rest of their lives starting in 1902 on a farm at Sandlebridge in Cheshire. Seen in Galtonian terms, feeblemindedness was inherited: Segregation would prevent its propagation.

The eugenics movement began in earnest after the turn of the twentieth century, taking additional impetus from the diffusion of Mendelian theory (named after Austrian botanist Gregor Mendel) after 1901. The Eugenics Education Society's (1907) founding drive was started by Sybil Gotto, another Galton admirer, then a young widow interested in social problems. The society took the now elderly Galton as its figurehead. It was mainly a propaganda group rather than a scientific society, but its projects included teaching the science of heredity and research on the inherited nature and relationships of the urban poor—what it called its Pauper Pedigree Project, a pauper being the term for someone receiving relief under the poor law. Its methodology was typically that of the pedigree, an easily understood and convincing demonstration of heredity. It focused on the elevated fecundity of the pauper class, in which, it alleged, every family, in their terms, was studded with paupers, the impoverished, inebriates, criminals, and the feebleminded. The Royal Commission on the Care and Control of the Feeble Minded of 1909, strongly supported by the Society, led to the segregationist Mental Deficiency Act (1914). Eugenists pointed to this Act as their proudest success.

Eugenics in the United States

In the United States, eugenics was first fostered by the American Breeders' Association (founded in 1903, renamed the American Genetic Association in 1914), in which a subcommittee concerned itself with human heredity, supporting itself scientifically on Mendelism and on the collection of pedigrees. Interestingly, the stockbreeders generally were uninterested in Mendelism; it was impossible to use it in pursuing practical, quantitative objectives, such as enhanced egg production and milk yield, or even improving the racing performance of thoroughbreds. Charles B. Davenport (1866–1944), Harvard Professor of Zoology and Director of the Eugenics Record Office at Cold Spring Harbor, New York, preached Galton and eugenics to his Harvard students. In *Heredity in Relation to Eugenics* (1911), he applied Mendelism to the inheritance of psychological traits such as memory, temperament, general bodily energy, and criminality as well as intelligence. Many of his exemplary pedigrees came from psychologist Henry H. Goddard, superintendent of the Training School for Defectives, Vineland, New Jersey. Low mental acumen was a unit character determined by Davenport to be a recessive condition due to the absence of a factor for intelligence. If the factor was absent in both parents, it would be absent in the children. Davenport's nominee as superintendent of the Eugenics Record Office was Harry H. Laughlin, an agriculturalist from Iowa who trained as a biologist specializing in heredity under Davenport at Cold Spring Harbor. As superintendent, he organized a collection of pedigrees mainly of poor families showing what he claimed to be inherited mental and social problems, and supported the campaign for eugenic sterilization. The first state sterilization law was passed in Indiana in 1907, and by 1917, 15 other states had legalized the sterilization of a number of different types of people deemed to be "defective." In 1923, an American Eugenics Society was formed, led by the Yale economist Irving Fisher; it soon had 28 state committees. But after World War I, the "vulgar Mendelism" of the early pedigrees was increasingly rejected by scientists. In the 1930s, the Eugenics Record Office began to lose its funding and eventually closed in 1939. Sterilization on eugenic grounds, however, continued. The numbers picked up after 1930 and the practice continued into the 1970s in the United States and Canada, until the laws permitting it were repealed one by one. Approximately 60,000 sterilizations took place under this system, usually of the poor, and often of "wayward girls," deemed "moral imbeciles" because they had given birth to a child out of wedlock. Science, in fact, mainly supplied only the rhetoric for eugenics. It was as much a political as a scientific movement, and its greatest success in the United States had been in persuading Congress in 1924 to limit immigration from the supposedly inferior populations of southern and eastern Europe.

Eugenics in Europe

In Britain, the Eugenics Society, as it was now called, led a campaign to legalize eugenic sterilization, from about 1930. But sterilization, even voluntary sterilization, was never legalized there. The Society's focus on controlling the "disturbing" fertility of the urban poor led to support for birth control clinics, though not for their rather quarrelsome advocate, Marie Stopes, even though she was an enthusiastic eugenist herself. It was also involved in setting up the International Union for the Scientific Investigation of Population Problems (IUSIPP), following a congress organized in Geneva in 1927 by Stopes's American counterpart, birth control leader Margaret Sanger (1879–1966). The congress was attended by leading eugenists from every country in which there was an organized movement. The first president of IUSIPP was American population ecologist and geneticist Raymond Pearl (1879–1940) of Johns Hopkins University, with Sir Bernard Mallet (1859–1932), retired Registrar-General of Britain, of the British Eugenics Society, as vice-president and treasurer. Its British component was the British Population Society, the members of which were all active in the Eugenics Society; IUSIPP's announcements and proceedings appeared in the Society's publication, the *Eugenics Review*. In 1936, another organization, the Population Investigation Committee was set up by the Eugenics Society as an autonomous joint committee, with the stated intention of developing a questionnaire on fertility. The project was interrupted by the outbreak of World War II, but the Committee survived, initially kept going by a series of grants from the Society. Its activities increasingly defined mainstream demography.

The country in which eugenics was both the most highly developed, and the most destructive, was Germany. Its earliest advocate was Wilhelm Schallmeyer (1857–1919), Darwinist, psychiatrist, and author of a thesis on the *Pressing Problem of the Physical Degeneration of Civilised Man* (1891). Like the British and American eugenists, he pointed to the burden on the state of caring for the "pauper idiot" who could produce nothing for society. Alfred Ploetz (1860–1940), a German physician, started the world's first eugenic society in 1905. Its focus was on what he termed the damage to the Caucasian race done by the protection of its weakest members. From the start it was envisaged as part of an international movement, and in 1912, the first Eugenics Congress met in London to hear papers by a mix of scientists, statisticians, social reformers and political activists. The Permanent International Eugenics Committee was an outcome of the Congress. Interrupted by World War I, there were two further international congresses, both held in United States, in 1921 and 1932.

German eugenicists soon left behind the simplistic pedigree methods of the British and the Americans. The Stuttgart statistician Wilhelm Weinberg took the lead in mathematizing Mendelism, a complex system of calculations taken up first by eugenists such as Fritz Lenz, a geneticist, and by the Munich psychiatrist Ernst Rüdin who applied it to the inheritance of schizophrenia. But, from the early 1920s, Mendelism was abandoned for Rüdin's more politically persuasive method, which he called empirical prognosis. A collection of data on the prevalence of a spectrum of different abnormalities in the families of schizophrenics could be used to point to the need for a sterilization program. The Nazi government in 1933 enacted the sterilization law, planned by Rüdin and modeled on laws in the United States, as soon as it came to power. Sterilization became compulsory for patients and families with several types of mental diseases and disabilities. Roughly 600,000 sterilizations took place. Racism was not at first a necessary part of this hereditarian program, but with state support, it expanded into systematic euthanasia, first for the inhabitants of mental hospitals, then for people with other chronic diseases, and finally for Jews, Gypsies, homosexuals, Communists, and Slavs. The Nazis thus managed to justify the extermination of several million of their own citizens. After World War II ended, the Nuremberg tribunal was unable to indict anyone for forced sterilization. The German law, it was pointed out, derived from American laws and the practice of forced sterilization was still legal in the United States.

Post-World War II Eugenics

In the 1930s, the British Eugenics Society endured attacks on its science and its ideology by left-wing geneticists. The attackers, Lancelot Hogben (1895–1975) of the London School of Economics, and J. B. S. Haldane (1892–1964) of University College, London, were offended by the eugenists' conflation of social class and social worth, and their rejection of the influence of environment. Hogben placed his hopes on genetic linkage and on blood groups as a genetic marker: If a trait is linked to a blood group, he felt, it must be truly biological, and not environmentally determined. The psychiatrist Lionel Penrose (1898–1972) attacked the association of feeblemindedness with an inherited pauper class.

After World War II, political changes in Britain eroded the class system. Its links to differential fertility and pauperism became less acceptable with the end of the poor law and the coming of the welfare state. The image of eugenics also suffered from its association with Naziism. Under Penrose, *Annals of Eugenics* became *Annals of Human Genetics* in 1954. In 1968, the *Eugenics Review* closed, and the Society turned to third world overpopulation and fertility in the *Journal of Biosocial Science.* In the United States, the Population Council, founded in 1952, also focused on the third world and its problems. The Council's first executive officer was the Wall Street banker Frederick Osborn (1889–1981), who had been president of the American Eugenics Society from 1946 to 1952; the offices of the Population Council and the Eugenics Society were initially at the same address. During the 1970s, eugenic sterilization of poor young women tailed off. More modern genetic counseling focused not on poverty and fertility, but on genetic disease. Amniocentesis was not expected to identify the social problem group, as the erstwhile pauper class was now called.

In 1989 the British Eugenics Society became the Galton Institute. The Institute has recently been interested in exploring its own past, a history of serious importance since the eugenic problematic has molded present day human genetics and population studies.

See also: *Demography, History of; Galton, Francis; Pearl, Raymond; Quality of Population; Reproductive Technologies: Ethical Issues; Sanger, Margaret.*

BIBLIOGRAPHY

Broberg, Gunner, and Nils Roll-Hansen. 1996. *Eugenics and the Welfare State: Sterilization Policy in Denmark, Sweden, Norway and Finland.* East Lansing: Michigan University Press.

Burleigh, Michael. 1994. *Death and Deliverance: Euthanasia in Germany 1900–1945.* Cambridge, Eng.: Cambridge University Press.

Kevles, Daniel J. 1985. *In the Name of Eugenics: Genetics and the Uses of Human Heredity.* Cambridge, MA: Harvard University Press.

Mazumdar, Pauline M.H. 1992. *Eugenics, Human Genetics and Human Failings: the Eugenics Society, its Sources and its Critics in Britain.* London: Routledge.

Reilly, Philip R. 1991. *The Surgical Solution: A History of Involuntary Sterilization in the United States.* Baltimore, MD: Johns Hopkins University Press.

Schneider, William H. 1990. *Quality and Quantity: The Quest for Biological Regeneration in Twentieth Century France.* Cambridge, Eng.: Cambridge University Press.

Soloway, Richard A. 1990. *Demography and Degeneration: Eugenics and the Declining Birthrate in Twentieth Century Britain.* University of North Carolina Press.

Stepan, Nancy Leys. 1991. *The Hour of Eugenics: Race, Gender and Nation in Latin America.* Ithaca, NY: Cornell University Press.

Thomson, Mathew. 1998. *The Problem of Mental Deficiency: Eugenics, Demography and Social Policy in Britain, c. 1870–1959.* Oxford: Clarendon Press.

Pauline M. H. Mazumdar

EULER, LEONHARD

(1707–1783)

Arguably the greatest mathematician of the eighteenth century, Leonhard Euler, a Swiss, made basic contributions to every branch of mathematics then being studied. His enduring place in the history of demographic analysis is assured due to his 1760 formula for a stable population.

An analysis of the formula begins by considering a population with fixed and known death rates at each age and a constant number of births per unit time in all generations. From the death rates, it is possible to create a life table giving the probability of survival to age x, denoted $l(x)$. If the number of births is $b(0)$, the population in the age group from x to $x + dx$, where dx is small, is $b(0)l(x)dx$, a constant over time. If the number of births is increasing at an exponential rate, r, t years into the future the number of births would be $b(0)e^{rt}$. Similarly, t years in the past, the number of births would have been $b(0)e^{-rt}$. Thus, taking the formula for births t years ago, and multiplying by $l(x)$, the proportion of births surviving to age x, gives a stable population with the age distribution $b(0)l(x)dx = b(0)l(x)e^{-rx}dx$. Euler was the first to develop this formula, which is the starting point for much subsequent population modeling.

If survivorship remains fixed and $r(x)$ varies, then the formula remains the same, but has a different interpretation; and more generally, allows for survivorship to vary as well. Then, given birth and death rates as they vary with time, researchers have the usual formula for population at the end of any time interval. At first this was called forecasting, but the unreliability of the process led to the more modest term *projection,* meaning simply the working out of the consequences of the assumed regime of birth and death rates.

The theory above stated has been reformulated as a set of partial differential equations more applicable to numerical work. Neither of these continuous models, developed as theory, is convenient for calculation with real data.

While Euler never went beyond fixed rates, he can reasonably be described as the originator of the field of projection and prediction that preoccupies demographers, and even more so, the public at the beginning of the twenty-first century.

Well over a century after Euler, demographer Alfred Lotka (1880–1949), with much wider demographic (and additional environmental) interests, published, in 1907, the renewal equation, the fundamental relationship in population dynamics, that permitted calculation of the rate of increase implied by a regime of birth and death rates.

Euler, called by his contemporaries the Prince of Mathematicians, commanded the respect of kings and the public, and above all of mathematicians. He was a lifelong friend of the brothers Daniel and Nicholas Bernoulli. He held an appointment at the University of Basel. He was invited to Russia by Catherine the Great, and to Berlin by Frederick the Great, both powerful patrons of the arts and sciences during the eighteenth-century Enlightenment. Euler's private life, however, was far from happy. He was blind for almost twenty years before his death. In 1768, he lost many of his unpublished papers when his house was destroyed in a fire. He died of apoplexy.

See also: *Demography, History of; Lotha, Alfred J.; Renewal Theory and the Stable Population Model.*

BIBLIOGRAPHY

SELECTED WORKS BY LEONHARD EULER.

Euler, Leonhard. 1977 (1760). "A General Investigation into the Mortality and Multiplication of the Human Species," trans. Nathan and Beatrice Keyfitz. In *Mathematical Demography: Selected Papers,* ed. David Smith and Nathan Keyfitz. New York: Springer-Verlag.

SELECTED WORKS ABOUT LEONHARD EULER.

Lotka, Alfred J. 1907. "Relation Between Birth Rates and Death Rates." *Science N.S.* 26: 21–22.

NATHAN KEYFITZ

EUTHANASIA

Euthanasia is the intentional taking of a person's life from a beneficent or kind motive—typically in a case of grave and terminal illness. Increasingly, however, the term is also used of cases in which a person, though gravely ill, is not immediately threatened with death. She simply does not want to live out the life to which illness has condemned her.

Three distinctions figure prominently in discussions of euthanasia: the distinction between active and passive euthanasia; the distinction among voluntary, involuntary, and non-voluntary forms; and the distinction between physician-assisted suicide and euthanasia.

Active and Passive Euthanasia

Active euthanasia involves taking steps to terminate a life. Passive euthanasia involves omitting steps to save a life or withdrawing treatment. At present, active euthanasia is frowned upon by law and the medical profession, whereas passive euthanasia—for example, withdrawing a ventilator that keeps alive a patient whose further care is deemed futile—is not.

The question of whether one can sustain a distinction between active and passive euthanasia is hotly debated. A person will die if injected with a large enough dose of morphine, which may be given in the guise of pain relief, but he will also die if feeding tubes are removed. In a patient whose further care is deemed futile, what is the moral difference between these two ways of producing death?

Voluntary, Involuntary, and Non-Voluntary Euthanasia

A distinction may be drawn among voluntary, involuntary, and non-voluntary euthanasia. In voluntary euthanasia, the steps taken to end life are taken with the patient's consent, and often at her instruction.

In involuntary euthanasia, the steps taken are without the consent of the patient, and without his request; in fact, euthanasia may be something to which he explicitly would not consent.

Non-voluntary euthanasia typically refers to taking steps to end the life of someone deemed incompetent by medical and legal authorities. The steps are taken at the consent of a trustee whom the person has designated to represent her interests. This can prove problematic if the patient has no designated trustee empowered to consent. It is possible that, if a trustee is then appointed to represent a patient's interests and consents to euthanasia on her behalf, the case has been transformed into one of involuntary euthanasia.

Physician-Assisted Suicide and Euthanasia

A distinction is usually drawn today between physician-assisted suicide and euthanasia. One useful way of marking this distinction is to say that, in the former, the last causal actor is the patient, whereas in the latter it is the doctor.

A doctor supplies a terminally ill patient who is competent, who is not suffering unduly from depression, and who voluntarily requests assistance in dying with a pill that will prove lethal. If the patient takes the pill and swallows it, the doctor does not produce the patient's death; the patient does so through accepting the pill and deciding to swallow it. The pill produces death only if it is swallowed, and the doctor does not force it down the patient's throat; rather, the patient voluntarily swallows it.

Euthanasia, Quality of Life, and Aging

The morality of so-called "mercy killing" has had a long history. This is inevitable, for there are two central facts about the human condition that dominate moral consideration of the topic.

First, the quality of human life can deteriorate massively, so that someone may remain alive, but in effect can come to have "no life." The objection is sometimes made that no one is entitled to say that someone else's life is not a life worth living; but it is possible to say this of those in permanently vegetative states or of anencephalic infants, who live lives that no one would wish for anyone. Indeed, the whole topic of physician-assisted suicide has arisen precisely because many of those condemned to live out lives blighted by amyotrophic lateral sclerosis and the like state that they do not wish to do so. If they are regarded as having a right to refuse treatment, then they do not have to live out their lives. But if they are not so regarded, or if they are no longer competent to insist upon this right, or if they have no advanced directive that is honored by authorities, then they are forced to continue to live.

Second, improved living conditions, increased prosperity, better health care, and technological innovation have increased human longevity dramatically. A larger elderly population has made nursing homes more important, has made geriatrics into a major medical science, and has focused attention upon the lives—and deaths—of elderly men and women. As they come to face death, especially as they come to face death in the context of lives plagued by illness and degenerative disease, the moral and social aspects of suicide, assisted death, and euthanasia inevitably become topics of debate. This is particularly true of moral implications as societies come to give greater weight to individual autonomy and to permit individuals a say in their own treatment and the ending of their lives.

Euthanasia and the Law

Relaxation of prohibitions against physician-assisted suicide and active voluntary euthanasia were frequently urged at the turn of the twenty-first century, and Oregon, the Netherlands, and the Northern Territory of Australia took some steps toward relaxation (since put on hold in the Australian case in the late 1990s). Preliminary data from both Oregon and the Netherlands suggest that neither physician-assisted suicide nor active voluntary euthanasia is yet used by a significant part of the elderly as a preferred option of ending lives. In 1998 in Oregon only 15 deaths were reported under the new law there, and the update of data in the Netherlands in 1995 found that vastly more patients chose to forego treatment than to take advantage of the suicide law. The option continues to exist, however.

The Morality of Euthanasia

Whatever the specific objections to relaxation of prohibitions on physician-assisted suicide and active voluntary euthanasia may be, opponents have fostered fear of a "slippery slope" as one of the lurking dangers of such a course. This means a fear that voluntary euthanasia shall soon pass to involuntary euthanasia; that competent patients requesting death shall soon pass to incompetent persons who have no idea what they are requesting (or for whom euthanasia is requested by someone else); that letting physicians prescribe pills for competent patients who voluntarily request assistance in dying shall soon pass to physicians killing off patients in all kinds of situation, for all sorts of nefarious reasons; that assisted death and euthanasia as socially approved options shall soon pass to circumstances in which patients feel pressured for various reasons to choose one of these options, even when they would otherwise want to prolong their lives.

Opponents of change almost always urge slippery-slope objections not only against social changes but against even thinking about changes, and this has long been the case with active voluntary euthanasia. In fact, good evidence is needed to believe such claims. However, for many opponents of active voluntary euthanasia, slippery-slope concerns are at bottom not the main argument. In circumstances where it was clear that slippery-slope effects were exceedingly unlikely to arise, few opponents to active voluntary euthanasia would remove their objections.

Most religions continue to insist that life is a gift from God that can only be justly taken by God. To many adherents it follows that quality of life concerns are not centrally germane to the whole issue of the prolongation of life. Advocates believe the fact that physician-assisted suicide and active voluntary euthanasia give voice to the value of autonomy, to the demands of patients to have a say in their own treatment, and to the wish of many to be able to decide not only how they will live but also how they will die, is unlikely to carry the day as a moral argument.

See also: *Religions, Population Doctrines of; Reproductive Technologies: Ethical Issues.*

BIBLIOGRAPHY

Beauchamp, Tom. L., ed. 1996. *Intending Death: The Ethics of Assisted Suicide and Euthanasia.* Englewood Cliffs, NJ: Prentice-Hall.

Brock, Dan. 1993. *Life and Death: Philosophical Essays in Biomedical Ethics.* Cambridge, Eng.: Cambridge University Press.

Callahan, Daniel. 1993. *The Troubled Dream of Life: Living with Mortality.*New York: Simon and Schuster.

Dworkin, Gerald., R. G. Frey, and Sissela Bok. 1998. *Euthanasia and Physician-Assisted Suicide.* Cambridge, Eng.: Cambridge University Press.

Rachels, James. 1986. *The End of Life: Euthanasia and Morality.* Oxford, Eng.: Oxford University Press.

VanDerMass, P. J., G. van der Wal, I. Haverkate, et al. 1996. "Euthanasia, Physician-Assisted Suicide, and Other Medical Practices Involving the End of Life in The Netherlands." *New England Journal of Medicine* 335: 1699–1705.

Verhovek, S. H. 1999. "Oregon Reporting 15 Deaths in 1998 Under Suicide Law." *New York Times,* February 18, 1998, A1.

R. G. Frey

EVENT-HISTORY ANALYSIS

Event-history analysis is a set of statistical methods designed to analyze categorical or discrete data on processes or events that are time-dependent (i.e., for which the timing of occurrence is as meaningful as whether they occurred or not). One example of such time-dependent processes is mortality: variation across individuals is not captured by the lifetime probability of dying (which is one for every individual), but by differences in the age at which death occurs. Another example is marriage: here, variation across individuals is captured by both the lifetime probability of getting married and differences in age at marriage.

Event-history analysis, sometimes called survival analysis, has applications in many fields, including sociology, economics, biology, medicine, and engineering. Applications in demography are particularly numerous, given demography's focus on age and cohorts. In addition to mortality, demographic events that can be investigated with event-history analysis include marriage, divorce, birth, migration, and household formation.

Comparison to Life Table Analysis

Event-history analysis has its roots in classical life table analysis. In fact, life table analysis is one of the methods covered by event-history analysis, and many of the concepts of event-history analysis, such as survival curves and hazard rates, have equivalents in a conventional life table. One difference from life table analysis is that event-history analysis is based on data at the individual level and aims at describing processes operating at that level. Also, whereas conventional life table analysis is deterministic, event-history analysis is probabilistic. Hence, many event-history analysis outcomes will have confidence intervals attached to them. Another feature of event-history analysis relative to conventional life table analysis is the use of covariates. Event-history analysis makes it possible to identify factors associated with timing of events. These factors can be fixed through time (such as ethnicity or parents' education), or vary with time (such as income and marital status).

Whereas conventional life table analysis can be applied to both longitudinal and cross-sectional data, event-history analysis requires longitudinal data. Longitudinal data can be collected either in a prospective fashion by following individuals through time, or retrospectively by asking individuals about past events.

Censored Data and Time-Varying Covariates

Because of its longitudinal nature, event history data have some features which make traditional statistical techniques inadequate. One such feature is *censoring,* which means that information on events and exposure to the risk of experiencing them is incomplete. *Right censoring,* the most common type of censoring in event-history analysis, occurs when recording of events is discontinued before the process is completed. For example, in longitudinal data collection, individuals previously included in a sample may stop contributing information, either because the study is discontinued before they experience the event of interest, or because they discontinue their participation in the study before they experience the event. Another, less common, type of censoring is *left censoring,* which occurs when recording is initiated after the process has started. In the remainder of this article, censoring will refer to right censoring.

It is important to include censored individuals in event-history analysis, because the fact that they did not experience the event of interest in spite of their exposure is in itself meaningful. Censoring can be handled adequately as long as it is independent—that is, as long as the risk of being censored is not related to the risk of experiencing the event, or, equivalently, provided that individuals censored at any given time are representative of all other individuals. If the two risks are related, however, the estimates obtained can be seriously biased.

Another particular feature of survival data is the potential presence of time-varying covariates. For example, an individual's income may vary over time, and these variations may have an effect on the risk of experiencing events. If this is the case, it is important to include information on these variations in the analysis.

Unlike traditional statistical techniques such as ordinary least squares (OLS), event-history analysis can handle both censoring and time-varying covariates, using the method of maximum likelihood estimation. With the maximum likelihood approach, the estimated regression coefficients are the ones that maximize the likelihood of the observations being what they are. That is, the set of estimated coefficients are more likely than any other coefficient values to have given rise to the observed set of events and censored cases.

Hazard Rates

An important concept in event-history analysis is the hazard rate, $h(t)$. The hazard rate is the risk or hazard that an event will occur during a small time interval, $(t, t+dt)$. It corresponds to the rate of occurrence of an event (number of occurrences/amount of exposure to the risk of occurrence) during an infinitesimal time or age interval. If the event under study is death, then the hazard rate is called the force of mortality, $\mu(x)$, where x is age. Event-history analysis can be used to explore how hazard rates vary with time, or how certain covariates affect the level of the hazard rate.

Types of Analysis

Methods of event-history analysis fall into three categories:

1. Nonparametric, in which no assumption is made about the shape of the hazard function;
2. Parametric, requiring an assumption about how the hazard rate varies with time; and
3. Semiparametric, requiring an assumption about how the hazard rate varies across individuals but no assumption about its overall shape.

Nonparametric Models

The life table approach to analyzing event history data is a nonparametric method. It is very similar to traditional life table construction in demography, although it is based on cohort rather than period data. The logic behind the life table approach is to calculate $Q(t_i)$, the probability of "failing" (for instance, dying) in the interval $[t_i, t_i+n]$, from data on $N(t_i)$, the number of individuals at risk of failing at time t_i, and $D(t_i)$, the number of failures between t_i and t_i+n. The number of individuals at risk needs to be adjusted for the fact that some individuals, $C(t_i)$, will be censored—that is, removed from the risk of experiencing the event during the interval. Hence $Q(t_i)$ can be expressed as:

$$Q(t_i) = \frac{D(t_i)}{N(t_i) - 0.5 \cdot C(t_i)}$$

The proportion of persons surviving at time t_i, $S(t_i)$, is then obtained as the product of the probabilities of surviving over all earlier time intervals as shown below.

$$\hat{S}(t_i) = \prod_{j=0}^{i-1} \left[1 - Q(t_j)\right]$$

Another output of the life table method is the hazard rate, $h(t_i)$, which is simply calculated by dividing the number of events experienced during the interval t_i by the number of person-years lived during the interval. The number of person-years is estimated by assuming that both failures and censored cases occur uniformly through the interval. Hence $h(t_i)$ is given by:

$$h(t_i) = \frac{D(t_i)}{n \cdot \left(N(t_i) - 0.5 \cdot D(t_i) - 0.5 \cdot C(t_i)\right)}$$

The above equations can produce biased results when time intervals are large relative to the rate at which events occur. If failures and censored cases are recorded with exact time, it is possible to correct for these biases by use of what is known as the Kaplan-Meier method. Suppose that d_j is the number of deaths at exact time t_j, and that N_j is the number of persons at risk at time t_j. The Kaplan-Meier estimator of the survival curve $S(t)$ is defined as:

$$\hat{S}(t) = \prod_{j:t_j \le t} \left[1 - (d_j / N_j)\right]$$

where N_j is obtained by subtracting all failures and censored cases that occurred before t_j from the initial size of the cohort. Compared to the life table method, the Kaplan-Meier method produces a more detailed contour of the survival curve. It is more appropriate than the life table approach when the recording of events is precise. The Kaplan-Meier method permits calculation of confidence intervals around the survival curve and the hazard rate. It also makes it possible to calculate survival curves for two or more groups with different characteristics, and to test the null hypothesis that survival functions are identical for these groups.

Parametric and Semiparametric Models

Although nonparametric life table approaches can perform some tests across groups, they do not permit direct estimation of the effect of specific variables on the timing of events or on the hazard rate. In order to estimate such effects, one needs to use regression models that fall into the category of fully parametric or semiparametric methods.

Accelerated failure-time models. The most common fully parametric models are called accelerated failure-time models. They postulate that covariates have multiplicative effects both on the hazard rate and on timing of events. They commonly take T_i, the time at which the event occurs, as a dependent variable. A general representation of accelerated failure-time models is:

$$\log T_i = \beta_0 + \beta_1 x_{i1} + \ldots + \beta_k x_{ik} + \sigma \varepsilon_i$$

where T_i is the time at which the event of interest occurs for individual *i*, and $x_{i1}, \ldots, x_{ik}$ is a set of *k* explanatory variables with coefficients β, ε_i is an error term, and σ is a scale parameter. (Taking the logarithm of T_i ensures that the timing of events will be positive whatever the values of the covariates for a specific individual.)

This model can be adapted to various situations by choosing a specific distribution for the error term ε_i. Common distributions chosen include normal (when the distribution of T_i is log-normal), extreme value (when the distribution of T_i is Weibull), logistic (when the distribution of T_i is log-logistic), and log-gamma (when the distribution of T_i is gamma). Accelerated failure-time models are fully parametric precisely because they require the choice of a model distribution of failure times. Although the above equation resembles that of an OLS regression, the estimation must be performed using the maximum likelihood procedure in order to accommodate the presence of censored cases. Regression coefficients in accelerated failure time models can be interpreted by calculating $100(e^{\beta}-1)$, which is an estimate of the percentage change in the time at which the event occurs for a one-unit increase in a particular independent variable.

Proportional hazard models. Another type of regression model in event-history analysis is the proportional hazard model. Such models postulate that the set of covariates acts in a multiplicative way on the hazard rate. A general formulation of proportional hazard models is:

$$\log h_i(t) = \log h_0(t) + \beta_1 x_{i1} + \ldots + \beta_k x_{ik}$$

where $h_0(t)$ is the baseline hazard that is increased or decreased by the effects of the covariates.

This model is called proportional hazard because for any two individuals the ratio of the risk of the hazard is constant over time. If the form for $h_0(t)$ is specified, the result is a fully parametric model. The most common specifications for $h_0(t)$ are the exponential, Weibull, and Gompertz models. Like accelerated failure time models, fully-parametric proportional hazard models are estimated using the maximum likelihood procedure.

Proportional hazard models can also be estimated without specifying the shape of $h_0(t)$. In an influential paper, D.R. Cox (1972) showed that if one assumes that the ratio of the hazards for any two individuals is constant over time, one can estimate the effect of covariates on hazard rates with no assumption regarding the shape of $h_0(t)$, using a "partial likelihood" approach. These models, commonly called Cox regression models, are semiparametric because of the absence of any assumption regarding the time structure of the baseline hazard rate. In order to interpret the coefficients (β_i) of such regressions, one can calculate the percent change in the hazard rate for a one-unit increase in the variable, using again the transformation $100(e^{\beta}-1)$. Cox regression models, which also can be easily adapted to accommodate time-varying covariates, are probably the most popular of available event history models.

Generalizations

In some cases it is important to distinguish among different kinds of events. For example, in demography it is sometimes necessary to focus on deaths from particular causes rather than on deaths from all causes. In such situations, individuals are being exposed to "competing risks," which means that at any time they face the risk of experiencing two or more alternative events. All the methods described above can be adapted to handle multiple events by estimating separate models for each alternative event, treating other events as censored cases. As in the case of censoring, the assumption is that risks of experiencing alternative events are independent of one another; violation of this assumption leads to biased estimates.

There are cases where the event of interest occurs in discrete time intervals. This can happen because of the nature of the event, or because the timing of events is not exactly recorded. Event-history analysis includes methods that are specifically designed for dealing with discrete time. The basic principle behind these models is to use discrete time units rather than individuals as the unit of observation. By breaking down each individual's survival history into discrete time units and pooling these observations, it is possible to estimate a model predicting the probability that the event occurs during a time interval, given that it has not occurred before. Such models are easy to implement and are computationally efficient. Also, since the unit of observation is a time interval, it is easy to include covariates taking different values for different time intervals.

All the models presented here assume that two individuals with identical values of covariates have identical risks of experiencing the event of interest. If there are no covariates in the model, the assumption is that risks are identical for all individuals. Such assumptions can be problematic in survival analysis. In fact, if some important characteristics are not accounted for, the aggregate risk may appear to decrease with time because the proportion of individuals with lower risks increases as time passes. Thus, in the presence of unobserved heterogeneity, it may be erroneous to use survival analysis to make inferences about individuals' risks. Although there are solutions to handle this potential bias, options for dealing with unobserved heterogeneity are limited and are highly sensitive to the underlying assumptions of the models.

Another implicit assumption in all the models discussed above is that events can be experienced only once, which implies that individuals are removed from the population "at risk" after they experience the event. There are many situations, however, in which events are repeatable. For example, a person who had a child or changed jobs can experience those events again. Under these circumstances, it is still possible to use single-event methods by analyzing each successive event separately, or by using a discrete-time analysis where the unit of observation is a time interval and where all time intervals, assumed to be independent for a single individual, are pooled together. However, these strategies are unsatisfactory for many reasons, and specific methods exist to deal with repeatable events. As in the case of unobserved heterogeneity, options for dealing with repeatable events are still limited.

See also: *Cohort Analysis; Estimation Methods, Demographic; Life Tables; Multistate Demography; Stochastic Population Theory.*

BIBLIOGRAPHY

Allison, Paul D. 1995. *Survival Analysis Using the SAS System: A Practical Guide.* Cary, NC: SAS Institute.

Cleves, Mario, William W. Gould, and Roberto Gutierrez. 2002. *An Introduction to Survival Analysis Using Stata.* College Station, TX: Stata Corporation.

Collett, David. 1994. *Modelling Survival Data in Medical Research.* London: Chapman and Hill.

Courgeau, Daniel, and Eva Lelièvre. 1992. *Event History Analysis in Demography.* Oxford, Eng.: Clarendon Press.

Cox, David R. 1972. "Regression Models and Life Tables." *Journal of the Royal Statistical Society* B(34): 187–220.

Manton, Kenneth, Eric Stallard, and James W. Vaupel. 1986. "Alternative Models for the Heterogeneity of Mortality Risks among the Aged." *Journal of the American Statistical Association* 81: 635–44.

Palloni, Alberto, and Aage B. Sorensen. 1990. "Methods for the Analysis of Event History Data: A Didactic Overview." In *Life Span Development and Behavior,* ed. Paul B. Baltes, David L. Featherman, and Richard M. Lerner. Hillsdale, NJ: Erlbaum.

Trussell, James, Richard K. B. Hankinson, and Judith Tilton. 1992. *Demographic Applications of Event History Analysis.* Oxford, Eng.: Clarendon Press.

Wu, Lawrence L. 2003. "Event History Models for Life Course Analysis." In *Handbook of the Life Course,* ed. Jeylan Mortimer and Michael Shanahan. New York: Plenum.

MICHEL GUILLOT

EVOLUTIONARY DEMOGRAPHY

The fields of human demography and population biology share intellectual roots and a common set of methodological tools for describing and analyzing population processes. The two disciplines, however, have developed independently with very little cross-fertilization. They developed independently probably because human populations experienced very rapid changes in patterns of mortality and fertility from the mid-nineteenth century to the early twenty-first century, suggesting to demographers that explanations of human population processes must be inherently social rather than biological.

Evolutionary demography analyzes population processes as reflecting the optimizing force of natural selection, the process by which alternative genotypes change in frequency due to differential reproduction of the phenotypes with which they are associated in given environments. Thus, gene coding for physiological and psychological mechanisms regulating fertility, mortality, and investment in offspring are seen to evolve under the influence of natural selection. Even though gene frequencies in populations are expected to change rather slowly over generational time, this does not imply similarly slow rates of change in demographic outcomes. Both plants and animals are capable of very rapid and *adaptive* (i.e, fitness-enhancing) adjustments in vital rates. Thus, rapid changes in human fertility and mortality per se do not imply a major discontinuity between humans and other organisms that would require a completely independent explanatory framework.

This article presents a broad overview of evolutionary demography, with a specific focus on humans. It considers three themes: (1) the timing of life events, including development, reproduction, aging, and risks of mortality; (2) the regulation of reproductive rates and parental investment in offspring; and (3) sexual dimorphism and its relationship to mating and marriage patterns.

Human Life History Adaptation in Comparative Perspective

Humans lived as hunter-gatherers for the vast majority of their evolutionary history (the genus *Homo* has existed for about 2 million years). Some life history features can be determined from the fossil record, but it is not yet possible to estimate many vital statistics from paleontological and archaeological remains. Modern hunter-gatherers are not living replicas of humans's Stone Age past because global socioeconomic forces affect them all. Yet, in spite of the variable historical, ecological, and political conditions affecting them, there is remarkable similarity among foraging peoples, and even the variation often makes adaptive sense. Comparisons between foraging peoples and other modern primates are an important source of information about the life histories of human ancestors and the selection pressures acting upon them.

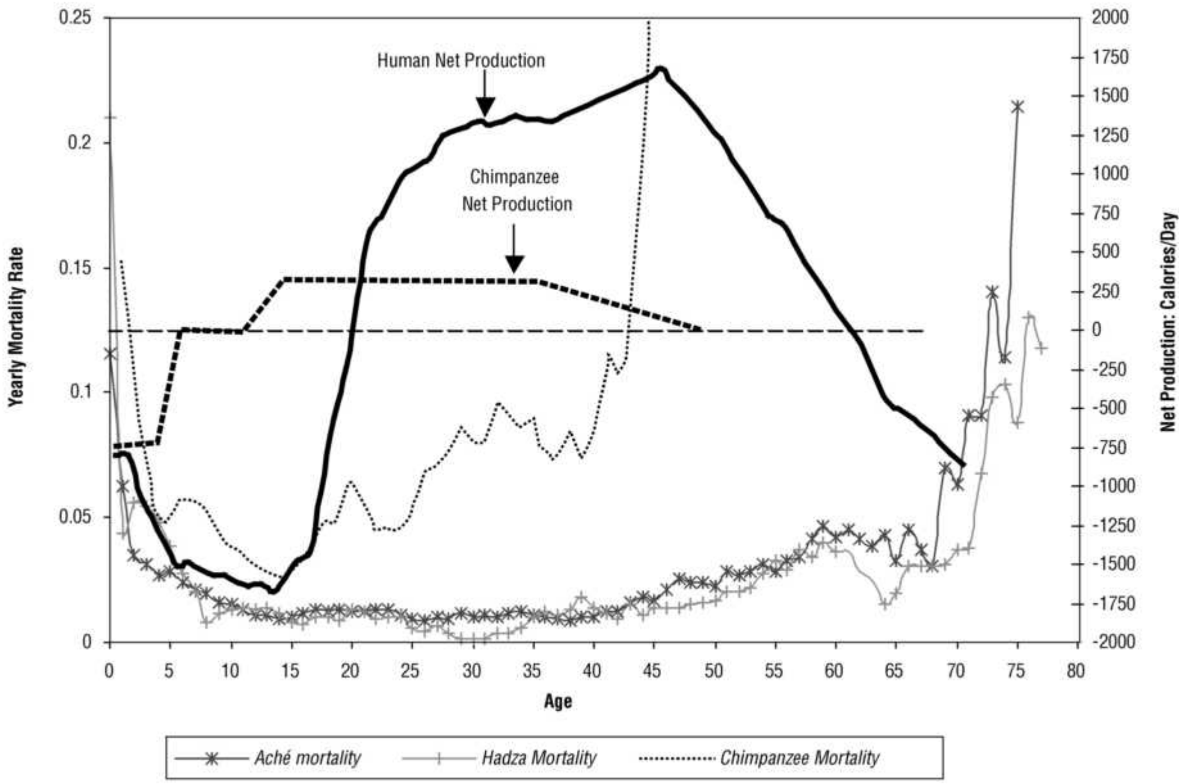
Relative to other mammalian orders, the primate order is slow-growing, slow-reproducing, long-lived, and large-brained. Humans are at the extreme of the primate continuum. Figure 1 illustrates the differences between human foragers and wild-living chimpanzees. The age-specific mortality profile among chimpanzees is relatively V-shaped, decreasing rapidly after infancy to its lowest point (about 3% per year) at about 13, the age of first reproduction for females, increasing sharply thereafter. In contrast, mortality among human foragers decreases to a much lower point (about 0.5% per year) and remains low with no increase between about 15 and 40 years of age. Mortality then increases slowly, until there is a very rapid rise beginning around age 70. The pattern is much more "block U-shaped." The strong similarities in the mortality profiles of the foraging populations suggest that this pattern is an evolved life history characteristic of the human species.

As a result of these differences in mortality patterns, hunter-gatherer children experience higher survival rates than chimpanzees to age of first reproduction: about 60 percent to age 19 versus 35 percent to age 13. Chimpanzees also have a much shorter adult lifespan than humans. At first reproduction, chimpanzee life expectancy is an additional 15 years, compared to 38 more years among human foragers. Importantly, women spend more than a third of their adult lives in a postreproductive phase, whereas very few chimpanzee females survive to reach this phase. Fewer than 10 percent of chimpanzees survive to age 40, but some 15 percent of hunter-gatherers survive to age 70.

Age profiles of net food production (food produced minus food consumed) also differ sharply (see Figure 1). Among chimpanzees, net production before age five is negative, representing complete, then partial, dependence upon mother's milk. The second phase is independent juvenile growth, lasting until adulthood, during which net production is zero. The third phase is reproductive, during which females, but not males, produce a surplus of calories that they allocate to nursing. Humans, in contrast, produce less than they consume for some 15 to 22 years, depending on the group. Net production becomes increasingly negative until about age 14 and then begins to climb. Net production of adult humans is much higher than in chimpanzees and peaks at about 35 to 45 years of age. This peak is about five times as high as the chimpanzee peak. The human age profile of production could not exist if humans had the same mortality profile as chimpanzees. Only 30 percent of chimpanzees reach the age when humans produce what they consume on average, and

FIGURE 1

Mortality and Net Food Production: Human Foragers and Chimpanzees



Note: Chimpanzee mortality rates are represented with the dashed curve, averaged from all six wild chimpanzee field sites where systematic data on mortality has been collected (Hill et al., 2001); Hadza and Aché foragers are presented individually to show the similarity between groups from Africa and South America. Data for the Hadza of Tanzania and Aché of Paraguay are derived from Blurton Jones et al., 2002 and Hill and Hurtado, 1996, respectively. Actual mortality rates are double-smoothed in five-year running averages and then as two-year running averages. Average net food production (food produced minus food consumed) for chimpanzees and humans is displayed on the right y-axis, with bold dashed and solid lines, respectively. Data on chimpanzee food consumption and production are from Gombe (Goodall, 1986). Net production data are averaged from Aché, Hadza, and Hiwi foragers.

SOURCE: Kaplan and Robson (2002).

fewer than 10 percent reach the age when human production peaks.

High levels of knowledge and skill are needed to acquire the variety of high-quality resources humans consume. These abilities require a large brain and a long time commitment to physical and psychological development. This extended learning phase during which productivity is low is compensated for by higher productivity during the adult period. Because productivity increases with age, and therefore the return on the investment in the development of offspring occurs at an older age, the time investment in skill acquisition and knowledge leads to selection for lowered mortality rates and greater longevity. Thus, it is likely that the long human lifespan co-evolved with the lengthening of the juvenile period, increased brain capacities for information processing and storage, and intergenerational resource flows.

Regulation of Reproduction under Natural Fertility Regimes

Traditionally, demographers have attempted to understand the onset and termination of reproduction and birth intervals in natural fertility regimes in terms of proximate determinants (i.e, those that have direct mechanistic impacts on fertility, such as coital and breast-feeding frequencies). For the most part, these determinants are treated as givens and there has been little consideration of the causal processes shaping them. In contrast, evolutionary demographers approach these determinants in terms of design and ask *why* the physiological, psychological, and cultural processes that regulate fertility take the forms that they do.

There is mounting evidence that human reproductive physiology is particularly specialized toward the production of high-quality, large-brained offspring. Two implications of this specialization are rigid control over embryo quality and a series of adaptations on the part of both mother and offspring designed to ensure an adequate energy supply for the nutrient-hungry, fast-growing brain. Given the massive investment in human offspring, this system ensures that investment is quickly terminated in an offspring of poor genetic quality. Fetal growth is more rapid in humans than in gorillas and chimpanzees, and both mother and offspring store exceptional amounts of fat, probably to support an equally exceptional rate of expensive brain growth during the first five years of life.

The physiological regulation of ovulation, fertilization, implantation, and maintenance of a pregnancy is highly responsive to energy stores in the form of fat, energy balance (calories consumed minus calories expended), and energy flux (rate of energy turnover per unit time). Low body fat, weight loss due to negative energy balance, and extreme energy flux (either very low intake and very low expenditure, or very high intake and very high expenditure) each lower monthly probabilities of conceiving a child that will survive to birth. Seasonal variation in workloads and diet has been shown to affect female fertility. Variation across groups in both age of menarche (first menstrual period) and fertility has been linked to differences in food intake and workload.

Behavior and the underlying psychological processes that govern parental investment in offspring affect fertility indirectly via maternal physiology. One route is through breast-feeding. Patterns of breast-feeding and solid food supplementation vary both cross-culturally and among mother–infant pairs. Unlike the growing body of knowledge about the physiological pathways mediating the effects of nursing, much less is known about the cultural, psychological, and physiological determinants of the duration and intensity of nursing, and the respective roles of the mother and infant in the process.

The second route relates to the additional energetic constraints involved in provisioning children. The age/sex profile of work and productivity, along with a system of food distribution, determine the net energy available for reproduction among women. People in foraging societies are sensitive to ecological variability in the trade-offs regarding children's work effort and their provisioning. Thus, natural selection appears to have acted upon both the psychology of parental investment and maternal physiology to produce a flexible system of fertility regulation. The key to this system is that maximizing lifetime-expected resource production through the optimal allocation of activities and food flows will tend also to maximize fitness when all wealth is in the form of food and when extra food translates into higher fertility. Nevertheless, empirical applications of optimality models, designed to determine whether the onset and termination of reproduction and the size of interbirth intervals actually maximize fitness, have produced mixed results.

Role of Men in Human Reproduction

Unlike most other male mammals, men in foraging societies provide the majority of the energy necessary to support reproduction. Among the ten foraging societies for which quantitative data on adult food production are available, men on average contributed 68 percent of the calories and almost 88 percent of the protein; women acquired the remaining 32 percent of calories and 12 percent of protein. Given that, on average, 31 percent of these calories are apportioned to support adult female consumption, 39 percent to adult male consumption, and 31 percent to consumption of offspring, women supply 3 percent of the calories to offspring and men provide the remaining 97 percent.

Complementarity between the investments of each sex in reproduction appears to be the principal force favoring decreased sexual dimorphism (i.e., differential expression of traits by males and females, respectively) and increased male parental investment. This kind of complementarity can occur when both direct care and resources are important to offspring viability, but they conflict with one another. For example, among many flying bird species, protection and feeding of nestlings are incompatible, leading to biparental investment and turn-taking in feeding and nest protection by males and females.

Hunting, as practiced by humans, is largely incompatible with the evolved commitment among primate females toward intensive mothering, carrying of infants, and lactation-on-demand in service of high infant survival rates. First, it often involves rapid travel and encounters with dangerous prey. Second, it is often most efficiently practiced over relatively long periods of time rather than in short stretches, because of search and travel costs. Third, it is highly skill-intensive, with improvements in return rate occurring over two decades of daily hunting. The first two qualities make hunting a high-cost activity for pregnant and lactating females. The third quality, in interaction with the first and second, generates life course effects such that gathering is a better option for females, even when they are not lactating, and hunting is a better option for males. Because women spend about 75 percent of their time either nursing or more than three months pregnant during their reproductive lives, they never get enough practice to make it worth while to hunt, even when they are not nursing or pregnant, or are postreproductive.

Human females evidence physiological and behavioral adaptations that are consistent with an evolutionary history involving extensive male parental investment. They decrease metabolic rates and store fat during pregnancy, suggesting that they lower work effort and are being provisioned. Women in foraging societies decrease work effort during lactation and focus on high-quality care. In contrast, nonhuman primate females do not store appreciable fat, increase work effort during lactation, and as a result, have increased risk of mortality. The human specialization could not have evolved if women did not depend on men for most of their food provisioning throughout human history.

Extensive cooperation among men and women would make sense only if the reproductive performance of spouses were linked. When women reach menopause in their late forties, men have the option to continue reproducing with younger women but they do not generally do so. Among the Aché, for example, 83 percent of all last births for women also represent a last child for the fathers.

Because men support reproduction only indirectly by affecting the energy intake rates of women and children, it is not surprising that spermatogenesis (the formation of sperm) is buffered from variations in food intake. Natural selection on male physiology and behavior appears to reflect the trade-off between mating investment and survival. Androgens, most notably testosterone, affect muscularity, competitiveness, and high-risk behavior, but they reduce immune function and fat storage, which, in turn, affect survival. Future research on the male endocrine system is likely to elucidate how natural selection has operated to produce both individual variation and age-related changes in male physiology and behavior.

Extra-Somatic Wealth and Its Implications for Human Demography

With the advent of agriculture and pastoralism (livestock raising), wealth storage in the form of land, livestock, luxury goods, and, eventually, money became commonplace practices. Around the globe, responses to these new economic practices were highly patterned and exhibited remarkable uniformity in response to similar ecological conditions. First, men became actively involved in competition for access to resources, which, in turn, were used for access to women. Second, parental investment extended beyond food and care, and well-defined inheritance practices emerged.

Among pastoralists, the male warfare complex, where livestock are stolen and brides are captured, became common. Patrilineal inheritance (through the male line) of livestock also became the norm, and men gained access to women through the transfer of bride wealth to the women's families. Polygyny (the taking of more than one wife), practiced to a much lesser degree among foragers, resulted from differences in wealth, and the number of wives increased in relation to wealth.

In the case of agriculture, social stratification of wealth increased in relation to the patchiness of arable land, with highly fertile river valleys generating the most intensive competition and the greatest wealth differentials. In a 1993 study of six despotic empires (Mesopotamia, Egypt, Aztec Mexico, Inca Peru, and imperial India and China), Laura Betzig detailed the impressive convergence of cultural evolution. Powerful men sequestered large harems of women (several thousand in the case of rulers) and enforced their exclusive sexual access. Nevertheless, legal marriage—being highly restricted and often monogamous, and controlling inheritance—was differentiated from concubinage. Marriages were often strategic, between families of similar social class, or involving dowries that were exchanged for the upward mobility of women. Inheritance often was distributed differentially with sibships, with the most common pattern being primogeniture. Because the complex societies of North and South America developed in the absence of contact with the Old World, cultural convergences between the New and Old Worlds are likely the result of an evolved human psychology interacting with new technologies of production (which themselves were most likely reactions to demographic pressures and reduced returns from foraging).

Such responses are largely consistent with evolutionary logic and are analogous to the behavior of other organisms, although there is some evidence that human responses to extra-somatic wealth may not be fitness-maximizing. It is possible that the psychology of social status striving, which was perhaps adaptive in foraging societies, is no longer adaptive in the context of extra-somatic wealth.

Demographic Transition

It is almost certainly the case that reproductive behavior in post–demographic transition societies (that is, those in which small families are the norm and mortality rates are low) is not fitness-maximizing. Even taking into account the effects of low fertility on increased parental investment and subsequent adult income of offspring, fertility is much lower than the predicted level for maximizing descendants. For example, a study of men's reproductive behavior in Albuquerque, New Mexico, found that the number of grandchildren was maximized by men with 12 or more children (the highest number reported), even though mean fertility was just over two children.

Nevertheless, just as increased payoffs to skill and mortality reduction may underlie the original evolution of long-term child dependence and human longevity, similar changes may explain the dramatic lowering of fertility accompanying modernization. Education is the best and most consistent predictor of fertility variation, both within and among nations. The payoffs to education have changed for two reasons. Changes in the technology of production within education-based labor markets have led to very high returns on parental investments in children's education. Changing medical technology and improved public health have greatly reduced mortality rates for all age groups. Increased survival rates during the period of parental investment increase the expected costs per child born, favoring further increases in offspring quality. Increased survival during the adult period increases the expected years of return on educational investments, further increasing the incentive to invest in children's education.

In response to the increased payoffs on investments in education and the expected costs of those investments, parents determine the number of children they can afford to rear, given their wealth. These factors result in fertility being regulated by a consciously determined fertility plan realized through birth-control technology and/or controlled exposure to sex. The low mortality rates also allow parents to plan reproduction at the outset, because the number of children born accurately predicts the number of children that will reach adulthood.

A great deal of further research is necessary, however, before there is a full understanding of why these changes in socioecology (i.e., the physical, biotic and social conditions characterizing the environment) have resulted in such low levels of fertility and high levels of parental investment and wealth consumption. People are not simply maximizing family wealth because net wealth of families would be maximized by higher fertility than is currently observed. Nor are they maximizing personal consumption; in that case, they would have no children. One possible hypothesis is that social dynamics of small groups in hunting and gathering economies resulted in greater fitness for those of higher social standing and selected for a psychology in which relative social position of self and offspring is valued highly. This psychology may have been fitness-maximizing under traditional conditions. If relative, as opposed to absolute, wealth and social standing guide human decisions regarding parental investment and fertility, it is possible that "runaway" consumption and investment in children's education result from the interaction of this psychology with modern education-based labor markets and consumption possibilities.

Conclusions

Evolutionary demography is best viewed not as an alternative to traditional approaches but rather as a general theoretical framework that existing models will contribute to and enhance. Economic modeling is fundamental to evolutionary analysis. Economists are primarily concerned with conscious, rational decision processes, but these are only a subset of the regulatory mechanisms of controlling fertility. Feminist demography details the conflicts of interest between men and women, and how they vary with social context. A more basic evolutionary understanding of why men and women differ and how socioecology affects the extent to which the behavior and goals of the two sexes converge and diverge will enrich such insights. Because information about the costs and benefits of alternative behavioral options is often socially acquired, the understanding of cultural diffusion is critical. Evolutionary logic provides a framework for the analysis of the active role that people play in determining which ideas they chose to adopt.

The application of evolutionary theory to humans is complicated by technological and social change. Given that evolution is a historical process, organized, flexible responses to environmental variation evolve when populations are exposed to fluctuations that are patterned and, to some extent, regular. When organisms are exposed to new, and radically different, environments, however, it is possible that their responses may be nonadaptive, reflecting physiological and psychological traits that evolved in the context of more ancient environments. The response of drastically reduced fertility may be a case in point. The analysis of a species in a novel, rapidly changing environment poses special challenges, but an understanding of the evolutionary past of humans should assist in explaining the present and predicting the future.

See also: *Animal Ecology; Archaeogenetics; Biodemography; Biology, Population; Darwin, Charles; Hunter-Gatherers; Paleodemography; Primate Demography; Sociobiology.*

BIBLIOGRAPHY

Bailey, Robert C., Mark R. Jenike, Peter T. Ellison, Gillian R. Bentley, Alica M. Harrigan, and Nadine R. Peacock. 1992. "The Ecology of Birth Seasonality among Agriculturalists in Central Africa." *Journal of Biosocial Science* 24: 393–412.

Betzig, Laura. 1993. "Sex, Succession, and Stratification in the First Six Civilizations: How Powerful Men Reproduced, Passed Power on to Their Sons, and Used Their Power to Defend Their Wealth, Women, and Children." In *Social Stratification and Socioeconomic Inequality,* ed. Lee Ellis. New York: Praeger.

Blurton Jones, Nicholas G. 1986. "Bushman Birth Spacing: A Test for Optimal Interbirth Intervals." *Ethology and Sociobiology* 4: 145–147.

Blurton Jones, Nicholas G., Kristen Hawkes, and Patricia Draper. 1994. "Differences between Hadza and !Kung Children's Work: Original Affluence or Practical Reason?" In *Key Issues in Hunter-Gatherer Research,* ed. Ernest S. Burch and Linda J. Ellana. Oxford: Berg.

Blurton Jones, Nicholas G., Kristen Hawkes, and James O'Connell. 2002. "The Antiquity of Post-reproductive Life: Are There Modern Impacts on Hunter-Gatherer Post-reproductive Lifespans?" *Human Biology* 14: 184–205.

Bock, John. 2002. "Learning, Life History, and Productivity: Children's Lives in the Okavango Delta, Botswana." *Human Nature* 13: 161–197.

Bongaarts, John, and Robert G. Porter. 1983. *Fertility, Biology, and Behavior: An Analysis of Proximate Determinants.* New York: Academic Press.

Boone, James. 1986. "Parental Investment and Elite Family Structure in Preindustrial States: A Case Study of Late Medieval–Early Modern Portuguese Genealogies." *American Anthropologist* 88: 859–878.

Borgerhoff Mulder, Monique. 1988. "Reproductive Success in Three Kipsigi Cohorts." In *Reproductive Decisions,* ed. Timothy Clutton Brock. Cambridge, Eng.: Cambridge University Press.

Bribiescas, Richard G. 2001. "Reproductive Ecology and Life History of the Human Male." *Yearbook of Physical Anthropology* 44: 148–176.

Dickemann, Mildred. 1979. "The Ecology of Mating Systems in Hypergynous Dowry Societies." *Social Science Information* 18: 163–195.

Ellison, Peter T. 2001. *On Fertile Ground: A Natural History of Human Reproduction.* Cambridge, MA: Harvard University Press.

Goodall, Jane. 1986. *The Chimpanzees of the Gombe: Patterns of Behavior.* Cambridge, Eng.: Cambridge University Press.

Hill, Kim, and A. Magdalena Hurtado. 1996. *Aché Life History: The Ecology and Demography of a Foraging People.* Hawthorne, NY: Aldine de Gruyter.

Hill, Kim, Christophe Boesch, Jane Goodall, Anne Pusey, Jennifer Williams, and Richard

Wrangham. 2001. "Mortality Rates among Wild Chimpanzees." *Journal of Human Evolution* 40(5): 437–450.

Hurtado, A. Magdalena, Kristen Hawkes, Kim Hill, and Hillard Kaplan. 1985. "Female Subsistence Strategies among Aché Hunter-Gatherers of Eastern Paraguay." *Human Ecology* 13: 29–47.

Hurtado, A. Magdalena, and Kim Hill. 1990. "Seasonality in a Foraging Society: Variation in Diet, Work Effort, Fertility, and the Sexual Division of Labor among the Hiwi of Venezuela." *Journal of Anthropological Research* 46: 293–345.

Irons, William 1979. "Cultural and Biological Success." In *Natural Selection and Social Behavior,* ed. Napoleon A. Chagnon and William Irons. North Scituate, MA: Duxbury Press.

Kaplan, Hillard S. 1996. "A Theory of Fertility and Parental Investment in Traditional and Modern Human Societies." *Yearbook of Physical Anthropology* 39: 91–135.

Kaplan, Hillard S., Jane Lancaster, John Bock, and Sara Johnson. 1995. "Does Observed Fertility Maximize Fitness among New Mexican Men? A Test of an Optimality Model and a New Theory of Parental Investment in the Embodied Capital of Offspring." *Human Nature* 6: 325–360.

Kaplan, Hillard S., Kim Hill, Jane B. Lancaster, and A. Magdalena Hurtado. 2000. "A Theory of Human Life History Evolution: Diet, Intelligence, and Longevity." *Evolutionary Anthropology* 9: 156–185.

Kaplan, Hillard S., Kim Hill, A. Magdalena Hurtado, and Jane B. Lancaster. 2001. "The Embodied Capital Theory of Human Evolution." In *Reproductive Ecology and Human Evolution,* ed. Peter T. Ellison. Hawthorne, NY: Aldine de Gruyter.

Kaplan, Hillard S., and Arthur Robson. 2002. "The Emergence of Humans: The Coevolution of Intelligence and Longevity with Intergenerational Transfers." *Proceedings of the National Academy of Sciences* 99: 10,221–10,226.

Lancaster, Jane, Hillard S. Kaplan, Kim Hill, and A. Magdalena Hurtado. 2000. "The Evolution of Life History, Intelligence, and Diet among Chimpanzees and Human Foragers." In *Perspectives in Ethology: Evolution, Culture, and Behavior,* ed. Françios Tonneau and Nicholas S. Thompson. New York: Plenum.

Mueller, Ulrich. 2001. "Is There a Stabilizing Selection around Average Fertility in Modern Human Populations?" *Population and Development Review* 27: 469–498.

Pennington, Renee. 2001. "Hunter-Gatherer Demography." In *Hunter-Gatherers: An Interdisciplinary Perspective,* ed. Catherine Panter-Brick, Robert H. Layton, and Peter Rowley-Conwy. Cambridge, Eng.: Cambridge University Press.

Pike, Ivy L. 1999. "Age, Reproductive History, Seasonality, and Maternal Body Composition during Pregnancy for Nomadic Turkana of Kenya." *American Journal of Human Biology* 11: 658–672.

Poppitt, Sally D., Andrew M. Prentice, Eric Jequier, Yves Schutz, and Roger G. Whitehead. 1993. "Evidence of Energy Sparing in Gambian Women during Pregnancy: A Longitudinal Study Using Whole-Body Calorimetry." *American Journal of Clinical Nutrition* 57: 353–364.

Wood, James W. 1994. *Dynamics of Human Reproduction: Biology, Biometry, and Demography.* New York: Aldine de Gruyter.

Hillard Kaplan

EXTERNALITIES OF POPULATION CHANGE

By externalities researchers mean those effects of human activities that occur without the agreement of the people who are affected. Logging in the upland forests of watersheds can cause water runoff and inflict damage on farmers and fishermen in the lowlands. The damage is an externality if those who suffer damage are not compensated by mutual agreement. Free-riding on the common property resources is another example of an activity that gives rise to externalities. The former example involves a "unidirectional" externality, while the latter reflects "reciprocal" externalities.

The above are examples of "external disbenefits." In contrast, when someone becomes literate at his own cost, he benefits not only himself, but also those others who are now able to correspond with him. This is an example of an "external benefit." More generally, the private production of public goods involves (reciprocal) external benefits.

The Theory of Externalities

The theory of externalities was discussed first by the economists A.C. Pigou (1920) and Erik Lindahl (1928). They noted that there is an over-supply of activities inflicting external disbenefits and an under-supply of activities conferring external benefits. Pigou in particular noted that externalities reflect a wedge between the (net) private and social benefits of human activities, the wedge being symptomatic of economic inefficiency. As remedy, Pigou suggested government intervention in the form of taxes and subsidies on the production of external disbenefits and benefits, respectively. Lindahl in contrast provided an outline of markets for externalities, assuming that such markets could be established. Lindahl noted that if the markets were efficient, they would eliminate the externalities. Ronald Coase (1960) generalized Lindahl's idea and stressed that even the direction of an externality (who affects whom) is a reflection of the structure of property rights. He argued, for example, that if the law recognizes polluters' rights, a negotiated settlement would have the lowland farmers and fishermen pay the upland firms to reduce logging. On the other hand, if the law recognizes pollutees' rights, a negotiated settlement would have the logging firm pay the farmers and fishermen for the right to engage in logging. Coase argued that in the absence of transaction costs there *could* be no externalities, because the parties would negotiate their way to an efficient allocation of resources (Coase's claim, even though seemingly tautological, is questionable, as shown by Kenneth Arrow [1971] and David Starrett [1973]). However, the externality would prevail if the costs of negotiation were prohibitive and the state remained aloof from the problem. In short, Coase argued that externalities are symptomatic of institutional failure.

Until recently economists did not take externalities seriously. Economics textbooks relegated the subject to later chapters. In the twenty-first century, however, studies on externalities abound, in large measure owing to a recognition that they are a key ingredient of environmental problems.

Reproductive and Environmental Externalities

The theory of externalities can be employed to explain the high fertility prevailing in many of the poorest regions of the contemporary world. This is done in a series of publications by Partha Dasgupta (1993, 1995, 2000), using the working hypothesis that people's reproductive decisions are based on their own interest but that the outcomes are inefficient because of reproductive or environmental externalities.

What could cause the private and social costs and benefits of reproduction to differ? Large-scale migrations of populations occasioned by crop failure, war, or other disturbances are an obvious form of externality. But by their very nature they are not persistent. Of those that are persistent, four deserve special mention: crowding, cost-sharing, interactions among institutions, and contagion.

Crowding. One likely source of externality is the finiteness of space. Increased population size implies greater crowding. Space being a common property, households acting on their own would not be expected to take into account the crowding externalities they inflict on others. The local commons in rural areas of poor countries offer an illustration. The private costs of having children are less than the social costs if the extent to which households have access to the commons is independent of household size. Crowding externalities favor high fertility.

Cost-sharing. Fertility behavior is influenced by the structure of property rights (e.g., rules of inheritance). In his analysis of fertility differences between preindustrial seventeenth- and eighteenth-century Northwest Europe, on the one hand, and Asiatic preindustrial societies on the other, the statistician John Hajnal (1982) distinguished between "nuclear" and "joint" household systems. He observed that in Northwest Europe marriage normally meant establishing a new household, which implied that the couple had to have, by saving or transfer, sufficient resources to establish and equip the new residence. This requirement in turn led to late ages at marriages. It also meant that parents bore the cost of rearing their children. Indeed, fertility rates in England averaged around the relatively low level of four children per woman in the years between 1650 and 1710, long before modern family planning techniques became available and long before women became widely literate (Coale, 1969; Wrigley and Schofield, 1981). Hajnal contrasted this with the Asiatic pattern of household formation, which he saw as joint units consisting of more than one couple and their children.

Parental costs of procreation are also lower when the cost of rearing the child is shared among the kinship. In sub-Saharan Africa fosterage within the kinship group is commonplace: children are not raised solely by their parents. The shared childrearing responsibility creates a free-rider problem if the parents' share of the benefits from having children exceeds their share of the costs. From the point of view of parents collectively, too many children are produced in these circumstances. In sub-Saharan Africa, communal land tenure within the lineage social structure has in the past offered further inducement for men to procreate. Moreover, conjugal bonds are frequently weak, so fathers often do not bear the costs of siring children. Weak conjugal bonds, communal land tenure, and a strong kinship support system of children, taken together, result in high fertility.

Interactions among institutions. Externalities are prevalent when market and nonmarket institutions co-exist. How and why might such externalities affect fertility behavior? A number of pathways suggest themselves.

When established long-term relationships break down, people look for alternatives to further their economic opportunities. The growth of markets in towns and cities, by making children less reliable as an investment for old age, can lead to a reduction in fertility. On the other hand, those who face particularly stressful circumstances may resort to draconian measures to build new economic channels. The anthropologist Jane Guyer (1994) has observed that in the face of deteriorating economic circumstances, some women in a Yoruba area of Nigeria have borne children by different men so as to create immediate lateral links with them. Polyandrous motherhood enables women to have access to more than one resource network.

Mead Cain (1981, 1983) showed that where capital markets are nonexistent and public or community support for the elderly are weak, children provide security in old age. The converse is that if communitarian support systems decline, children become more valuable. But communitarian support systems in rural areas may degrade with the growth of markets in cities and towns. So there is a curious causal chain here: growth of markets in towns and cities can lead to an increase in fertility in poor villages, other things being the same. There is scattered evidence of this. N. Heyzer (1996) has observed that one half of the total forest area in Sarawak, Malaysia, has now been lost, disrupting the lives of indigenous people in different ways. Communities that lived in the heart of the forest were most severely affected, while others, living near towns, were able to turn from swidden agriculture to wage labor. This transformation, however, involved male migration, leaving women behind to cope with a decreasing resource base. As subsistence alternatives declined, children became one of the few remaining resources that women could control. There was thus a new motivation for having children: to help their mothers with an increased workload.

Conformity and "contagion." That children are seen as an end in themselves provides another mechanism by which reasoned fertility decisions at the household can lead to an unsatisfactory outcome for the collectivity of all households. The mechanism arises when traditional practice is perpetuated by conformity. Procreation in closely-knit communities is not only a private matter, it is also a social activity, influenced by both family experiences and the cultural milieu. Behavior is conformist if, other things being equal, each household's most desired family size is the greater, the larger is the average family size in the community. So, conformism is the source of an externality (one person's behavior influences another's desires).

There can be many reasons for conformist behavior. Whatever the reason, there would be practices encouraging high fertility rates that no household would unilaterally desire to break. Thus, so long as all others follow the practice and aim at large family size, no household on its own would wish to deviate from the practice. However, if all other households were to restrict their fertility rates, each would desire to restrict its fertility rate as well. In short, conformism can be a reason for the existence of multiple reproductive equilibria. Moreover, a community could get stuck at one mode of behavior even though another (equilibrium) mode of behavior would be better for all. Social systems involving conformist behavior are called "coordination games." The reference group that influences individual behavior expands as newspapers, radio, television, and the Internet transmit information about other lifestyles.

Dasgupta (2000) has shown that such pathways can give rise to demographic transitions: fertility rates display little to no trend over extended periods, only to cascade downward over a relatively short interval of time, giving rise to the classic logistic curve of diffusion processes.

Demographers have made few attempts to discover evidence of behavior that is guided in part by an attention to others. In an exception to this neglect, Richard Easterlin, R. Pollak and M. Wachter (1980) studied intergenerational influence in a sample of families in the United States, reporting a positive link between the number of children with whom someone had been raised and the number of children they themselves had. Another exception is the study by Susan Cotts Watkins (1990) of demographic change in Western Europe over the period from 1870 to 1960. Watkins showed that in 1870, before the large-scale declines in marital fertility had begun, demographic behavior differed greatly among provinces (e.g., counties and cantons) but differences within provinces were low—suggesting an influence of local communities on behavior. By 1960 interprovincial differences had narrowed, a convergence she explains in terms of increases in the geographical reach of national governments and the spread of national languages.

A study in Bangladesh could also point to contagious behavior. An experimental birth control program in Matlab Thana, Bangladesh, showed both a substantial rise in contraceptive use in villages offered intensive services and a modest rise in its use in the set of "control" villages that were offered no such special services. The uptake was reflected in the fertility rates, which declined in both sets of villages but faster in the treatment area. The new fertility behavior spread to the control villages, but the contagion was less than complete.

See also: *Common Property Resources; Cost of Children; Intergenerational Transfers; Population Policy.*

BIBLIOGRAPHY

Arrow, K. J. 1971. "Political and Economic Evaluation of Social Effects of Externalities." In *Frontiers of Quantitative Economics,* ed. M. Intriligator. Amsterdam: North Holland

Baumol, W. M., and W. Oates 1975. *The Theory of Environmental Policy.* Englewood Cliffs, NJ: Prentice-Hall.

Bongaarts, J., and S. C. Watkins. 1996. "Social Interactions and Contemporary Fertility Transitions." *Population and Development Review* 22(4): 639–682.

Cain, M. 1981. "Risk and Insurance: Perspectives on Fertility and Agrarian Change in India and Bangladesh." *Population and Development Review* 7(3): 435–474.

Cain, M. 1983. "Fertility as an Adjustment to Risk." *Population and Development Review* 9(4): 688–702.

Caldwell, J. C., and P. Caldwell. 1990. "High Fertility in Sub-Saharan Africa." *Scientific American* 262(5): 82–89.

Coale, A. J. 1969. "The Decline of Fertility in Europe from the French Revolution to World War II." In *Fertility and Family Planning: A World View,* ed. S. J. Behrman, L. Corsa, and R. Freedman. Ann Arbor: University of Michigan Press.

Coase, R. 1960. "The Problem of Social Cost." *Journal of Law and Economics* 3.

Dasgupta, P. 1993. *An Inquiry into Well-Being and Destitution.* Oxford: Clarendon Press.

———. 1995. "The Population Problem: Theory and Evidence." *Journal of Economic Literature* 33(4): 1,879–1,902.

———. 2000. "Population and Resources: An Exploration of Reproductive and Environmental Externalities." *Population and Development Review* 26(4): 643–689.

Easterlin, R., R. Pollak, and M. Wachter. 1980. "Toward a More General Model of Fertility Determination: Endogenous Preferences and Natural Fertility." In *Population and Economic Change in Developing Countries,* ed. R. Easterlin. Chicago: University of Chicago Press.

Guyer, J. L. 1994. "Lineal Identities and Lateral Networks: The Logic of Polyandrous Motherhood." In *Nupitality in Sub-Saharan Africa: Contemporary Anthropological and Demographic Perspectives,* eds. C. Bledsoe and G. Pison. Oxford: Clarendon Press.

Hajnal, J. 1982. "Two Kinds of Preindustrial Household Formation Systems." *Population and Development Review* 8(3): 449–494.

Heyser, N. 1996. *Gender, Population and Environment in the Context of Deforestation: A Malay-*

sian Case Study. Geneva: United Nations Research Institute for Social Development.

Hill, K. 1992. "Fertility and Mortality Trends in the Developing World." *Ambio* 21(1): 79–83.

Lindahl, E. 1958. "Some Controversial Questions in the Theory of Taxation." In *Classics in the Theory of Public Finance,* ed. R. A. Musgrave and A. T. Peacock. London: Macmillan.

Mäler, K.-G. 1974. *Environmental Economics: A Theoretical Enquiry.* Baltimore: Johns Hopkins University Press.

Meade, J. E. 1973. *The Theory of Externalities.* Geneva: Institute Universitaire de Hautes Etudes Internationales.

Pigou, A. C. 1920. *The Economics of Welfare.* London: Macmillan.

Starrett, D. 1972. "Fundamental Non-Convexities in the Theory of Externalities." *Journal of Economic Theory* 4(1): 180–199.

Starrett, D. A. 1973. "A Note on Externalities and the Core." *Econometrica* 41(1): 179–183.

Watkins, S. C. 1990. "From Local to National Communities: The Transformation of Demographic Regions in Western Europe 1870–1960." *Population and Development Review* 16(2): 241–72.

Wrigley, E. A., and R. S. Schofield. 1981. *The Population History of England 1541–1871: A Reconstruction.* Cambridge, Eng.: Edward Arnold.

Partha Dasgupta

EXTINCTION, HUMAN

Even a small risk of near-term human extinction (within one century, for example) should be taken seriously, considering the stake. It is therefore remarkable that there has been so little systematic study of this topic—less than on the life habits of the dung fly. Some particular threats have been studied, however, and some thinkers have made attempts to synthesize what is known about the risks of human extinction. Because many of the dangers are hard to quantify, it is often necessary to fall back on informed subjective risk estimates.

Threats to near-term human survival include:

- *Nanotechnology disaster.* Advanced molecular manufacturing will make it possible to construct bacterium-scale self-replicating mechanical robots that can feed on dirt or other organic matter, and that could be programmed to destroy the biosphere by eating, poisoning, or burning it, or by blocking out sunlight. This capability could be extremely dangerous, and countermeasures could take a long time to develop. While the possibility of global-scale nanotech accidents shouldn't be ignored, deliberate misuse poses the gravest risk.
- *Nuclear holocaust.* Current arsenals are probably insufficient to obliterate all human life, although it is hard to be certain of this because science has a poor understanding of secondary effects (such as impact on global climate—"nuclear winter"). Much larger arsenals may be created in future arms races.
- *Superbugs.* Advanced biotechnology will almost certainly lead to better medicine, but it could also be used to create a super-pathogen. Increased urbanization and travel could also increase the risk posed by natural pandemics.
- *Evolution or re-engineering of the human species.* While natural biological human evolution takes place on time-scales much longer than a hundred years, one can imagine that scientists will develop technologies, such as nanomedicine (medical interventions based on mature nanotechnology) or very advanced genetic engineering, that will enable them to re-design the human organism to such a degree that these new humans become what could arguably be classified as a different species. Alternatively, humans might be able to "upload" their minds into computers. Evolution in a population of "uploads" could happen on much shorter time-scales than biological evolution. (Whether human extinction in this sense would be a bad thing presumably depends on what humans become instead.) Further, some have suggested the possibility that humans are currently living in a simulated world within computers built by some super-advanced civilization. If so, then one possible risk is that these simulators will decide to terminate the simulation.
- *Artificial intelligence takeover.* In this scenario, a badly programmed superhuman artificial

intelligence is created and proceeds to destroy humanity.

- *Something unforeseen.* Certainly scientists cannot anticipate all future risks; none of the risks listed here were known to people a hundred years ago.

Additionally, a number of lesser risks deserve mention: *physics disasters*—there have been speculations that high-energy physics experiments could knock the space nearest Earth out of a metastable vacuum state, and future developments in theoretical physics may reveal other disturbing possibilities; *asteroid or comet impact*—this is a small but real threat; *runaway global warming*—the warming effect would have to be very large to kill all humans; and *annihilation in encounter with an extraterrestrial civilization.*

To directly estimate the probability of human existence a century into the future, statisticians would analyze the various specific failure-modes, assign them probabilities, and then subtract the sum of these disaster probabilities from one to determine the success probability. A complementary, indirect way of estimating this success probability is by studying relevant theoretical constraints. One such constraint is based on the Fermi paradox: Could the absence of any signs of extraterrestrial civilizations be due to the fact that that nearly all civilizations reaching a sufficiently advanced stage develop some technology that causes their own destruction? Another is the highly controversial Doomsday argument. The Doomsday argument purports to show that there is now indexical information about current humanity's position in the human species that lends support to the hypothesis that there will not be a significantly larger number of people living after us than have lived before us. Others include the simulation argument mentioned above and studies of risk estimation biases. It is possible that there is a "good story" bias shaping perceptions of risk; scenarios in which humankind suddenly and uncinematically becomes extinct may rarely be explored because they are boring, not because they are improbable.

The gravest near-term risks to human existence are of humanity's own making and involve present or anticipated technologies. Of course, it does not follow that trying to stop technological progress would make the world safer—it could well have the opposite effect. A sensible approach to risk reduction would involve increasing awareness and funding more research on "existential risks;" fostering peace and democracy to reduce the risks of future war; promoting development of protective technologies such as vaccines, anti-viral drugs, detectors, nanotech defense systems, and surveillance technologies; creating a comprehensive catalogue of threatening meteors and asteroids; and retarding the development and proliferation of dangerous applications and weapons of mass destruction. Another possible longer-term approach to risk-reduction involves colonizing space. Proactive approaches must emphasize foresight: In managing existential risks, there is no opportunity to learn from mistakes.

Prospects for long-term human survival remain unclear. If humans begin to colonize other planets, it may be much harder to cause the extinction of the widely-scattered species. Whether the physical laws of the universe will permit intelligent information processing to continue expanding forever is an open question. Scientists' current best understanding of the relevant physics seems to rule this out, but cosmology and quantum gravity still hold many mysteries. If humans survive another hundred years, the species and their intelligent machine descendents may well have a *very* long time to look for possible loopholes.

See also: *Disasters; Future Generations, Obligations to; Outer Space, Colonization of.*

BIBLIOGRAPHY

Bostrom, Nick. 2002. *Anthropic Bias: Observation Selection Effects in Science and Philosophy.* New York: Routledge.

Drexler, K. Eric. 1985. *Engines of Creation: The Coming Era of Nanotechnology.* London: Fourth Estate.

Jaffe, Robert L., et al. 2000. "Review of speculative 'disaster scenarios' as RHIC." *Review of Modern Physics* 72: 1125–40.

Leslie, John. 1996. *The End of the World: The Science and Ethics of Human Extinction.* London: Routledge.

Morrison, David, et al. 1994. "The Impact Hazard." In *Hazards Due to Comets and Asteroids.* T. Gehrels. Tucson: The University of Arizona Press.

INTERNET RESOURCES.

Bostrom, Nick. 2002. "Existential Risks: Analyzing Human Extinction Scenarios and Related Hazards." *Journal of Evolution and Technology* 9. <http://www.transhumanist.com/volume9/risks.html>.

Freitas, Robert A., Jr. 2000. "Some Limits to Global Ecophagy by Biovorous Nanoreplicators, with Public Policy Recommendations." *Foresight Institute.* Richardson, TX: Zyvex Preprint. <http://www.foresight.org/NanoRev/Ecophagy.html>.

Gubrud, Mark. 2000. "Nanotechnology and International Security." *Foresight Institute, Fifth Foresight Conference on Molecular Nanotechnology.* <http://www.foresight.org/Conferences/MNT05/Papers/Gubrud/index.html>

NICK BOSTROM

F

FAMILY

HISTORY	Andrejs Plakans
FUTURE	Frank F. Furstenberg

HISTORY

Historical research on individual families in the Western world was carried out by genealogists long before the field was systematized in the 1960s and 1970s. In those two decades, however, as a result of the confluence of new initiatives and organizational developments in several disciplines, family history established itself as a specialized endeavor with strong links to cognate disciplines such as demography, sociology, and anthropology. The "new social history," proceeding from the influence of the French *Annales* school, pursued the history of "structures of long duration," including microstructures such as families, households, and kin groups.

The pioneering essays in *Population in History* (Glass and Eversley 1965) demonstrated the potential of the historical study of populations, and John Hajnal's essay on European marriage patterns in that volume put forth a seminal hypothesis about an important aspect of the long-term evolution of European family life. The formation of the Cambridge Group for the History of Population and Social Structure in 1967 resulted in an inclusive program for both historical demography and family/household structural analysis on the basis of historical sources such as parish registers and household listings. Independently of these initiatives, Philippe Ariès's *Centuries of Childhood* (1962) pointed to important historical shifts in the manner in which children were socialized.

By the early 1970s these initiatives had coalesced into a research agenda that dealt with the family, broadly defined, in both the distant and the recent past and used a wide variety of analytical concepts and approaches. Over the next 30 years the agenda widened to include questions not dealt with by the "founding generation."

Family Households and Historical Demography

In the decades between 1970 and 2000 historical demography and family history developed simultaneously, with findings on historical patterns of mortality, fertility, marriage, and migration creating in any historical period the context in which the family as a social structure had to be understood and with the historical sources used in family history (household listings, parish registers) providing much of the raw data for historical-demographic generalizations. It was clear that decisions about marriage, childbearing, and geographical movement always involved the family in some fashion; death, by contrast, was not a result of personal decisions but did have wide ramifications for family structure and life.

Changes in marital, childbearing, and migration behaviors were shown to be interrelated with changes in family size and structure over time. In pre-modern, pre-contraceptive societies, in which births outside wedlock brought stigma for both the mother and the child, most births took place after marriage. Consequently, the age at first marriage was identified as an important variable influencing the ultimate size of the nuclear family group. Normally, women bore children every two years; hence, marriage in the late teens, in contrast to the late twenties, could result in a size difference in offspring groups of four or five, assuming the same levels of infant and child mortality.

Hajnal's (1965) hypothesis of "western" and "eastern" marriage patterns on the European continent proposed that in the western half of the continent marriages on average took place when both partners were in their late twenties, whereas in the eastern half women tended to marry in the late teens. The larger number of ever-born children per couple in the east, however, was offset by higher levels of infant and child mortality. In the east both long- and short-distance movement was restricted by institutions such as serfdom so that localities retained more of the human material out of which cultural choices often fashioned families that were more complicated than those in the west. The survival into later life of the initially somewhat larger sibling groups and the reduced pace of dispersion of those groups meant that there were more related adults in a given locality who could live together if they chose to do so. Mean family household size in Western Europe averaged four to five persons, whereas in the east it was closer to eight to nine. In the west the proportion of family households with more than two generations and with complex structures was low; in the east, by contrast that proportion tended to be high.

These pre-modern interrelationships between demographic patterns and family structures were dissolved during the "demographic transition," when mortality, and later fertility, started to decline. The timing of the onset of the transition and its duration were the subject of the Princeton Fertility Project that was initiated in the 1970s. Although the project failed to show convincingly the precise relationship between demographic, cultural, and socioeconomic change, it did demonstrate that the timing of the beginning of the decline varied substantially across the continent. The transition started first in Western Europe, notably in France, in the early nineteenth century. Central Europe experienced it in the middle decades of the century, and it did not take hold in the eastern part of the continent until the late nineteenth and early twentieth centuries. The project also noted the presence of "pioneering" localities where fertility decline began earlier than in the surrounding areas in all of Europe's regions.

At the family level, the transition meant that couples could count on more of their children surviving past the childhood years, increasing pressure on family resources. One response to this pressure was to begin to limit childbirth, initially by spacing births and then with the aid of artificial means of birth control. This had the effect of delinking age at first marriage from the start of childbearing: the end of a historical pattern. The increased probability of survival of each individual child, entailing educational expenses first for boys and later for girls as well, meant that the ideal number of children per couple fell steadily.

Coinciding with the demographic transition were political reforms that lifted restrictions on movement, especially in Eastern Europe. As the industrial and service sectors grew and as urban areas became more capable of absorbing in-migrants, the dispersion of sibling groups became a more common occurrence, diminishing the scope for complex families. Large multi-generational complex family groups remained important only in those areas, such as Serbia, where cultural imperatives for their creation were particularly strong. These shifts were not as meaningful in Western countries where even in earlier times family complexity had for the most part manifested itself in elderly parents coresiding with married children rather than as the coresidence of married siblings.

Relationships between demographic patterns and family structures still existed in the twentieth century but the connection was weakening. By the end of the century, in the domains of marriage, family formation, and childbearing, cultural imperatives and personal choice seemed to have moved into positions of dominance in all the regions of Europe. Marriage was no longer a prerequisite to sexual gratification, as the stigma of premarital sex had nearly vanished and cohabitation of unmarried persons had become widely accepted. The timing of marriage became increasingly disconnected from the question of offspring, which was determined more by the economic and professional readiness of couples to "begin having children." Divorce had lost it stigma as well. Net reproduction fell below one (the replacement level) first in Western and then in Eastern European countries. Low fertility, together with increased life expectancy, meant that most European populations were aging, with steadily increasing proportions of elderly persons and falling proportions of children.

Historical Changes in Family Structure

Although it was possible to trace from historical-demographic trends the different consequences for different aspects of family life, changes in the structure of family groups *as groups* required different kinds of evidence. The systematic study of family household structure over time began in the late 1960s with the work of the Cambridge Group, particularly the investigations by Peter Laslett of the "listing of inhabitants." Thousands of those listings were uncovered throughout the Continent and were mined for their content. In some localities, nominal listings were randomly spaced over time; in others, they were made at systematic intervals.

In these listings it was possible to research family structure at moments in past time or in a series of moments. Occasionally communities recorded information about family groupings continuously, permitting the tracking of changes in family groups over long stretches of generations. Some listings carefully recorded the relationship between each member and the group head, whereas others left it unspecified. Some lists distinguished between groups, whereas in others such boundaries had to be interpreted. Successful record linkage involving household listings and parish registers sometimes could be used to enrich both kinds of evidence.

Research on these sources demonstrated the flaws in various earlier claims about structural changes, expanded geographical coverage of family research, and showed that the boundaries of the family in the past were much more porous than had been thought. Geographically, Europe and North America rapidly became the best-researched parts of the world, but historical sources revealed significant historical information about China and Japan as well. Within Europe the western countries and Scandinavia became the most thoroughly researched regions, with southeastern Europe, Italy, and Iberia in second place and Eastern Europe not yet explored fully. Several typologies of European patterns, an east-west division, and a four-part division, served as useful guides to research but were questioned with regard to oversimplification. Chronologically, research was most thorough for the centuries between the seventeenth and nineteenth, with the classical world remaining to be described fully. For the twentieth century, questions of family dynamics largely supplanted questions of structural change.

Broadly speaking, research on Europe since the early 1970s has shown that although nineteenth-century sociological theories of familial evolution describing a trajectory from simple to complex structures held in some regions, they misrepresented the history of other regions. The simply structured two-generational family (father, mother, children) everywhere and always accounted for a significant proportion of all family groupings, and in the European west this structure was predominant ever since the availability of historical records. Elsewhere in Europe the story was more complicated. In the European east (including Russia), under conditions of serfdom that limited movement, and in some regions of the Balkans where local traditions celebrated joint ownership of land and property, complex family structures (coresidence of married siblings and of parental couples with married children) historically represented a significant proportion of any community's total family households. Similar statistical importance of complex groups was found in localities of such widely dispersed countries as Finland, France, and Italy, where these patterns usually were associated with labor needs and inheritance patterns. Wealthier family households were generally more complex than poorer ones, though there are many exceptions to this generalization. The growing size of the "middle class" during the nineteenth century introduced value-based preferences that favored the small nuclear unit.

In most localities a family household almost always contained various nonrelated members: farmhands, apprentices, lodgers, and paupers. Family structure varied with the age of the household head, exhibiting the "family developmental cycle" (from simple to complex to simple as the head aged). Over time until the twentieth century, complicated groups tended to change the nature of their complexity from horizontal to vertical: married siblings earlier in the developmental cycle and aging parents coresident with a married child later. A unilinear evolutionary pattern (from wholly complex to wholly simple) at the local level, however, could not be found anywhere, as family groups responded to crises by expanding their ranks, becoming simple again when times turned less threatening. The association of particular familial structures with particular ethnic or nationality groups was shown to be irrelevant, and so claims about the "typical French family" or the "typical German family" fell by the wayside. From the functional viewpoint, familial units everywhere reacted to plenty and to adversity generally in the same fashion.

During the twentieth century, however, there was a convergence of structural patterns throughout Europe, though this question has yet to receive a conclusive answer. Also, since the mid-twentieth century new forms of cohabitation have emerged that have required redefinition of what a "family" and a "household" are. The definitions that served to keep research comparable for the pre-twentieth century period have been revealed to be increasingly time-specific.

The early programs of the Cambridge Group to systematize historical family research and make it comparative eventually were criticized as researchers turned increasingly to the study of family dynamics in the past. It was suggested that the constant changes in family life made talk of "structures" irrelevant because any family could experience numerous structural changes in the course of its existence. Some researchers shifted the focus from the family group to individuals within the family group, underlining the interconnectedness between the group's evolution and the individual lives of the persons within the group. Indeed, in the course of time research on the history of the family tended to leave the question of "structure" behind, preferring to look instead at the intergenerational transmission of property (inheritance) within the family group, the distribution of power (patriarchal authority) within it, the effects on it of state policy (public welfare institutions), the experience of crises within the group (widowhood and widowerhood), and the play of emotions within it (parent–child relationships). Some researchers have begun to investigate other social groups of a quasi-familial nature, such as guilds and brotherhoods. The study the of history of the family presents a clear example of a field developing new research directions before early questions were fully answered.

Household, Family, and Kin Group

Successful studies of kinship within the family coresidential group in the European past showed that when kin beyond the head's immediate family were present, they tended to be kin of a certain kind, for the most part patrilineal. Thus, in the European context there was a higher probability that the coresident parental couple would be the husband's parents, that the coresident siblings of the head would be the husband's brothers, and that the coresident married offspring would be the sons rather than the daughters. These configurations were all predictable from knowledge of the way patrilineal societies worked at any time and in any place. What was always of interest in the European past was who was excluded from the domestic group and on what basis. From the very beginning this question hovered just offstage: If kinship within the domestic group was important, what was the significance of kin ties that crossed household boundaries?

The strongest argument for looking beyond the family household for important family connections lay in already documented behaviors. Aristocracies of various kinds as well as wealthy urban patriciates had always had a keen interest in their lineages, and a similar preoccupation existed in some peasantries, in France for example. In some areas of Europe such as Albania, clan-like organizations were said to have continued to exist well into the twentieth century. Unfortunately, the functioning of larger kin groups is poorly documented in the European past. Whether the influence of the larger kin group on families was peripheral and weak or strong but subtle was an empirical question and could not be answered with any certainty unless such larger kin ties were mapped and the dynamics of domestic units within them were explored.

Several hypotheses about these matters emerged in the course of research. Laslett (1988) contended that people who lived in nuclear families encountered difficulties when faced with crises such as widowhood, unemployment, sickness, and senility. Accordingly, they sought support from their kin or, in the absence of kin, from friends, neighbors, or institutions in the community at large. Yet in the European historical record kin groups were not simply exemplars of the "ethic of amity" (Fortes 1969); they involved antagonisms and divisions as well, especially when disputes involved property, position, or other forms of wealth. Moreover, large kin-linked formations could experience internal shifts. In his explorations of kinship formations in the German village of Neckarhausen in the period from 1600 to 1900, David Sabean (1990, 1998) showed that large kin configurations could undergo transformations of emphasis even while retaining general characteristics such as "patrilineality." Marriage choices within large configurations changed, as did the persons whose job it was to cultivate and maintain kin relations. Sabean's larger point is that the characterization of a kinship system as bilateral or patrilineal was only the first step because historians confronted historical kinship not as a full-blown "system" but as a collection of concrete acts and transactions, each of which had to be understood and interpreted. The temporal changes that are worth knowing about could occur without changing the general "tilt" of the entire system. However, in order to understand the meaning of the change-producing decisions, those decisions have to be laid against a reconstructed network showing how the makers of everyday decisions, within the domestic group context and outside it, were related to each other. A full understanding of the growing autonomy of the domestic group and its growing tendency to make collective decisions without reference to any outside persons required knowledge of the larger group from which autonomy was sought. If the modern state gradually assumed many of the functions that supportive kin networks may have served in earlier times, this transfer of obligations did not cancel, even as it may have weakened, kin ties, and such ties continued to stand ready to be reactivated when the state failed in its duties. Important questions of this kind remain largely unanswered for most of the European continent.

See also: *Family Reconstitution; Henry, Louis; Historical Demography; Household Composition; Laslett, Peter.*

BIBLIOGRAPHY

Anderson, Michael. 1980. *Approaches to the History of the Western Family 1500–1914*. London: Macmillan.

Ariès, Philippe. 1962. *Centuries of Childhood: A Social History of Family Life,* trans. Robert Baldick. New York: Knopf.

Coale, Ansley J., and Susan Cotts Watkins, eds. 1986. *The Decline of Fertility in Europe.* Princeton, NJ: Princeton University Press.

Fortes, Mayer. 1969. *Kinship and the Social Order: The Legacy of Lewis Henry Morgan.* Chicago: Aldine.

Glass, David, and D. E. C. Eversley, eds. 1965. *Population in History.* Chicago: Aldine.

Hajnal, John. 1965. "European Marriage Patterns in Historical Perspective." In *Population in History,* ed. David Glass and D. E. C. Eversley. Chicago: Aldine.

Hareven, Tamara K. 1996. *Aging and Generational Relations over the Life Course.* Berlin: De Gruyter.

Kaser, Karl. 1995. *Familie und Verwandschaft auf dem Balkan: Analyse einer Untergehenden Kultur.* Vienna: Suhrkampf.

Kertzer, David. 1991. "Household History and Sociological Theory." *Annual Review of Sociology* 17: 155–179.

Laslett, Peter. 1966. "The Study of Social Structure from Listings of Inhabitants." In *An Introduction to English Historical Demography.* New York: Basic Books.

———. 1983. "Family and Household as Work Group and Kin Group: Areas of Traditional Europe Compared." In *Family Forms in Historic Europe,* ed. Richard Wall, J. Robin, and Peter Laslett. Cambridge, Eng.: Cambridge University Press.

———. 1988. "Family, Kinship, and Collectivity as Systems of Support in Pre-Industrial Europe: A Consideration of the 'Nuclear-Hardship' Hypothesis." *Continuity and Change* 3: 153–175.

Laslett, Peter, and Richard Wall, eds. 1972. *Household and Family in Past Time.* Cambridge, Eng.: Cambridge University Press.

Plakans, Andrejs. 1984. *Kinship in the Past: An Anthropology of European Family Life 1500–1900.* Oxford: Blackwell.

Ruggles, Steven. 1990. "Family Demography and Family History: Problems and Prospects." *Historical Methods* 23: 22–33.

Sabean, David. 1990. *Property, Production, and Family in Neckarhausen, 1700–1870.* Cambridge, Eng.: Cambridge University Press.

———. 1998. *Kinship in Neckarhausen 1700–1870.* Cambridge, Eng.: Cambridge University Press.

Segalen, Martine. 1985. *Fifteen Generations of Bretons: Kinship and Society in Lower Brittany 1720–1980.* Cambridge, Eng.: Cambridge University Press.

Smith, Daniel Scott. 1993. "The Curious History of Theorizing about the History of the Western Nuclear Family." *Social Science History* 17: 325–353.

Wall, Richard, J. Robin, and Peter Laslett, eds. 1983. *Family Forms in Historic Europe.* Cambridge, Eng.: Cambridge University Press.

Wetherell, Charles. 1998. "Historical Social Network Analysis." *International Review of Social History* 43, Supplement: 125–144.

Wrigley, E. A., ed. 1966. *An Introduction to English Historical Demography.* New York: Basic Books.

———. 1969. *Population and History.* New York: McGraw-Hill.

Andrejs Plakans

FUTURE

Changes in the institution of the family probably occur more rapidly in modern and modernizing societies than in the past, but historians and anthropologists have long been aware that shifts in kinship and marriage practices take place even in traditional societies, albeit at a slower pace. What is also true in the early twenty-first century, far more than in the past, is that through social science research, government reports, and stories in the mass media, people are acutely conscious of the changes that are taking place in family norms and behaviors. It is known that the family is changing, but it is nonetheless difficult to project the course of that change beyond a decade or two. Charting the future of the family, then, is an exercise in imagination or science fiction.

Having conceded an inability to read the future, there are certain straws in the wind that can provide some clues of what might be in store for the Western family. Also, it may be worth revisiting ideas about convergence in family forms that were popular in the middle decades of the twentieth century.

Future of Marriage in the West

The widespread practice of cohabitation, the rising age of marriage, and high levels of marital instability have lead some observers to question the viability of the institution of marriage. Certainly, the practice of lifelong monogamy, which became the cornerstone of the Western family with the spread of Christianity, has given way to more varied arrangements: consensual unions not sanctioned by state or church; single-parenthood; homosexual unions; and conjugal succession or "serial marriage." Such arrangements have always existed in many societies, but without the legitimacy that they are accorded today.

The conditions that have given rise to greater variation in family forms in which childbearing or, at least, childrearing occurs can be traced to many different factors. The decline of church and state authority to shape public morality is one important source of family change. The breakdown of strict gender roles that once created a high degree of interdependence between spouses is another powerful impetus for revising matrimonial arrangements. The spread of education and of the ideology of choice is a third reason for increasing variability in family forms and in the roles of family members.

It appears unlikely that any of these conditions that have undercut the hegemony of the nuclear family are going to recede. Yet it is entirely possible that customs and fashions, economic forces, or the growth of state authority may influence the distribution of family types within and between Western nations. In the United States, for example, politicians are mounting strenuous efforts to promote marriage. Whether public policies or official rhetoric are likely to have any effect on marriage practices is at best dubious.

According to David Ellwood and Christopher Jencks (2001), variation in family forms in the United States is much more conspicuous as one goes down the socioeconomic ladder. Over the past several decades, family behavior among the privileged has changed little, while in other social strata rates of marital instability and single-parenthood have increased, especially among the poor. This observation suggests that the flux in marriage may be partly produced by economic strains or, perhaps, by gender discord resulting from changing expectations of men and women. The exploration of class differences in family forms is an intriguing area for further investigation.

Future of Fertility in the West

If the fate of marriage is unpredictable, low fertility within marriage appears to have a more secure future. Technological developments in fertility control have increased the ability of couples to manage fertility effectively. Given the high cost of children and low levels of mortality during childhood, large family size is becoming a relic of the past. It is difficult to imagine conditions that will produce, once again, a demand for large families.

The challenge of raising fertility to replacement levels has become an urgent issue of public policy in many Western nations. More than any other, this policy problem is likely to have important effects on the family. The difficulty of combining work and family roles and the high costs involved in rearing children are leading many parents to severely restrict childbearing. It seems likely that societies will experiment with arrangements that alleviate the private costs of rearing children and with building institutions that enable parents to combine work and family roles more easily. Innovations in these areas are already evident, but there is likely to be a good deal more institutional invention as technology allows parents of children to work in the home, or as daycare arrangements permit parental monitoring of children's safety and comfort.

Techniques of Reproduction

Nowhere has reality come closer to science fiction, if not actually surpassing it, than in the area of reproductive technology. Fertility has become evermore controllable through new medical and biological procedures. The capacity of parents to predetermine at least some of their children's physical characteristics is just around the corner; however, it is not at all clear how different societies will handle the potential benefits and abuses of new reproductive technologies. It seems likely that legal prescriptions will be developed to impose rules on the use of new reproductive technologies, and equally likely that such regulations will create a black market in the use of proscribed practices.

Future of Kinship in the West

High rates of divorce and remarriage reshaped kinship arrangements in last half of the twentieth century. Rising levels of cohabitation and nonmarital childbearing have added complexity to the family as broadly defined. The links across households produced by nonresidential parents and their partners, not to mention their siblings, parents, and children, have created wider but shallower family bonds. Moreover, gay couples and their families have established new kinship arrangements not formed by blood or marriage—the traditional ways of constructing a family. Western societies allow greater latitude in defining family but, in doing so, may be attaching lower levels of obligation to kinship.

Kinship has always been socially constructed, even if members of a society come to think of these ties as "natural." Parent and child relationships based on biological and genetic ties tended to be seen as fundamental, while in-law relations created by legal arrangements were accepted as socially binding. By the beginning of the twenty-first century, both of these axes of kinship had become more questionable in law and practice. The father who sires a child but never lives with him or her has less relevance than the sociological parent (man or woman) who is the mother's partner and helps in raising the child. Moreover, this partner's family becomes part of the child's family, with views of rights and obligations to the child that may be highly variable. Relatively little research exists on new family forms, especially on the way that these forms affect family members' relations with each other in every day practice.

The charting of kinship bonds over time within nontraditional families is an attractive way of understanding how such bonds are created and maintained, and illustrates the strength of relationships in families that are not established by blood or marriage. Students of the family should examine the transfer of property, the keeping of family albums, the frequency of family reunions, and many other everyday aspects of behavior as ways of establishing the meaning of kinship in alternative and traditional families. As yet, virtually no literature exists on this topic.

Convergence of Western and Non-Western Families

In the 1960s some social scientists argued that family systems were converging across the world, gradually moving toward a Western model. The sociologist William J. Goode argued that the fit between the nuclear family and the needs of a modern economy would ultimately force different kinship systems to take on the Western form. Although there is abundant evidence of change in kinship systems worldwide, the evidence suggesting convergence to a Western model of the family is equivocal at best.

It may be still too soon to detect the movement away from complex to simpler forms of the family. However, the thesis put forth by family sociologists in the mid-twentieth-century seems naive in light of what has occurred in the West. In the first place, the assumption of a uniquely appropriate fit seems doubtful in view of the vast changes that have taken place in the Western form of the family and the continuing stresses that are evident between work and family. Moreover, it is clear that traditional forms of the family persist even as economic change takes place.

Will plural marriage—polygamy—where it still exists survive economic development and the spread of Western corporate institutions? Can multi-generational households co-exist with modern economic markets that promote the interests of individuals over aggregates? It seems likely that some accommodations will occur as economic development advances and the market economy spreads to non-Western nations. Clearly, fertility has declined and may continue to drop, forcing changes in household structure and living arrangements. It remains to be seen, however, whether the kinship arrangements that result will have a Western look.

Variations in family forms worldwide have been more resilient than many observers predicted. Goode's thesis that the Western, nuclear family would be imported to nations of varied kinship arrangements has not yet come true, even though changes in marriage and divorce practices and fertility are evident in many developing nations. The hegemony of the nuclear family is less evident and variety is more apparent. In this respect, kinship is proving to be a more durable feature of culture than was thought by those who predicted the demise of the family or the convergence of family forms to a single model.

See also: *Childlessness; Cohabitation; Divorce; Fertility, Below-Replacement; Fertility, Nonmarital; Marriage; Parenthood; Partner Choice.*

BIBLIOGRAPHY

Ellwood, David T., and Christopher Jencks. 2001. "The Growing Differences in Family Structure: What Do We Know? Where Do We Look for Answers?" Paper prepared for the New Inequality Program. New York: Russell Sage Foundation.

Goode, William J. 1963. *World Revolution and Family Patterns.* New York: Free Press of Glencoe.

Johnson, Coleen. 1988. *Ex Familia: Grandparents, Parents, and Children Adjust to Divorce.* New Brunswick, NJ: Rutgers University Press.

Popenoe, David. 1996. *Life without Father.* New York: Free Press.

Waite, Linda, and Maggie Gallagher. 2000. *The Case for Marriage: Why Married People Are Happier, Healthier, and Better off Financially.* New York: Doubleday.

Weston, Kath. 1991. *Families We Choose: Lesbians, Gays, Kinship.* New York: Columbia University Press.

Wilson, James Q. 2002. *The Marriage Problem.* New York: HarperCollins.

Frank F. Furstenberg

FAMILY ALLOWANCES

Family allowances (also known as child allowances or child benefits) are cash transfers made by governments to families with children. The allowances usually are paid monthly to parents. In 2001 family allowances were provided to families in most industrialized countries and some developing countries. Family allowance schemes vary greatly across countries, especially in terms of their amounts, eligibility criteria, and mode of financing. Furthermore, these schemes have been the subject of significant reforms during the preceding few decades.

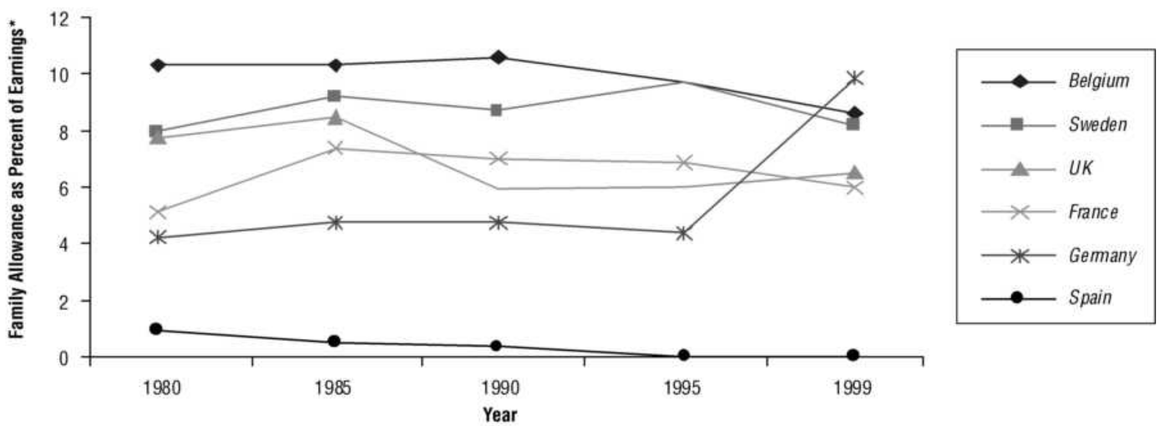
History of Family Allowances

Family allowances have a history that goes back to the late nineteenth century. Their origin can be traced to France, where several private and public family allowance schemes were introduced in the 1890s. Under these schemes, allowances were paid to wage earners as a supplement to their wages to help families meet their needs. In the following decades private family allowance schemes gained popularity among employers. To administer these schemes, equalization funds (*caisses de compensation*) were set up throughout France, each of them grouping a number of employers. By 1923 there were an estimated 120 funds in operation, covering 7,600 firms and distributing family allowances to 880,000 wage earners, or about 20 percent of all wage earners.

These schemes were the object of numerous criticisms. Workers' organizations were critical of the fact that only workers at selected firms benefited from the allowances, that different rates of family allowances were in force in the different equalization funds, and that, since the funds were under employers' control, the allowances could be terminated at any time. Instead, they called for family allowance schemes to be administered by the state. Their call

FIGURE 1

Trends in the Value of Family Allowances, 1980–1999



*Allowance paid to a two-child family as a percentage of the earnings of an average production worker.

SOURCE: Computed by the author from OECD and U.S. Social Security Administration data.

was answered in 1932 with the adoption of a state-administered family allowance scheme that extended allowances to all wage earners with children. In 1939 the minimum family allowance rates were made uniform across regions (*départements*).

In the other industrialized countries, the adoption of state-administered universal family allowance schemes was preceded by various other schemes, including widows' and orphans' pensions (introduced in the 1910s and 1920s in several countries), family cost-of-living bonuses, and assistance schemes for large families. Aimed at helping families financially, several of these earlier schemes were targeted at low-income families and/or were restricted to large families. By 1949 universal family allowance schemes were in place in 15 industrialized countries.

During subsequent decades, family allowance schemes were adopted in most other industrialized countries, with the notable exception of the United States. In the 1950s and 1960s these schemes underwent various changes, such as the harmonization of rates across different categories of workers, the elimination of means tests, and the increase in coverage to include all children. (Previously, allowances were often provided beginning only with a family's third child.) Additional programs were introduced to provide further assistance to low-income families and single-parent families.

This historical expansion of state support for families ended in the 1980s. Restricted budgets and growing levels of unemployment led governments in Australia, Canada, Italy, New Zealand, Portugal, and Spain in the 1980s and 1990s to impose means tests on previously universal family allowances or to replace them by other means-tested schemes.

Trends in the Value of Allowances in Selected Countries

The size of the allowances received by families varies substantially across countries. In Western Europe in 1999 the highest allowances for a two-child family were found in Luxembourg, Germany, and Belgium. In Luxembourg the amount exceeded $300 (U.S.) per month, more than 14 percent of the average monthly earnings of a production worker.

Figure 1 shows the trends in the value of allowances for a two-child family in selected countries, expressed as a percentage of the average monthly earnings of a production worker. Between 1980 and 1999 the value decreased in Belgium, the United Kingdom, and Spain. In Germany it strongly increased after a major reform in 1996. It should, however, be noted that family allowances represent only one form of public financial support for families. Tax relief for children also is provided in several countries, along with other means-tested benefits. The country rankings therefore vary depending on the type of cash support considered. They also vary by the age and number of children, household income, and family type.

Effects of Family Allowances on Welfare and Fertility

Although mainly intended as a welfare benefit for families with children, family allowances have also been seen by some governments as a way to encourage parents to have more children. Such pronatalist attitudes prevailed in France, Germany, Italy, and Spain during World War II and have since been observed (in some periods) in various other countries, such as Singapore and Israel. In countries where pronatalist objectives have dominated, allowances have tended to be larger for children of higher birth order and to be supplemented by generous birth grants.

The effect of such allowances and grants on fertility is questionable. Blanchet and Ekert-Jaffé (1994) have estimated that family allowances like those provided in France have resulted in a fertility rate about 0.2 child higher. On the basis of cross-national data from 22 countries and a time series spanning the period 1970–1990, Gauthier and Hatzius (1997) have estimated that a 25 percent increase in family allowances would result in an increase in the total period fertility rate of 0.07 children per woman. Cash support for families may encourage parents on average to have more children, but the effect is very small.

It sometimes is argued, especially in the United States, that means-tested cash benefits may have the unintended consequence of encouraging low-income families, single mothers, and teenage girls to have children. The empirical evidence, however, suggests that this is not the case, or that any such effect is very small. Similarly, family allowances and other types of cash benefits for families with children have been found to have no effect or a limited effect on women's likelihood of marrying or divorcing, their use of welfare, and their labor force participation. The same is true of the provision of maternity and childcare benefits and child care facilities. The decision to have a child or to withdraw from the labor market has undeniable economic consequences. Family allowances and other types of support for families, however, appear to have limited effects on these decisions.

See also: *Cost of Children; Family Policy.*

BIBLIOGRAPHY

Blanchet, Didier, and Olivia Ekert-Jaffé. 1994. "The Demographic Impact of Family Benefits: Evidence from Micro-Model and from Macro-Data." In *The Family, the Market and the State in Ageing Societies,* ed. J. Ermisch and N. Ogawa. Oxford, Eng.: Clarendon Press.

Bradshaw, Jonathan, John Ditch, Hilary Holmes, and Peter Whiteford. 1993. "A Comparative Study of Child Support in Fifteen Countries." *Journal of European Social Policy* 3(4): 255–271.

Gauthier, Anne H. 1996. *The State and the Family: A Comparative Analysis of Family Policies in Industrialized Countries.* Oxford, Eng.: Clarendon Press.

Gauthier, Anne H., and Jan Hatzius. 1997. "Family Benefits and Fertility: An Econometric Analysis." *Population Studies* 51: 295–306.

Glass, David. 1940. *Population Policies and Movements in Europe.* Oxford, Eng.: Clarendon Press.

King, Leslie. 2002. "Demographic Trends, Pronatalism, and Nationalist Ideologies in the Late Twentieth Century," *Ethnic and Racial Studies* 25(3): 367–389.

MacNicol, John. 1992. "Welfare, Wages, and the Family: Child Endowment in Comparative Perspective, 1900–50." In *In the Name of the Child: Health and Welfare, 1880–1940,* R. Cooter, ed. London: Routledge.

Moffitt, Robert. 1992. "Incentive Effects of the U.S. Welfare System: A Review." *Journal of Economic Literature* 30(1): 5–62.

Anne H. Gauthier

FAMILY BARGAINING

Bargaining approaches to family decision-making developed in the last two decades of the twentieth century. Because interactions between spouses are simpler than most other family interactions, bargaining approaches have been most fully articulated in the context of marriage. This entry begins by describing pre-bargaining approaches to interactions between spouses and then surveys bargaining approaches. It concludes by discussing briefly the application of bargaining approaches to other interactions within families—between parents and children and between elderly parents and adult children.

Bargaining Approaches and Game Theory

Bargaining approaches are based on game theory and this entry uses the terms bargaining approaches and game-theoretic approaches interchangeably. Within game theory, the threshold distinction is between noncooperative and cooperative games. Cooperative game theory analyzes outcomes or solutions under the assumption that the players can communicate freely and make costlessly-enforceable agreements. Thus, cooperative game theory treats all feasible outcomes as potential equilibria. In contrast, noncooperative game theory treats as potential equilibria only those outcomes that correspond to self-enforcing agreements in the sense that each player's strategy is a best response to the strategies of the others.

Economists say that an equilibrium is "efficient" (or "Pareto efficient" or "Pareto optimal") if no individual can be made better off without someone else being made worse off. Efficiency implies that any division of a cake is efficient provided it leaves none on the plate and none on the floor—thus, a division may be efficient without being fair or equitable. The efficiency of social arrangements and practices is a central concern of economics, yet pre-bargaining models of the family and cooperative bargaining models simply assumed that families are efficient. A major advantage of approaches based on noncooperative game theory is that they do not assume efficiency and thus allow us to investigate the conditions that enable families to achieve and sustain efficient outcomes.

Becker's Altruist Model

Gary Becker, in his work of 1974 and 1981, proposed the first model of family decision-making or household collective choice, his "altruist" model. Three implications of Becker's altruist model deserve attention. First, it implies that family decisions are Pareto efficient. Second, it implies a distribution of the benefits and burdens of family life in which the head of the family—Becker's altruist—attains his most preferred point in the feasible set. Third, it implies that family members pool their resources.

The altruist model is rigged to produce these results, but none of these results—efficiency, the lopsided distribution of benefits and burdens, or pooling of family resources—is an essential feature of bargaining models of family decision-making. Robert A. Pollak in 1985 interprets Becker's altruist model as an "ultimatum game" in which one family member can confront the others with take-it-or-leave-it offers. Without the ultimatum game interpretation, the conclusions of the altruist model and of Becker's so-called Rotten Kid Theorem hold only in a narrow range of environments. This is discussed in Theodore Bergstrom's 1989 article, the introduction to the enlarged edition of Gary Becker's *Treatise of the Family* published in 1991, and in Robert Pollack's 2003 paper.

Bargaining Models

Cooperative bargaining models of marriage were introduced by Marilyn Manser and Murry Brown in 1980 and Marjorie B. McElroy and Mary J. Horney in 1981 as an alternative to Becker's altruist model. A typical cooperative bargaining model of marriage assumes that if the spouses fail to reach agreement, both husband and wife receive the utilities associated with a default outcome. The utilities associated with the default outcome are usually described as the "threat point." In Manser and Brown and in McElroy and Horney the threat point is interpreted as divorce, while in the "separate spheres" model of Shelley Lundberg and Robert A. Pollak, introduced in their 1993 article, the threat point is interpreted as a noncooperative equilibrium within the marriage.

The Nash bargaining model, developed by John Nash in 1950, provides the leading solution concept in cooperative bargaining models of marriage. The utility received by husband or wife in the Nash bargaining solution depends on the threat point; the higher a spouse's utility at the threat point, the higher the utility that spouse will receive in the Nash bargaining solution. This dependence is the critical empirical implication of Nash bargaining models: the couple's expenditure pattern depends not only on prices and the couple's total income, but also on the threat point.

The income-pooling hypothesis. As the divorce-threat and separate spheres models show, cooperative bargaining does not imply income pooling. If the fraction of the couple's income controlled by each spouse individually affects the threat point, then it will affect the couple's expenditure pattern and the relative well-being of husbands and wives. This dependence implies that public policy, for example, tax and welfare policy, may affect distribution within marriage.

Empirical rejections of family income pooling have been the most influential in weakening economists' attachment to the altruist model. Income pooling implies a restriction on family demand functions that appears simple to test: If family members pool their incomes and allocate the total, then only total income will affect demands. The fraction of family income received or controlled by one family member should not influence those demands. A large number of later empirical studies have rejected pooling, finding instead that earned or unearned income received by the husband or wife significantly affects demand patterns when total income or expenditure is held constant.

For technical reasons discussed in Shelly Lundberg and Robert Pollak's 1996 work, the pooling hypothesis is not simple to test. The ideal test would be based on an experiment in which some husbands and some wives were randomly selected to receive income transfers. A less-than-ideal test could be based on a natural experiment in which some husbands or some wives received an exogenous income change. Lundberg, Pollak, and Terence J. Wales in 1997 examine the effects of such a natural experiment—the policy change in the United Kingdom that transferred substantial resources from husbands to wives in the late 1970s. The policy change involved child allowances, a program of government transfer payments to parents. The child allowance payments were conditioned on the number of children in the family, but not on family income, so that, in welfare-program terminology, the program is not "means tested." Lundberg, Pollak, and Wales find strong evidence that a shift toward relatively greater expenditures on women's goods and children's goods coincided with this income redistribution, and they interpret this finding as a rejection of the pooling hypothesis.

Because efficiency is much more difficult to test than pooling, the discussion of efficiency has focused on theoretical issues. The most convincing rationale for the usual assumption that bargaining in marriage leads to efficient outcomes is the belief that efficiency is likely to emerge from repeated interactions in environments that remain stable or change slowly over time. Most, but not all, marital bargaining involves repeated interactions in stable environments. Lundberg and Pollak in 2001 argue that when a decision affects future bargaining power, inefficient outcomes are plausible. If the spouses could make binding commitments—in effect, commitments to refrain from exploiting future bargaining advantages—then this source of inefficiency would disappear. But spouses seldom can make binding commitments regarding future allocations within marriage. As an example, Lundberg and Pollak consider the location problem of a two-earner couple, where the husband would be advantaged in future bargaining by one location and the wife by the other. Location decisions provide transparent and analytically tractable examples of choices likely to affect future bargaining power, but the logic of the analysis applies to many other decisions. For example, decisions about education, fertility, and labor force participation are also potential sources of inefficiency.

The possibility of divorce (perhaps followed by remarriage) limits the scope for bargaining within marriage by placing bounds on the distributions that can emerge as equilibria. The assumption that individuals are rational implies that no one would accept less than he or she would receive outside the marriage. "Divorce bounds" apply to all bargaining models, cooperative and noncooperative. The divorce bounds depend upon the costs of divorce, including psychic costs, the resources available to divorced individuals, and conditions in the remarriage market. When the divorce bounds are tight, there is little scope for bargaining within marriage. Bargaining models of marriage are motivated by the assumption that, in at least some marriages, the divorce bounds are loose enough that the allocation of the surplus is worth modeling.

Extensions

Bargaining approaches based on game theory provide a framework for analyzing not only interactions between spouses but all strategic interactions involving family members. Yoram Weiss and Robert J. Willis, in their 1985 and 1993 articles, show how the analytical tools of game theory can be used to investigate the distribution of child support responsibilities between ex-spouses. Because bargaining models are most tractable in simple strategic situations—two-person games in relatively stable environments—it is not surprising that bargaining models of marriage are better developed than bargaining models of interactions between parents and children. Nor is it surprising that models of interactions between parents and children are better developed than bargaining models of interactions in blended families or in families that span three or more generations. Nevertheless, bargaining models of marriage are not simple and, in the interest of tractability, analysis usually focuses on relatively stable environments and avoids dynamic ones in which decisions in one period affect bargaining power in the future.

Despite the differences among bargaining models and despite their complexity, bargaining models offer the most promising analytic approach to understanding the formation, dissolution, and functioning of households and families. Although bargaining models are unlikely to lead directly to equations that can be estimated, they are a fruitful source of hypotheses about regularities that may be found in data and of interpretations of such empirical regularities.

See also: *Becker, Gary S.; Microeconomics of Demographic Behavior; Partner Choice.*

BIBLIOGRAPHY

Becker, Gary S. 1974. "A Theory of Social Interactions." *Journal of Political Economy* 82(6): 1063–1094.

———. 1981; enlarged edition, 1991. *A Treatise on the Family.* Cambridge, MA: Harvard University Press.

Bergstrom, Theodore C. 1989. "A Fresh Look at the Rotten Kid Theorem—and Other Household Mysteries." *Journal of Political Economy* 97(5): 1138–1159.

Lundberg, Shelly, and Robert A. Pollak. 1993. "Separate Spheres Bargaining and the Marriage Market." *Journal of Political Economy* 101(6): 988–1010.

———. 1996. "Bargaining and Distribution in Marriage." *Journal of Economic Perspectives* 10(4): 139–158.

Lundberg, Shelly, Robert A. Pollak, and Terence J. Wales. 1997. "Do Husbands and Wives Pool Their Resources? Evidence from the U.K. Child Benefit." *Journal of Human Resources* 32(3): 463–480.

Manser, Marilyn, and Murray Brown. 1980. "Marriage and Household Decision-Making: A Bargaining Analysis." *International Economic Review.* 21(1): 31–44.

McElroy, Marjorie B., and Mary J. Horney. 1981. "Nash-Bargained Household Decisions: Toward a Generalization of the Theory of Demand." *International Economic Review.* 22(2): 333–349.

Pollak, Robert A. 1985. "A Transaction Cost Approach to Families and Households." *Journal of Economic Literature* 23(2): 581–608.

———. 2003. "Gary Becker's Contribution to Household and Family Economics." *Review of Economics of the Household* 1.

Weiss, Yoram, and Robert J. Willis. 1985. "Children as Collective Goods in Divorce Settlements." *Journal of Labor Economics* 3(3): 268–292.

———. 1993. "Transfers among Divorced Couples: Evidence and Interpretation." *Journal of Labor Economics* 11(4): 629–679.

Robert A. Pollak

FAMILY DEMOGRAPHY

Family demography is the study of the composition of families and of the transitions individuals make into and out of various types of families. Family composition includes factors such as the number of family members, their ages, marital and cohabitation status, and relationship to other family members. Transitions include life-course characteristics such as the timing and duration of cohabitation, marriage, separation, divorce, and remarriage.

Demographers developed the field of family demography during the mid-twentieth century as a means of better understanding the number and timing of births. In the 1950s and 1960s, when most births in Western countries occurred within marriages, family demographers mainly studied the nuclear family of husband, wife, and children. But as the family changed in similar ways throughout most Western countries, family demographers broadened their focus to include adults living independently, single-parent families, cohabitating couples (unmarried couples living together), and rates of divorce and remarriage. As birth rates declined during the second half of the twentieth century, family demographers began to study these family forms independent of their impact on fertility.

In 1940 the U.S. Bureau of the Census published its first report classifying families into different types; categories included normal (meaning a married couple), other male headed, and all female headed. Labeling families with a married husband and wife "normal" reflects the dominance of the nuclear family in the mid-twentieth century. As that dominance faded, the bureau changed its terminology, broadened its categories, and began to collect more information in its monthly *Current Population Survey*. In the 1970s surveys conducted for other purposes, such as the Panel Study of Income Dynamics, provided useful information, and in the 1980s and 1990s specialized surveys such as the National Survey of Families and Households provided the first detailed information about cohabitation. In the United Kingdom one of the first sets of papers on family demography was presented at a 1983 meeting of the British Society for Population Studies. Family demographers in Western Europe, including Louis Roussel and Ron Lesthaeghe, published influential books and articles during the 1980s and 1990s about the enormous changes in European families.

At about the middle of the twentieth century, demographers noted a demographic transition involving a long-term decline in fertility and mortality rates. After 1965, as the post–World War II baby boom faded, family demographers began to write of a "second demographic transition." This transition refers to the set of changes in family formation and childbearing including increases in independent living among young adults, extensive premarital cohabitation, older ages at marriage, high levels of divorce, fertility at or below the population replacement levels, and increased childbearing outside of marriage. Economists such as Gary Becker theorized that changes in family formation occurred because the economic gains of the traditional breadwinner–homemaker marriage decreased: As women's employment opportunities rose, so did the cost in lost wages of remaining a full-time housewife. Ideational theorists such as Lesthaeghe and Johan Surkyn asserted that the second demographic transition reflected a long-term shift in societal values toward greater individual autonomy and self-fulfillment, and away from moral obligations to family and society. Just as the economic changes were said to reduce the gains in efficiency that being married provides, the ideational changes were said to reduce the satisfaction and fulfillment that people gained from being married and raising children.

Independent Living

At the beginning of the twentieth century, most young adults lived at home until marriage. The prevailing values of the time discouraged independent living, many families relied on young adults' contributions to household income, and a shortage of housing for single people limited opportunities for leaving the family home. All of these factors changed after mid-century, and the typical age at marriage rose. As a result of these changes, the percentage of young adults living by themselves or with roommates increased during the last half of the twentieth century. The rise in divorce rates through the 1960s and 1970s also resulted in a greater number of formerly married adults living on their own.

At the turn of the twentieth century, a majority of the elderly lived in their children's homes. This, too, changed during the twentieth century, as increased life expectancies and greater affluence among the elderly led to a substantial increase in the number of older people living alone. Yet even though most of the elderly lived apart from their children by the year 2000, they tended to see them regularly and to provide assistance to them.

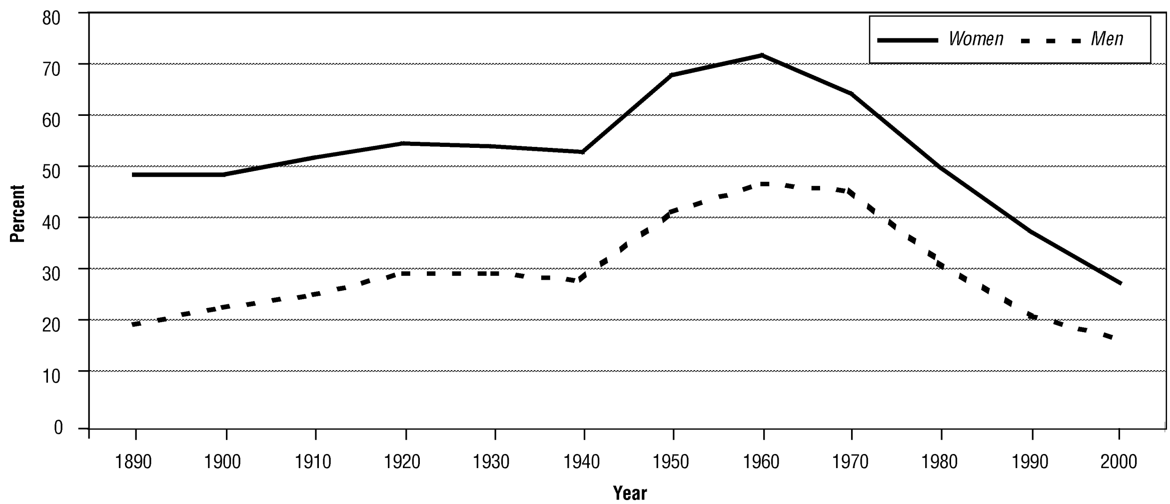
Marriage

Through the 1950s age at marriage was the most important determinant of fertility in the Western countries because sexual intercourse was mostly limited to married couples. In Western countries marriage typically occurs well after young women become fertile. This delay is an important contributing factor to the relatively small family size in Western countries, even before industrialization.

Figure 1 illustrates the change in percentage of 20- to 24-year-old women and men in the United States who had ever been married, from 1890 to 1998. At the beginning of the twentieth century, marriages occurred at relatively older ages, so that fewer 20- to 24-year-olds had married. During the baby boom years of 1945 to 1965, the typical age at marriage dropped sharply, so that the proportion of young adults who had ever been married increased. After the baby boom, ages at marriage rose back to

FIGURE 1

Percent Ever–Married for Women and Men Aged 20 to 24, United States, 1890–2000



SOURCE: For 1890–1990: Andrew J. Cherlin (1992). For 2000: U. S. Bureau of the Census (2001).

the pre–baby boom levels for men and rose even further for women. At the end of the twentieth century, the mean age at first marriage in the United States was approximately 25 for women and 27 for men, and the percentage of ever-married young adults was at or near an historic low. Young adults in the 1990s were marrying later because higher education and early investment in a career were considered extremely important, the labor market opportunities for men without college educations had diminished, and sexual relations outside of marriage were more culturally acceptable and carried less risk of an unwanted pregnancy due to improved contraceptive technology such as the birth control pill.

Although rates decreased from the 1960s through the 1990s, marriage remained an important part of the Western family system. Throughout most of the twentieth century, at least 90 percent of all individuals eventually married in the United States, and nearly as many married in most other Western nations. Marriage rates were lowest for adults who came of age during the Great Depression of the 1930s, and highest for those who came of age during the baby boom. Joshua Goldstein and Catherine Kenney projected in 2001 that about 90 percent of white young adults in the United States would eventually marry, but that only about two-thirds of African-American young adults would. According to the U. S. Bureau of the Census, 64 percent of children in the United States lived with both biological or adoptive parents in 1996, but marriage was not as dominant a family form as it was a half-century before. More and more individuals were living in unmarried couples, single-parent families, and stepfamilies.

Cohabitation

Prior to the last few decades of the twentieth century, cohabitation, a living arrangement in which an unmarried couple share a household, was uncommon in most Western countries except among the poor. Beginning in the 1960s, cohabitation increased among all social classes, but remained more prevalent among the less affluent and less educated. At the end of the twentieth century, a majority of young adults in the United States lived in a cohabiting relationship prior to marrying. Premarital cohabitation was even more common in many Scandinavian and Northern European countries. Cohabitation after the disruption of a marriage was also widespread. In fact, about a third of cohabiting couples in the United States in 2000 had a child from a partner's previous marriage or relationship. Cohabitation increased because of improvements in birth control, such as the introduction of the birth control pill in 1960 and the legalization of abortion in 1973; the stagnant earning prospects of young men in the 1970s and 1980s, which discouraged marriage; and the greater societal acceptance of sex outside of marriage.

The meaning of cohabitation seems to vary from couple to couple. For some, cohabitation is similar to a trial marriage. An American survey from the 1990s indicates that young adults were most likely to choose "couples can be sure they are compatible before marriage" as the primary reason a couple would decide to cohabit. Consistent with this view, most cohabiting couples in the United States in the 1990s either broke up or married within a few years. Half remained living together outside of marriage for one year or less, and only one out of ten cohabiting couples lasted as long as five years. Studies from the 1990s also show that a majority of cohabiting white couples marry before the birth of a child. For others, however, cohabitation may be a substitute for marriage: cohabiting African-American couples are less likely to marry before a child's birth than are whites. For some others, cohabitation may be merely a continuation of the single life—a living arrangement that does not require but does not preclude commitment.

Marital Dissolution

Until the mid-nineteenth century formal divorce was rare in Western nations, although informal separations undoubtedly occurred. Prior to 1858 divorces could only be granted in England by acts of Parliament and most petitioners were men who claimed their wives were adulterous. In the latter part of the nineteenth century, it became easier to gain a divorce, as the legislatures of Western countries added grounds such as habitual drunkenness or mental cruelty. Figure 2 shows the annual divorce rate in the United States from 1860 to 1998. The figure illustrates that divorce rates rose steadily but gradually until the 1960s, with the exception of a temporary surge after World War II. Between 1960 and 1980 the divorce rate virtually doubled in the United States, and similar increases occurred in other Western countries. Between 1980 and 2000 divorce rates settled on a high plateau, with perhaps a slight decline toward the end of the century. Demographers for the U.S. National Center for Health Statistics have developed projections of lifetime levels of divorce that young adults are likely to experience. These projections assume that the duration-specific rates of the early twenty-first century will continue to hold, and will therefore overestimate lifetime divorce if duration-specific rates fall in the future, and provide underestimates if these rates rise. The projections suggest that about half of all first marriages in the United States would end in divorce or permanent separation. The projections for many other Western nations are nearly as high. Divorces tend to occur early in marriages—about half occurring within the first seven years in the United States—and are more common among families with lower income, African Americans, and persons who cohabited prior to marrying, married as teenagers, or whose parents divorced.

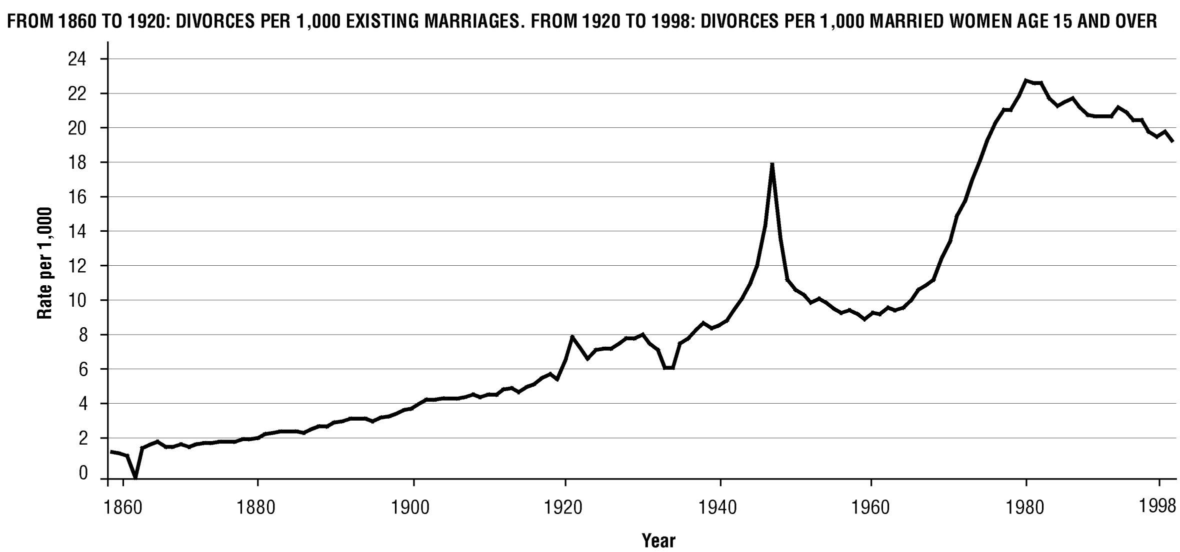
Several social trends contributed to the rise in divorce over the second half of the twentieth century. One cultural trend was a greater emphasis on personal fulfillment, which made divorce a more acceptable option for people who felt unfulfilled by their marriages. Economic trends also affected divorce rates: Increased employment opportunities for women led to a rise in the number of wives working outside the home. Employment gave wives greater economic independence, which made divorce a feasible option for those who were unhappy in their marriages. In the 1970s and 1980s in the United States, decreasing economic opportunities for men without a college education may have reduced their earning potential and also increased the stresses on some marriages.

Remarriage

Before the twentieth century, most remarriages followed widowhood. But the decline in mortality rates and the rise in divorce rates during the twentieth century changed remarriage, so that by the end of the century more than nine in ten remarriages in the United States followed a divorce. According to the U.S. National Center for Health Statistics, at 2001 rates 75 percent of divorced women in the United States would remarry within 10 years. At the beginning of the twenty-first century, remarriage was more likely among non-Hispanic whites than among African Americans or Hispanic Americans. The latter two groups generally had lower income levels and therefore benefited less from the legal protections marriage provides. In addition, the lesser centrality of marriage in African-American kinship and the Catholic Church's opposition to remarriage may influence these racial and ethnic differences.

FIGURE 2

Annual Divorce Rate, United States, 1860–1998



SOURCE: For 1890–1990: Andrew J. Cherlin (1992). For 1991–1992: U. S. National Center for Health Statistics (1993). *Monthly Vital Statistics Report,* vol. 41, no. 13. Washington: U. S. Government Printing Office. For 1993–1994: U. S. National Center for Health Statistics (1995). *Monthly Vital Statistics Report,* vol. 43, no. 13. Washington: U. S. Government Printing Office. For 1995– 1998, unpublished data from the U. S. National Center for Health Statistics.

Studies at the end of the twentieth century indicate that remarriages are somewhat more likely to end in divorce than first marriages. The higher risk of divorce may result from the lack of culturally agreed upon norms for how remarried persons should interact with partners and children. In addition, people who divorce and remarry may be more likely, because of their experiences or their personalities, to end a marriage if they are having difficulties. Remarriages after divorce often create complex stepfamilies that extend across more than one household. For example, children from previous marriages may live with or be in contact with parents in other households. Remarriages are even more likely to be preceded by a period of cohabitation than are first marriages. During the 1980s and 1990s cohabiting unions were more common and remarriages were delayed among individuals divorced five years or less.

Childbearing Outside of Marriage

In the 1950s more than 90 percent of children were born to married mothers in most Western countries. Beginning in the 1960s the percentage of children born outside of marriage began to rise. By the end of the twentieth century, one-third of all births in the United States were to unmarried mothers. In Great Britain this figure was slightly more than one-third, and in Sweden, slightly more than one-half of births were to unmarried mothers. In the United States, strong racial and ethnic differences exist in the rates of births outside of marriage; 22 percent of births to non-Hispanic whites, 42 percent to Hispanics, and 69 percent to African Americans were to unmarried mothers in 1999. A majority of these unmarried mothers in the United States formed single-parent families, but about four in ten were cohabiting with men at the time of their child's birth. Cohabitation rates for parents were even higher in Western Europe, with at least six in ten unmarried mothers cohabiting in Great Britain, and more than nine in ten in Sweden. Unmarried teenagers who give birth tend to have lower completed education, lower incomes, and less stable marriages than women who do not give birth until their twenties. Having a child as an unmarried teenager may make it difficult to complete one's education or to gain labor market experience, or teenagers who are likely to give birth may already be from disadvantaged backgrounds.

Family and Household Composition

All of the developments discussed above have greatly changed the typical household composition of families in the Western nations. In the first half of the twentieth century, the percentage of families headed by two parents increased because mortality rates fell and divorce rates were still relatively low. But in the second half of the twentieth century, the percentage of families headed by two parents decreased due to the rise in divorce, cohabitation, and childbearing outside of marriage. For example, in the United States in 1950, single parents headed only 7 percent of all families with children under 18; the corresponding figure in 2000 was 27 percent. Even the simple one- versus two-parent distinction is increasingly inadequate as an indicator of diverse household composition, because some single parents are cohabiting and some two-parent households are stepfamilies.

The living arrangements of children have changed dramatically over the course of the twentieth century. In the mid-twentieth century, about half of all children in the United States were living with a father who worked outside the home and a mother who was a full-time homemaker. By the 1990s only about one-fourth of children were living in these so-called breadwinner–homemaker families. The great increase in married women working outside the home, as well as trends in marriage, cohabitation, and divorce rates, had produced more families with two earners as well as more single-parent families. Children at the end of the twentieth century were also more likely to live in a series of different family arrangements as their parents moved into and out of marital and cohabiting unions. At 2000 rates, for example, about 40 percent of children in the United States would witness the breakup of their parents' marriages, and about 10 percent would witness the breakup of two marriages. Moreover, about 40 percent of children would spend some time living with a parent and her or his cohabiting partner.

Children's Well-Being

The great changes in the demography of families over the course of the twentieth century affected children's well-being. In general, children living in single-parent families in 2000 had levels of well-being that were lower than children in two-parent families. Studies of divorce, for instance, suggest that it raises the risks of undesirable outcomes in the lives of children, such as dropping out of school, having a child before marrying, or having mental health problems. Some of these difficulties, however, may have preceded the divorce and may reflect other underlying problems (such as poverty or parental depression) rather than the number of parents in the home. Other studies suggest that a majority of children whose parents divorce will not experience serious long-term problems. Children who were living with a biological parent and a stepparent in 2000 had levels of well-being that were no better, on average, than children in single-parent households. Some studies suggest that the more transitions in family structure that a child experiences (as when parents divorce or remarry), the more difficult his or her adjustment becomes.

Research generally indicates that the increases in childbearing outside of marriage, divorce rates, and remarriage have been detrimental to children's well-being, although the long-term effects are not yet known. There is little evidence, however, that having both parents work outside the home is detrimental to children, except perhaps for infants. Other demographic trends may have been positive for children: lower fertility means that they have fewer brothers and sisters and should therefore receive more parental time and resources; rising levels of parental education may help parents ready children for school and assist them in learning.

Diversity or Decline?

There is no question that the place of marriage in the family systems of the Western nations has declined over the past half-century. Once the near universal setting for bearing and raising children, marriage rates during the twentieth century decreased as single-parenthood and cohabitation increased. Marriage is still highly valued, but it is not as necessary to be married as it used to be: In Western society in the twenty-first century, it is possible to have a long-term sexual relationship without marrying, it is possible to support oneself economically without marrying, and it is possible to shun marriage and still be respected by family and community. Marriage, then, has declined as an institution. The more difficult question is whether, more broadly, the family has declined as an institution, and on this point there is continuing debate. According to some, the family has declined because the living arrangements that have become more common are not as good for children, and possibly adults, as marriage. According to others, the family has always been changing and has weathered that change much better than its critics have feared. The growing diversity of family life, some assert, has some positive effects, such as providing greater opportunities for women who want to combine a career with raising a family.

See also: *Divorce; Fertility, Nonmarital; Household Composition; Life Course Analysis; Marriage.*

BIBLIOGRAPHY

Becker, Gary S. 1991. *A Treatise on the Family,* enlarged edition. Cambridge, MA: Harvard University Press.

British Society for Population Studies. 1983. "The Family." *Occasional Paper* 31.

Bumpass, Larry L., James A. Sweet, and Andrew Cherlin. 1991. "The Role of Cohabitation in Declining Rates of Marriage," *Journal of Marriage and the Family* 53: 913–27.

Bumpass, Larry L., and Hsien-hen Lu. 2000. "Trends in Cohabitation and Implications for Children's Family Contexts in the United States." *Population Studies* 54: 19–41.

Cherlin, Andrew J. 1992. *Marriage, Divorce, Remarriage,* revised and enlarged edition. Cambridge, MA: Harvard University Press.

Cherlin, Andrew J. 1999. "Going to Extremes: Family Structure, Children's Well-Being, and Social Science." *Demography* 36: 421–428.

Cherlin, Andrew J., and Frank F. Furstenberg, Jr. 1992. *The New American Grandparent: A Place in the Family, A Life Apart.* Cambridge, MA: Harvard University Press.

Goldscheider, Frances K., and Calvin Goldscheider. 1993. *Leaving Home Before Marriage: Ethnicity, Familism, and Generational Relationships.* Madison: University of Wisconsin Press.

Goldstein, Joshua R., and Catherine T. Kenney. 2001. "Marriage Delayed or Marriage Forgone? New Cohort Forecasts of First Marriage for U.S. Women." *American Sociological Review* 6(4): 506–519.

Hernandez, Donald J. 1993. *America's Children: Resources from Family, Government, and the Economy.* New York: Russell Sage Foundation.

Kiernan, Kathleen E. 2001. "European Perspectives on Nonmarital Childbearing." In *Out of Wedlock: Causes and Consequences of Nonmarital Fertility,* ed. Lawrence L. Wu and Barbara Wolfe. New York: Russell Sage Foundation.

Lesthaeghe, Ron. 1995. "The Second Demographic Transition: An Interpretation." In *Gender and Family Change in Industrialized Countries,* ed. Karen O. Mason and Ann-Marie Jensen. Oxford: Clarendon Press.

Lesthaeghe, Ron, and Johan Surkyn. 1988. "Cultural Dynamics and Economic Theories of Fertility Change." *Population and Development Review* 14: 1–45.

Roussel, Louis. 1989. *La Famille Incertaine.* Paris: Editions Odile Jacob.

Smock, Pamela J. 2000. "Cohabitation in the United States: An Appraisal of Research Themes, Findings, and Implications." *Annual Review of Sociology* 26: 1–20.

U.S. Bureau of the Census. 2001. "Living Arrangements of Children: 1996." *Current Population Reports,* 70–74.

U.S. National Center for Health Statistics. 2000. "Nonmarital Childbearing in the United States, 1940–99." *National Vital Statistics Reports,* 48: 16.

U.S. National Center for Health Statistics. 2001. "First Marriage Dissolution, Divorce, and Remarriage: United States." *Advance Data from Vital and Health Statistics,* 323.

Andrew J. Cherlin

FAMILY LIFE CYCLE

The concept of the life cycle was originally developed for individuals and was then extended to an aggregate, the family, in influential articles published in the 1930s. The life cycle for a family includes three major phases. The first, family formation, extends from marriage to the birth of the first child. The second phase, family development, consists of extension as children are born and contraction as they leave home. The third phase, family dissolution, extends from the death of the first spouse to the death of the second spouse.

As originally formulated, the concept of a family life cycle was crucially linked to the nuclear family, the events of marriage and childbearing, and a presumed continuity of membership. Later social scientists broadened the definitions of the family and its phases and avoided restrictive or normative definitions that require formal marriage or childbearing. Many individuals never marry, many couples never have children, and many couples divorce and remarry with or without children. It is common to encompass these broad variations under the rubric of the life course, rather than the life cycle, for families as well as for individuals.

Analytical Approaches

Many of the attributes of a family are simply the attributes of the members of that family and can be studied with individuals as units of analysis. The concept of the family life course has value to the degree that the lives of family members are interdependent, with a collective identity and continuity over time.

Because the family is a social unit, usually consisting at least of two adults or one adult and at least one child, it inherently has less continuity than an individual person. An individual has dates of birth and death, but there is much less precision about the dates when a family begins or ends. There may be a typical or modal life course for a family and typical amounts of time spent in different phases, but the sequences and durations can vary greatly.

Much research has tried to articulate the links between individuals and families. For example, most individuals make a transition from being a child in one family—the family of socialization—to being an adult in another family. Life table methods have been devised to produce synthetic measures, such as the expected number of years that an individual would spend as a child in a two-parent household, as a married adult with children living in the household, as a widowed person, and so on. Another strategy is to follow a family over time by linking it to a particular member, termed an index person, such as the senior female. When the family status of such a woman determines the family unit, it is possible to describe transitions in the woman's life course as transitions in the family's life course. There is less concern than in the past over identifying a single individual as the head of the family. For example, the U.S. Census Bureau last used this concept in the 1970 census.

Family Formation and Development

A family generally begins with a union between a man and a woman. (In some countries, same-sex unions are also accorded a legal status equivalent to that of the family.) High levels of education and legal protections have led to greater economic independence for women, and their status is less tied to being married and to the status of their spouse than in the past. Thus, age at marriage has risen for couples in Europe and the United States; couples may cohabit for years before marrying, and some couples never marry. Many women work after marriage, sometimes because of a need for two incomes and sometimes because of the importance of work itself for the woman's identity.

The traditional link between marriage and childbearing has been weakened in several respects. Many married couples never have children, and many children are raised by a single parent, either never-married or divorced. Increased education and labor force participation of women has had substantial effects on the pattern of childbearing. Children tend to be born later and closer together.

In virtually all developed countries, fertility is below replacement level, and in most developing countries it has fallen dramatically since the 1960s. In general, parents provide far more support for their children than they expect ever to receive in return. A large share of family resources is dedicated to the education and socialization of children, although children tend not to regard their behavior as a reflection on their family. In low-fertility countries, it is increasingly common to have no children at all, either by choice or because extensive delay impaired the ability to conceive. Most people would prefer to have two children, ideally a boy and a girl. A substantial proportion of births beyond two are motivated by a desire to have a child of each sex.

Young adults often have an extended period of financial and emotional dependence upon their parents, even if they no longer live with them. Nevertheless, in developed countries the support of elderly parents is not generally seen as the responsibility of their adult children.

Family Dissolution and Reconstitution

Divorce and widowhood are approximately equally common endings for a marriage. Divorce tends to occur at a much earlier stage, often while children are present. Thus many children are likely to spend several years with a single parent, more often the mother than the father. Alternatively, because most divorces are followed by a remarriage, various kinds of blended households can arise. Children who are biological half siblings or stepsiblings may be raised, and may self-identify, as full siblings.

The generalizations in this article have been biased toward the situation in the United States, Europe, and other developed countries. Beyond these generalizations, there is considerable diversity across racial and ethnic groups, educational levels, and some religions. Probably the most important contemporary issue is the compatibility, or lack thereof, between women's labor force participation and their role in a family.

See also: *Household Composition; Intergenerational Transfers; Life Course Analysis.*

BIBLIOGRAPHY

Bongaarts, John, Thomas K. Burch, and Kenneth W. Wachter, eds. 1987. *Family Demography: Methods and Their Application.* Oxford: Oxford University Press.

Mason, Karen Oppenheim, and An-Magritt Jensen. 1995. *Gender and Family Change in Industrialized Countries.* Oxford: Oxford University Press.

Mason, Karen Oppenheim, Noriko O. Tsuya, and Minja Kim Choe, eds. 1998. *The Changing Family in Comparative Perspective: Asia and the United States.* Honolulu, HI: East-West Center.

Oppenheimer, Valerie Kincade. 1982. *Work and the Family: A Study in Social Demography.* New York: Academic Press.

Waite, Linda J., ed. 2000. *The Ties That Bind: Perspectives on Marriage and Cohabitation.* New York: Aldine de Gruyter.

Yi, Zeng. 1991. *Family Dynamics in China: A Life Table Analysis.* Madison: University of Wisconsin Press.

Thomas W. Pullum

FAMILY PLANNING PROGRAMS

Family planning programs are organized outreach activities, often under government auspices, that distribute information, services, and supplies for modern means of fertility regulation. While they vary greatly, the following are regarded as the principal ingredients of an acceptable program:

- A delivery system that includes, at a minimum, community clinics and referrals to secondary and tertiary health centers for complications, side-effects, sterilizations, and, where legal, abortion services. In many cases, the delivery system includes community-based household distribution systems.
- A range of contraceptive methods, including both temporary and permanent methods of contraception. Often this range includes "traditional" or "natural" methods.
- Good counseling services and fully-informed consent and choice in the decision to use a method, and which method to use.
- Accurate information about contraception and its side-effects, and appropriate referrals for alternative methods.

Origins

The birth control movement had its roots in Europe, principally Great Britain, and the United States in the nineteenth century, but it began to grow rapidly during the two decades before World War II. It was a movement closely allied with feminism and was led by Marie Stopes (1880–1958) in Britain and Margaret Sanger (1883–1966) in the United States. Its principal aim was to grant to individuals, but especially women, control over their own reproduction.

The global family planning movement in a sense began in 1952. In that year, a group of birth control activists, the heads of the family planning associations in eight western and Asian countries (the Federal Republic of Germany, Hong Kong, India, the Netherlands, Singapore, Sweden, the United Kingdom, and the United States) met in Bombay for the purpose of forming an international organization to spread birth control information and technology. The result was the International Planned Parenthood Federation.

Among the western countries, the family planning movement was at the outset strictly a private and philanthropic enterprise, and its leaders were not necessarily guided by identical motivations. Some, often called "neo-Malthusians" after the English economist and population theorist T. R. Malthus (1766–1834), were primarily driven by concerns about rapid population growth and its implications for social, economic, and political well-being. Eugenicists, active prior to World War II, were concerned with perceived dysgenic effects of fertility differentials that they traced to low contraceptive use among the lower classes. Still others, the "family planners," were motivated by a desire to bring modern contraception and its benefits to the largest possible number of people and to liberate them from the burden of unwanted pregnancies and childbearing. Some of the early leaders, like Sanger, had roots in each of these three camps.

Also in 1952, the Indian government identified uncontrolled fertility and the high rate of population growth as a national problem and promulgated the first national population policy. During the decade that followed, Taiwan, South Korea, Hong Kong, Pakistan, and Singapore initiated family planning activities. By the mid-1960s most of the countries of South and East Asia had established nationwide government programs.

Debate about "Supply" and "Demand"

Both the neo-Malthusians and the family planners believed that national family planning programs were urgently needed. For the planned parenthood movement, family planning programs were the goal. For demographers and population control advocates, family planning was a means to an end. But not all neo-Malthusians saw family planning programs as necessarily an effective means. Many scholars and intellectuals viewed family planning programs as perhaps a necessary but hardly a sufficient means to bring down high birth rates in poor countries. This skepticism about the ability of family planning programs to reduce fertility, particularly programs in which individuals and couples participate on a purely voluntary basis, resulted in a deep and sometimes bitter debate about what constituted appropriate population policy.

At the heart of the debate were these questions:

- Were people sufficiently motivated to limit their childbearing that voluntary family planning programs could bring about substantial fertility declines?
- If sufficient motivation existed, would organized programs be needed to spread birth control practice?
- Were additional measures ("beyond family planning") required to change childbearing behavior, either through inducement or coercion?
- Would people respond to direct appeals to bear fewer children?
- What priority should family planning programs command in comparison to other health programs and among government social expenditures in general?

One approach to seeking answers to these questions was through a series of surveys of knowledge, attitudes and practice (KAP) regarding fertility and birth control. These surveys were conducted in a number of countries from the late 1950s through the 1960s. They asked mostly women, but sometimes also husbands, how many children they wanted, whether they knew about and/or approved of family planning, whether they had ever used a family planning method, and so on. The surveys demonstrated a much higher than expected level of what was called "latent demand" for family planning: women knew about it, generally approved of it, and in many cases wanted fewer children than they actually had, or wanted to postpone or avoid the next birth, but were nonetheless not practicing a method. This information was used to try to persuade governments in developing countries to adopt population policies, with voluntary family planning programs as a central element.

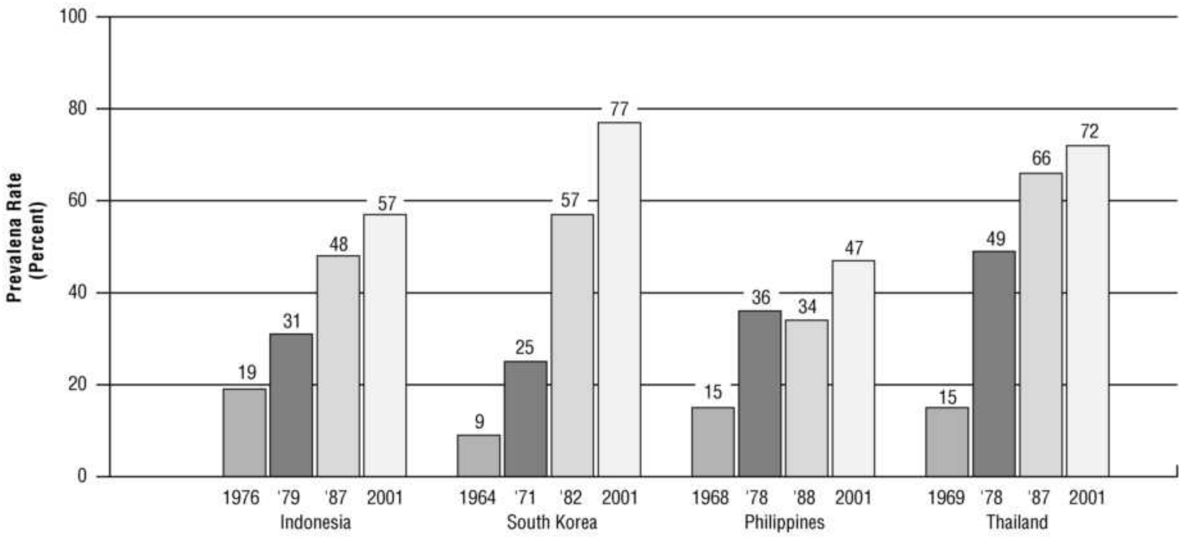
Early Program Efforts and International Assistance

By the early 1960s the invention of both the birth control pill—the oral contraceptive—and the intrauterine contraceptive device (IUD) revolutionized family planning. Now, for the first time, easy-to-use, unobtrusive and easily distributed contraceptives could be made available at relatively low cost to entire populations.

The new technologies permitted large-scale family planning programs to be established or greatly expanded. With modern contraceptives, it became much easier to mount experimental service delivery systems and to test, in practice, how people would respond to the availability of family planning services. A number of field experiments were set up

FIGURE 1

Trends in Contraceptive Prevalence Rates, Selected Countries and Years



SOURCE: Nortman (1974); Population Reference Bureau, *World Population Data Sheets* (1978, 1988, 2001).

around the world. One of the earliest and most successful was the Taichung experiment in Taiwan. A carefully designed experiment, with both treatment and control areas and excellent data collection and monitoring, the Taichung project demonstrated that there could be a strong and lasting effect from a voluntary family planning program.

International assistance for population programs began in the late 1950s and grew in the early and mid-1960s. In 1958 Sweden became the first western country to provide assistance for family planning with grant aid to Sri Lanka. Projects quickly followed in India, Pakistan, and other countries. Other western donors followed suit, providing grants to the International Planned Parenthood Federation and in a few cases directly to governments in developing countries. But the big breakthrough in public support for international family planning came in the late 1960s, first in 1966 and 1967 when the United States officially began to provide population assistance through the Agency for International Development (USAID), and a year later when the United Nations Fund for Population Activities (UNFPA—today called the United Nations Population Fund) was established and began to operate as a mechanism for channeling donor funds to developing countries.

Disappointing Results in South Asia

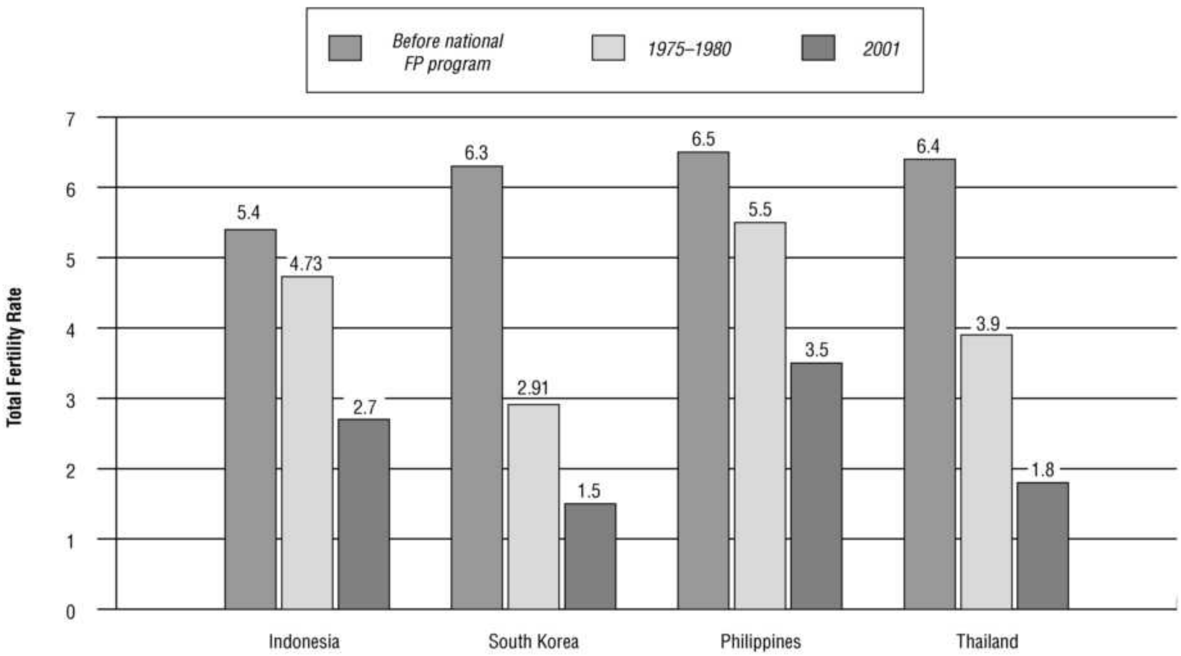
While the Taichung experiment and early program efforts in East Asia looked promising, the results of large-scale family planning program efforts in South Asia were quite discouraging. India and Pakistan both decided in the early 1960s to mount major national family planning programs based primarily on the IUD. While the programs were voluntary, women were strongly encouraged to accept IUD insertions, often in camp-like settings or on special days at clinics and dispensaries. In addition, the providers of the services, especially doctors trained to insert IUDs, received payments on a per-case basis.

Evaluations carried out a few years after these programs were initiated revealed widespread discontinuation of use, rampant rumors (often false) about side-effects, many cases of fraudulently reported insertions, and virtually no effect on birth rates. These results were disheartening to the two governments and to family planning advocates outside South Asia. Moreover, they seemed to confirm the skepticism of many demographers toward the family planning approach to fertility decline.

The failures of the IUD programs in India and Pakistan severely diminished support for the family planning approach and reinforced the view that a

FIGURE 2

Trends in Total Fertility Rates*, Selected Countries and Periods



*Average number of births per woman over reproductive lifetime

SOURCE: Nortman (1974); Population Reference Bureau, *World Population Data Sheets* (1975–1980; 2001).

broader "developmental" approach to population policy was required—an approach that, in programmatic terms, emphasized raising literacy levels, especially for girls; reducing infant and young child mortality; improving employment opportunities for women; establishing mechanisms to provide old-age social and economic security; and generally reducing the conditions of poverty and underdevelopment that give rise to a high demand for children.

Many economists, arguing that high fertility was a rational response to poverty and high child loss due to mortality, began to gain influence among development planners and policymakers. In South Asia there were calls for approaches beyond family planning, including cash incentives, "no-birth" bonus schemes, and even outright coercion on couples to limit their childbearing.

USAID's "Supply-Side" Approach

Notwithstanding such disappointing early results in South Asia, USAID, by then the largest donor of international population assistance, adopted an almost pure family planning approach as it rapidly expanded its population operations in the late 1960s and early 1970s. USAID's population program director, R. T. Ravenholt, believed firmly that there were millions of women throughout the world who, if given access to safe and effective methods of contraception, would use them. He often stated that true demand could only be measured in the context of actual availability of services. He was determined that USAID would do everything it could to ensure that such services would be available in as many countries as possible.

East Asian countries other than China, Vietnam, and North Korea (which in their family planning programs mixed the provision of services with application of strong administrative pressures to ensure that the services had clients) turned out to be the ideal testing ground for USAID's "supply-side" approach. Governments there, increasingly worried about rapid population growth and encouraged by the success of the Taichung experiment and Taiwan's subsequently successful family planning program, were now ready to move ahead with family planning programs (see Figure 1). A key figure in promoting this evolution of thinking and policy in the region was Spurgeon "Sam" Keeny of the Population Council.

Following the early efforts of planned parenthood pioneers and of organizations such as the Population Council, USAID moved quickly to establish major assistance programs in Korea, the Philippines, Indonesia and Thailand—and all of them thrived. The adoption of contraception grew rapidly in the early 1970s and fertility soon fell, in some cases more dramatically than ever before seen (see Figure 2). These were among the earliest major family planning success stories at a national level and they helped to restore confidence in the family planning approach.

Bucharest—the 1974 World Population Conference

The continuing uncertainty about the effectiveness of the family planning approach set the stage for the debate that ensued at the first intergovernmental World Population Conference, held in Bucharest under United Nations auspices in August 1974. Western delegations, led by the United States, hoped that the Bucharest Conference would adopt a global demographic goal, and that individual countries could be persuaded to set demographic targets for themselves—expressed either in terms of the rate of population growth or declines in birth rates. But this aspiration faced fierce opposition, both to demographic targets and to Western neo-Malthusianism. Many developing countries, supported by the Soviet bloc, China, and other non-aligned and socialist states, denied that rapid population growth was the serious problem alleged by the West and attacked efforts to push them toward adopting anti-natalist policies and programs as "neo-colonialist" or "imperialist." In addition, countries with large Roman Catholic populations and strong Vatican influence opposed efforts to spread modern birth control technologies—an opposition that has remained a constant at international conferences on population ever since.

This opposing coalition successfully blocked the United States and its Western allies in their efforts to press a strong demographic agenda. On the other hand, the vast majority of countries agreed on language that established access to family planning information and services as a basic right. In the words of the World Population Plan of Action adopted at Bucharest in 1974, it is "the basic human right of all couples and individuals to decide freely and responsibly the number and spacing of their children and . . . to have access to the necessary education, information and means to do so."

It is important to note that many of the countries of East and Southeast Asia that had already adopted anti-natalist population policies and strong family planning programs remained relatively quiet during the debate, refusing to join the more vocal opponents of the neo-Malthusian approach in Latin America, the Middle East, and Africa. India, the population policy and family planning pioneer, was among the most vocal countries in its opposition to Western-imposed population policies and family planning programs and was the strongest advocate of the alternative "developmental" approach. The head of the Indian delegation, Minister of Health Karan Singh, uttered perhaps the most famous quote at the Bucharest conference: "Development is the best contraceptive."

Progress after Bucharest

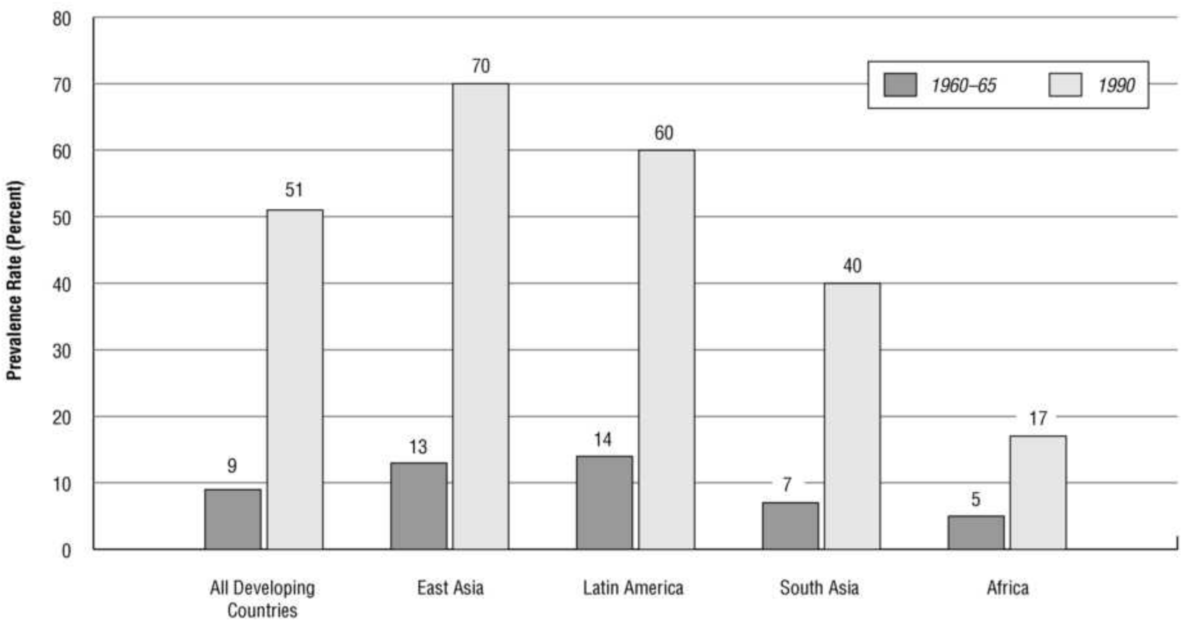
The debate about family planning reached a peak of intensity at Bucharest, largely owing to the absence of solid empirical evidence regarding the effect of family planning programs on fertility. Apart from scattered evidence from a few experimental projects and some highly suspect statistics generated by family planning programs themselves, there was little information from which persuasive conclusions could be drawn.

Fortunately, in the early 1970s USAID and UNFPA had agreed to launch the World Fertility Survey (WFS). The WFS was to collect information from women (and later their partners) in as many developing countries as possible on fertility aspirations, actual fertility experience, knowledge about and attitudes toward contraception, use of contraception, and many other variables, including socioeconomic background factors such as education, religion, income, and occupation. The purpose of the survey was to help developing countries, as well as donor nations and international organizations, to measure both what was happening to fertility and the reasons behind whatever changes were discovered.

The WFS was a great success. In its first five years, it conducted surveys in more than 40 coun-

FIGURE 3

Contraceptive Prevalence in Major Development Regions, 1960–1965 and 1990



SOURCE: Nortman (1974); Population Reference Bureau, *World Population Data Sheet* (1990).

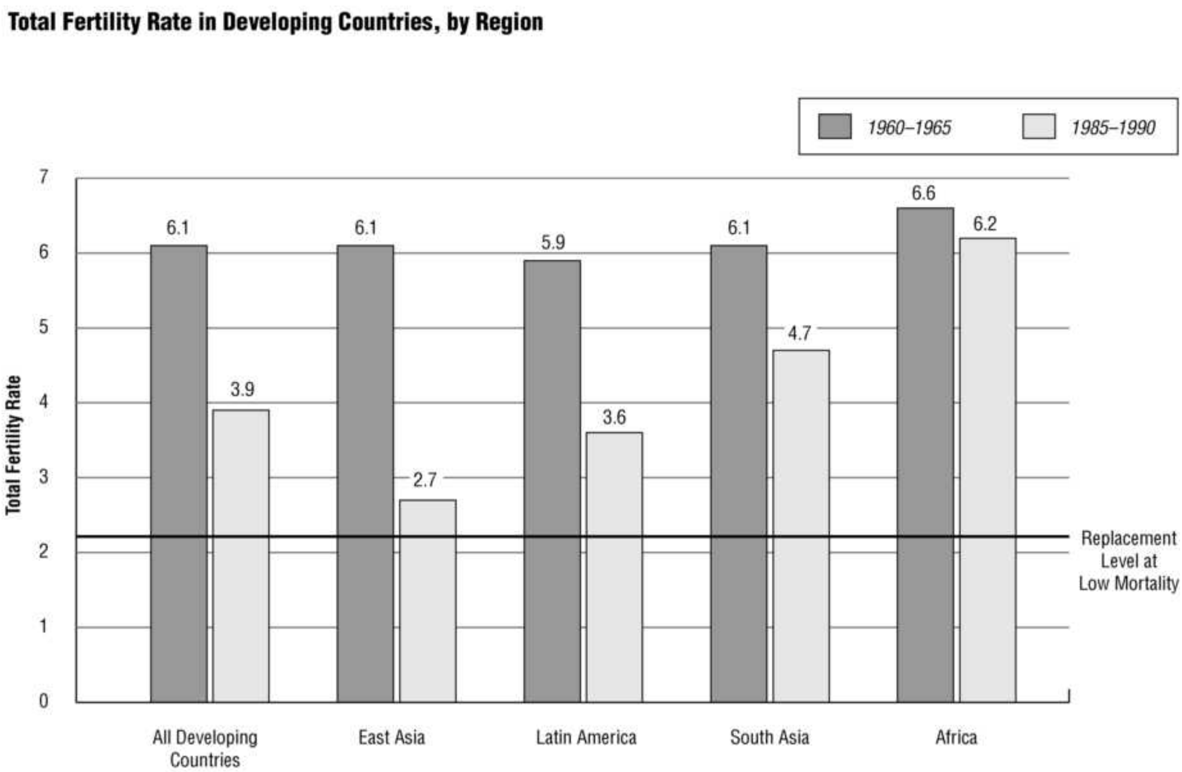
tries, including many of the largest. By the late 1970s analysis of these surveys and comparisons among them indicated that social and economic development variables, were, indeed, powerful determinants of fertility but that family planning programs in many countries were accelerating the rate of fertility change and, in some cases, apparently having an independent effect on it.

Another scientific enterprise that helped to resolve the debate was a family planning experiment in the Matlab area of Bangladesh. There, the International Centre for Diarrhoeal Disease Research maintained a detailed demographic and health surveillance system that permitted measurement of the effects of a variety of health interventions. Taking family planning as one of these, scientists succeeded in demonstrating that even in a highly impoverished, resource-constrained setting, the provision of a reasonably high quality family planning program could bring about significant and lasting effects on fertility. The Matlab Project seemed to disprove the assertion that fertility could not decline except in the context of broadly and substantially improved living standards.

The decade between the Bucharest Conference and its successor, the International Conference on Population (ICP) in Mexico City, held in 1984, was a period of consolidation and expansion of family planning programs. Nearly all countries, whatever their position had been at Bucharest, either developed or permitted the development of family planning service delivery programs during this decade. This was true whether countries had explicit antinatalist population policies or not. Indeed, many countries in Latin America, for example, encouraged the expansion of voluntary family planning programs on the grounds that they were shown to improve both maternal and child health. The Mexico City conference, which was intended as a review of the World Population Plan of Action adopted at Bucharest, strongly reaffirmed the idea that family planning should be a basic right that governments should ensure for their people.

In the mid and late 1980s family planning programs flourished. Impressive gains in contraceptive use were recorded in nearly all parts of the world, and there were corresponding declines in fertility (Figure 3). By the end of the decade, contraceptive

FIGURE 4



SOURCE: Nortman (1974); Population Reference Bureau, *World Population Data Sheets* (1985–1990).

use globally was estimated to be over 50 percent among women of reproductive age, and the total fertility rate had fallen from its mid-1960s peak of around six children per woman to less than four (Figure 4). A significant majority of women in the developing world were getting contraceptive supplies and services from publicly-supported family planning programs.

New Challenges

But there had been clouds building on the family planning horizon for a number of years. Critics of the family planning movement began to call for reforms over concerns that some countries, including such large countries as India, China, Bangladesh, and Indonesia, were employing coercive or semi-coercive measures to induce people to limit their fertility. Feminist groups in several countries began calling quite vocally and insistently for a broader, more inclusive approach to women's health needs. They called this new approach "reproductive health."

Some in the reproductive health movement blamed the demographic goals of many family planning programs for creating a narrow perspective that often ignored women's health. They insisted that programs should no longer provide just contraceptives and family planning information, but should also attend to other women's health problems such as unsafe abortion, sexually transmitted diseases and reproductive tract infections (including HIV/AIDS), and emergency obstetrical care. Furthermore, they argued, the family planning approach ignored such other important aspects of population policy as girls' education, women's employment, the empowerment of women in matters of inheritance and political participation, and reducing infant and child mortality. These feminists called for comprehensive population policies that replaced demographic targets with holistic concern about women's well being, most especially their health.

By the early 1990s these calls for reform and for the reproductive health approach had penetrated the thinking of many international organizations and donor agencies. Governments in the developing world were somewhat slower to respond, but the issue exploded onto the world political stage at the International Conference on Population and Development (ICPD) at Cairo in 1994, the third decennial intergovernmental population conference.

It is probably fair to say that the family planning approach to population policy ended at Cairo, to be replaced, in the ICPD Programme of Action, by what was now being called the reproductive and sexual health and rights approach. To be sure, family planning remained a significant, even a central, part of reproductive health, but the 180 or so governments that gathered at Cairo clearly rejected demographic and family planning targets in favor of the more comprehensive approach. While Bucharest and Mexico City had certainly mentioned these other measures, it was not until Cairo that the international women's movement had acquired sufficient strength to place the empowerment of women at the forefront of population policy.

In the years since Cairo, most governments around the world have modified their population and health policies to conform with the Cairo Programme of Action. Governments vary widely, though, in the extent to which they have really made the transition from family planning to a more comprehensive approach. For many governments the rhetoric of Cairo has not been translated into real program reforms.

See also: *Birth Control, History of; Contraception, Modern Methods of; Contraceptive Prevalence; Induced Abortion: Prevalence; Population Policy; Reproductive Rights; Sanger, Margaret; Unwanted Fertility*

BIBLIOGRAPHY

Berelson, Bernard. 1969. "Beyond Family Planning." *Science* 163: 533–543.

Berelson, Bernard, and W. Parker Mauldin. 1978. "Conditions of Fertility Decline in Developing Countries, 1965–1975." *Population and Development Review* 9 (5): 84–148.

Bongaarts, John. 1991. "The KAP-Gap and the Unmet Need for Contraception." *Population and Development Review* 17 (2): 293–313.

———. 1994. "Population Policy Options in the Developing World." *Science* 263 (5148): 771–776.

Bongaarts, John, W. Parker Mauldin, and James F. Phillips. 1990. "The Demographic Impact of Family Planning Programs." *Studies in Family Planning* 21 (6): 299–310.

Bruce, Judith. 1990. "Fundamental Elements of the Quality of Care: A Simple Framework." *Studies in Family Planning* 21 (2): 61–91.

Cleland, John, and Christopher Wilson. 1987. "Demand Theories of the Fertility Transition: An Iconoclastic View." *Population Studies* 41 (1): 5–30.

Critchlow, Donald T. 1999. *Intended Consequences: Birth Control, Abortion, and the Federal Government in Modern America.* New York: Oxford University Press.

Davis, Kingsley. 1967. "Population Policies: Will Current Programs Succeed?" *Science* 158: 730–735 (10 November).

Dixon-Mueller, Ruth. 1993. *Population Policy and Women's Rights: Transforming Reproductive Choice.* New York: Praeger Publishers.

Donaldson, Peter. J. 1990. *Nature Against Us: The U.S. and the World Population Crisis, 1965–1980.* Chapel Hill: University of North Carolina Press.

Freedman, Ronald. 1979. "Theories of Fertility Decline: A Reappraisal." *Social Forces* 58 (1): 1–16.

Freedman, Ronald, and John Y. Takeshita. 1969. *Family Planning in Taiwan: An Experiment in Social Change.* Princeton, NJ: Princeton University Press.

Harkavy, Oscar. 1995. *Curbing Population Growth: An Insider's Perspective on the Population Movement.* New York: Plenum Press.

McIntosh, C. Alison, and Jason. L. Finkle. 1995. "The Cairo Conference on Population and Development: A New Paradigm?" *Population and Development Review* 21 (2): 223–260.

Nortman, Dorothy L. 1974. "Population and Family Planning Programs: A Factbook." *Reports on Population/Family Planning,* No. 2.

Piotrow, Phillis T. 1973. *World Population Crisis: The United States Response.* New York: Praeger Publishers.

Population Reference Bureau. Annual. *World Population Data Sheet.* Washington, D.C.: Population Reference Bureas.

Pritchett, Lant H. 1994. "Desired Fertility and the Impact of Population Policies." *Population and Development Review* 20 (1): 1–55.

Ravenholt, R. T. 1969. "AID's Family Planning Strategy." *Science* 163: 124 and 127 (10 January).

Robey, Bryant, Shea O. Rutstein, Leo Morris, and Richard Blackburn. 1992. "The Contraceptive Revolution: New Survey Findings." *Population Reports* Series M, No. 11. Baltimore, MD: Johns Hopkins University.

Sinding, Steven W. 2000. "The Great Population Debates: How Relevant Are They for the 21st Century?" *American Journal of Public Health* 90 (12): 1841–1846.

Sinding, Steven W., John A. Ross, and Allan G. Rosenfield. 1994. "Seeking Common Ground: Demographic Goals and Individual Choice." *International Family Planning Perspectives* 20 (1): 23–27, 32.

United Nations. 1994. *Program of Action of the International Conference on Population and Development.* New York.

Watkins, Susan C. 1987. "The Fertility Transition: Europe and the Third World Compared." *Sociological Forum* 2 (4): 645–673.

Women's Declaration on Population Policies. 1993. International Women's Health Coalition. New York.

Steven W. Sinding

FAMILY POLICY

Family policies are a subset of government social policies that have as their object the well-being or the behavior of families, particularly families with children.

Conflicts of Principle in Family Policy

To what extent and in what circumstances should a government policy be directed at the family rather than at the individual person on the one hand or at larger social units such as communities on the other? The answer to the question is not straightforward because policies at different levels, particularly at the family and individual levels, often have outcomes that conflict. A policy that has benefits at the family level may have negative effects on individuals within the family. For example, a cash benefit provided to low-income families that is means-tested by family income may be a work disincentive to individuals within low-income families because the cash benefit would be withdrawn as the family income rose. Here a family policy designed to promote family stability by providing an income supplement to low-income families may conflict with a policy to promote self-reliance of individuals through employment. Family policy, policy designed to produce family-level outcomes, is rife with such conflicts.

One response to this conflict would be to assert that there should be no family-level policy, with the contention being that policies directed at individuals will flow through to families without distorting the behavior of individuals in unintended ways. The problem with this approach is that, without family-related incentives, individuals may be better off remaining as individuals and not forming themselves into families. The most obvious example relates to children. If a society provides no recognition of the costs of raising children and the loss of income and career potential related to having children, this may discourage individuals from having children. Yet very low fertility has obvious deleterious outcomes for the society as a whole. Where people already have children, the negative outcome of not providing support to those with children is the possibility that, through poverty or neglect, poor development outcomes for children will flow on to negative social outcomes.

The other central conflict in the design of family policy is the extent to which one family form is favored by policy over other forms. In most advanced industrialized countries, at least in the first half of the twentieth century, family support policy favored the family in which the father was in paid employment and the mother stayed at home to care for the children. This "male breadwinner model" of the family was backed by the social values of the time. Family policies of this era were founded on the assumption that mothers were not in paid employment. No supports were provided to working mothers, even to those who were single parents, because such supports were seen as providing the wrong incentives. The marriage bond was seen as weakened if women were able to support themselves, and children were seen as vulnerable if their mothers were in paid employment. Subsequently, with the advance of the women's movement, policies based on the assumption of the male breadwinner model of the family have come under intense criticism, the result of which is reflected in the evolution of contemporary family policies.

In the conflicts between individual and family approaches and between support of one family form over another, resolution must rely upon a determination of social values. The more that values are in flux and the more pluralistic is the society, the harder it is to resolve these conflicts. Ideally, a social consensus would be built around a chosen policy direction, but where a small number of votes can make a difference, governments are often reluctant to address these fundamental issues. This description encapsulates the state of family policy at the beginning of the twenty-first century. Governments, fiscally unable to satisfy all preferences in a pluralistic society, may satisfy none adequately.

Objectives of Family Policy

Family policy has three broad objectives:

- Family foundation: to support and strengthen family relationships;
- Nurture: to support families to care for their dependent members;
- Reproduction: to support the production of the next generation of productive adults.

Forms of Family Policy

Family policy takes four main forms:

- Legal: laws designed to promote family policy objectives;
- Financial: tax or transfer policies that favor family policy objectives;
- Industrial: policies related to wages or working conditions that favor family policy objectives;
- Services: provision, subsidization, or promotion of services that support family policy objectives.

Types of Family Policy According to Form

Family policies often have overlapping objectives. Thus, it is convenient to talk about particular family policies in terms of their four main forms.

Legal. Marriage laws define who is able to marry (in terms of kin relationship, minimum age, sex of partner, whether already married, and so on) and whether or not people getting married are able to make their own free choice about marrying. Marriage laws also conventionally define the rights and responsibilities of the partners to the marriage and may also define the legal status of children born to the marriage. These laws are designed to meet the family-foundation and nurture objectives and generally reflect social or religious values surrounding the institution of marriage. Divorce laws specify the circumstances under which divorce is permitted, how matrimonial property is to be distributed, and the care and financial support of any children of the marriage. Here again it is family-foundation and nurture aims that are paramount. Over time, divorce laws in most countries have been liberalized, reflecting the enhanced value attached by societies to individual rights in comparison to family rights.

There may also be laws that relate to the care, protection, and financial support of children, satisfying the nurture and reproduction aims. Many countries also have laws that define the responsibilities of adult children for their aged parents. These laws are often not effective in practice because they require parents to instigate a legal action against their children.

Finally, industrial legislation may prohibit discrimination in employment on the grounds of pregnancy status, gender, or family status.

Financial. Governments may favor families through the tax or cash transfer systems. Such policies take three main forms: periodic cash payments, lump-sum payments or low-interest loans, and tax rebates, credits, or deductions.

Periodic cash payments generally take the form of payments made to parents in respect of each child. The payments might vary according to the age of the child. For example, it could be considered that a higher payment should be made when a child is very young to compensate for the expected loss of income of parents at that stage. Alternatively, payments may be higher when children are older and more expensive. The payment may also vary by birth order. If the third child is considered to be particularly important as far as reproduction policy is concerned (on the assumption that many parents would anyway wish to have two children), then a much larger payment could apply to this child (and subsequent children). Essentially, these payments are a form of horizontal equity—that is, a recognition through the tax-transfer system of the additional costs of raising children. Some vertical equity (equalization of incomes across households) might be applied if the payments are income-tested, that is, if they are reduced or eliminated as income rises. As already noted, however, income-tested payments can be inefficient if they create work disincentives for second earners.

Lump-sum payments or loans include payments at the time of birth of a baby (e.g., baby bonus, maternity benefit), at the time a child starts school, or at some other age. An establishment loan (or family founding loan) may be provided at the start of a marriage or relationship with segments of the loan being written off as the couple has each child. There could be endowment schemes contributed to by the government and the family to spread the costs of children across the lifetime. Repayments of loans might be tied to a small percentage of earned income, that is, child costs might be paid off as income rises. Births might be deemed to be equivalent to (large) lump-sum contributions to social insurance or retirement pension schemes. As reproduction policy instruments, however, immediate benefits are more likely to be successful than deferred benefits. That is, assistance with immediate housing costs is probably more likely to affect fertility decision-making than the promise of future assistance with university education or a higher old-age pension.

Tax rebates, credits, or deductions (collectively called tax expenditures) may include tax reductions or credits based on the presence of a child or a spouse. Again, these measures can be targeted to children of different ages or different birth orders. Rebates and credits allow for social equity; deductions are generally socially inequitable with the rich benefiting most. While cash payments may be more closely targeted to the need (that is, more likely to be spent on the child) than benefits delivered through the tax system, tax expenditures are less visible to those concerned with fiscal restraint than are cash expenditures. Tax approaches may thus be more politically sustainable in certain contexts than cash approaches.

Tax may be applied on the separate incomes of the two members of a couple (individual taxation) or on their joint incomes (couple taxation). The use of couple taxation is sometimes described as inefficient because it can affect the level of involvement in the labor force of the second earner—that is, it operates as a work disincentive. As women's work force participation rates have increased, countries have moved in the direction of individual taxation.

Industrial. There are a range of potential policy measures that are designed to assist parents to combine work and family responsibilities. These policies may have the aim of supporting reproduction, but they can also arise as a means of protecting individual and family rights in relation to work. Parental leave (maternity or paternity leave) provides the right of return to a position following leave related to the birth of a child. Leave policy has many nuances such as its duration, whether the leave is paid and at what level, eligibility criteria, how much of the leave is available to mothers or to fathers, and whether there is a right of return to part-time work.

If the leave is paid, should the payment be made by the employer, by social or private insurance, or directly by the government? Payment by employers presents a major burden on small businesses. As having a pregnant worker is a high-cost but low-risk situation, insurance is the obvious approach to paid maternal leave. There is some evidence that leave entitlements of up to three years have a more significant impact on childbearing than one-year leave entitlements.

Flexible working hours, part-time work, and short-term leave for family-related purposes assist families to combine work and family. If the nature of the occupation allows work to be done at home, appropriate provision might be made for this option from time to time but especially when the child is an infant. Overlap of standard work hours and school hours is a work-family benefit.

Services. Education and information services can be directed at enhancing the quality of family relationships, aiding persons in coping with and managing the needs of dependent or disabled family members, family planning and health care, or the management of family finances.

There is a wide range of direct family services that can assist families to deal with children and other dependent family members. Beyond services that are universally required, such as education and health, the most general of these is child care, but the list also includes services that are related to a particular illness or disability, services that assist family members to care for aged persons, respite care services, and sporting and recreational services.

A fundamental policy in this area is the provision of free or subsidized child care of high quality to support the work and family aspirations of parents and to assist in the child's development. It can be argued that child care should be equally available to those who are not employed as this may allow them opportunities for training or for job-seeking as well as providing socially beneficial development opportunities for their children. Besides free provision, the main forms of public support include capital grants to child-care centers and subsidized child-care fees. As an alternative, some countries provide tax breaks for child-care expenses. Child-care expenses might also be exempted from consumption or value-added taxes or, if paid by the employer, treated as a business expense. Arrangements might be made to facilitate the care of children by their grandparents. Child-care eligibility is often tied to the age of the child, especially where there is an emphasis upon parental leave in the child's earliest years. Policy needs to address the balance between parental leave and child-care provision according to community standards. Child care includes the need for "out-of-school-hours" care. This can be provided at a neighborhood center or at the child's school.

See also: *Cohabitation; Family Allowances; Intergenerational Transfers; Marriage; Population Policy.*

BIBLIOGRAPHY

Ditch, John, Helen Barnes, and Jonathan Bradshaw, eds. 1998. *Developments in National Family Policies in 1996.* Brussels: Commission of the European Communities, D.G.V.

Gauthier, Anne. 2002. "Family Policies in Industrialized Countries: Is There Convergence?" *Population*–English Edition 57(3): 447–474.

Kamerman, Sheila B. 2001. *Early Childhood Education and Care: International Perspectives.* New York: Columbia University, Institute for Child and Family Policy.

Kamerman, Sheila B., and Alfred J. Kahn, eds. 1997. *Family Change and Family Policies in Great Britain, Canada, New Zealand, and the United States.* Oxford, Eng.: Clarendon Press, Oxford.

McDonald, Peter. 2002. "Sustaining Fertility through Public Policy; the Range of Options." *Population*–English Edition 57(3): 417-446.

Millar, Jane, and Andrea Warman. 1996. *Family Obligations in Europe.* London: Family Policy Studies Centre.

Organisation for Economic Co-operation and Development. 1997. "Family, Market, and Community: Equity and Efficiency in Social Policy." *OECD Social Policy Studies 21* Paris.

INTERNET RESOURCE.

The Clearing House on International Developments in Child, Youth and Family Policies at Columbia University. <http://www.childpolicyintl.org>.

Peter McDonald

FAMILY RECONSTITUTION

Family reconstitution is the process of reconstructing historical data on family membership, the relationships among family members, and family change over time from often incomplete registers of vital events and similar sources. The techniques of family reconstitution are an important part of the tool kit of historical demographers.

Historical Development of the Practice

The genealogical renaissance of the late-nineteenth century provided the modern starting point for reconstituting families. Of course, the practice has had a much longer lineage: In the Old Testament there are long lists of family trees and lines of descent. And in later periods, whenever the issues of descent and origins were considered to be of particular importance, genealogies were traced back through the family archives. Much of this early study was one-sided: It usually considered only the male line of descent through first-born heirs (only for royalty and princely houses was a much wider root system considered to be of interest). The late nineteenth century saw the democratization of this practice when it was realized that the vital registers of Renaissance and Reformation states provided a way to study the origins of whole populations. Much of the early effort in this field went to the preservation of records that could be analyzed in a more individualized fashion by private researchers. Any large university library is likely to hold proceedings of nineteenth-century local record societies, along with privately published books detailing the archival rescue work of concerned social investigators from that time.

Before World War II the demographic analysis of these records was a very marginal pursuit. To be sure there was a small controversial literature among economic historians of early industrial England, who argued about whether the population rise of the period from 1750 to 1850 was the result of rising birthrates or falling death rates. But this research was based on aggregative analysis, not the reconstitution of families. The flourishing *Ortsippenbücher* (local kinship books) studies in Nazi Germany, which were concerned to glorify *Blut und Boden* (blood and soil) and thereby enhance the vanishing ties of an increasingly urban society with its landed past, are something of an exception to such a generalization, although the rationale of this first-stage effort of family reconstitution was the concern with racial purity rather than insight into demographic change.

Louis Henry's Pioneering Work

The major breakthrough in the study of historical vital records came in France and can be linked directly to the pioneering work of Louis Henry (1911–1991). In his capacity as director of research at the Institute national d'études démographiques (INED), Henry was asked by French President Charles de Gaulle to determine why Frenchmen (and women) were raising so few children. (This *faiblesse de berceau* [failure of the cradle] had long been an issue in French military thinking.) Henry realized that at least part of the answer to de Gaulle's question called for an understanding of pre-Revolutionary (that is, prior to 1789) demographic dynamics—about which the parish registers of the ancien régime (the pre-Revolutionary political order) provided a unique source of information. Henry set out to exploit these registers, with an eye to demographic issues rather than genealogical ones. He devised a method to rework these primary data by reallocating the vital events recorded by the church into what might be termed demographic units of reproduction.

The first family reconstitution studies were labor intensive. Every baptism (birth), burial (death), and marriage was encoded on a separate piece of colored paper. Henry had chosen the Norman village of Crulai, near the cheese-making town of Camembert, to be his test case. It was a fortuitous choice, because Crulai's vital records ran in an unbroken series from the middle of the seventeenth century until the Revolution. Crulai's vital records were also kept in an exacting manner. For each birth event, for example, not only was the child's name and date of baptism recorded but the village clerk also noted the father's name and occupation and place of residence as well as the mother's father's name, occupation, and place of residence. Even if there were two or three young women called Jeanne Mance living in Crulai at the same time, the chance that they shared all these other individualizing characteristics was virtually nil. Ambiguities of individual identification were all but nonexistent.

The many thousands of color-coded pieces of paper were sorted according to family name, event, date, and so on. Henry (and his research associate, Étienne Gautier) then laboriously assembled these data into family units of reproduction. Each family was assigned its own starting date—the date of a couple's marriage. (Those married outside the village were discarded, wastage that was seen as a necessary cost in establishing a reliable core sample.) Subsequent events were added to the family record until the stacks of color-coded pieces of paper had been reassigned into new units of analysis—units that could answer demographic questions.

Crulai was a propitious choice for substantive reasons, too. Surprisingly, the average age at first marriage for both men and women was the mid-twenties; only 10 percent of all brides were teenagers—the same as the percentage of women who married for the first time after their thirtieth birthday. Henry also discovered that for the cohorts marrying before 1740 there was no discernible difference in age-specific fertility rates between those marrying earlier than average and those marrying later than average, but for the post-1740 cohorts the later-marrying women had higher fertility in their thirties than did their sisters, cousins, and neighbors who differed from them only in marrying earlier than average.

Using the labor of INED students, a national sample of reconstituted village populations was soon created. But if it was thus a fairly straightforward matter to establish the quantitative parameters of ancien régime demography, explaining the results proved to be a far more complicated matter. Indeed, the history of family reconstitution studies in most European countries has followed a similar course: first the establishment of quantitative parameters, then arguments about the meaning of the results.

The statistics derived from family reconstitution studies have provided a veritable mountain of facts.

The interpretation of these facts, however, has not—and indeed cannot—be addressed within a purely demographic form of analysis. In parish register demography of the early modern period the time has clearly come to acknowledge the truth of the twentieth-century English poet Stephen Spender's point:

> Of course, the entire effort is to put oneself
> Outside the ordinary range
> Of what are called statistics.

See also: *Family: History; Hayami, Akira; Henry, Louis; Historical Demography; Laslett, Peter.*

BIBLIOGRAPHY

Dupâquier, Jacques. 1988. *Histoire de la population française,* Vol. 2: *De la Renaissance à 1789.* Paris: Presses universitaires de France.

Gautier, Étienne, and Louis Henry. 1958. *La population de Crulai: Paroisse normande.* Paris: Presses universitaires de France.

Henry, Louis. 1967. *Manuel de démographie historique.* Paris: Presses universitaires de France.

Laslett, Peter. 1965. *The World We Have Lost.* London: Methuen.

Levine, David. 1977. *Family Formation in an Age of Nascent Capitalism.* New York: Academic Press.

———. 1998. "Sampling History." *Journal of Interdisciplinary History* 28: 605–632.

Wrigley, E. A., and R. S. Schofield. 1997. *English Population History from Family Reconstitution, 1580–1837.* Cambridge, Eng.: Cambridge University Press.

David Levine

FAMILY SIZE DISTRIBUTION

A family is often defined as a group of people who are related through marriage, blood, or adoption. The size of this unit depends on the criteria used for establishing membership. One common application of the term *family size* refers to women alone and counts only the number of children born to them. That is the usage that will be employed here.

Suppose that a person asked a woman how many children she had borne and that she replied, "three." Suppose that the person also asked each of those three children how many children his or her mother had borne. The answer should also be "three." For an individual family, there should be no difference between the "family size" of the mother and the "family size" of a child (that is, the number of children borne to the mother of a particular child).

When measurement is extended to a population, on the other hand, these two measures need not and typically will not have the same value. Consider a population in which one-half of the women have one child and the other half have seven. The mean family size among the women is four. But the mean family size among their children will not be four but some larger number. The reason for the discrepancy is that each woman with seven children leaves seven times as many children to testify about her family size as a woman with one child. In this particular example, the mean family size among the children will be $[7(7) + 1(1)]/8 = 6.25$.

It is clear that the relation between the family size of women and the family size of children depends on how much variability exists in the fertility performance of women. If all women had three children, then all children would derive from three-child families and the mean family size of women, three, would be the same as the mean family size of children. But if there is any spread at all in the distribution of women's family sizes, then women with higher fertility will be overrepresented in reports by children about their mother's childbearing.

The formula that relates the mean family size of children, C^*, to the mean family size of women, W^*, is:

$$C^* = W^* + V/W^*,$$

where V is the variance in family sizes among women. If there is no variance in childbearing among women, then C^* will equal W^*. Any variance whatsoever will increase C^* above W^*.

This relationship would be a mere statistical oddity were it not for the huge variability in childbearing among women in most populations. Among women in the United States who had completed childbearing between 1890 and 1970, the mean family size of their children exceeded the mean family size of women by 1.8 to 3.1 children. The mean family size of children was never less than 4.4 during this period. The variance of family size among women often grows in the course of a fertility transition as subgroups of the population develop small family norms while others retain their previous behaviors. When this happens, family sizes among children decline more slowly than family sizes of women or may even rise.

One striking disparity between the two measures of family size occurred in the United States when the low fertility rates of the Great Depression were replaced by the high fertility rates of the baby boom. Women who bore the bulk of their children during the 1930s wound up with about 2.3 children, whereas those at the peak of their childbearing years in the 1950s bore an average of about 2.7. But the mean family size of the Depression-era children, 4.9, was actually higher than that of the baby boomers, 4.5. The reason for the discrepant trends is that the baby boom was accompanied by much lower variability in family sizes among women. Facile attributions of baby boomers' characteristics to their unusually large families were clearly based on a false premise.

There are several other useful implications of the disparity between the two measures. First, one should not try to infer directly the aggregate fertility levels of women in the past from the accounts of their children. Such histories provide a very biased view of fertility in the past unless they are corrected for variability in the distribution of family sizes. Such corrections are rarely undertaken, and the result is that people often gain an inflated impression of the past volume of childbearing from personal testimonials about the fertility of ancestors.

A second implication is that there must be a "revolt against childbearing" each generation simply to keep a population's fertility rate constant. Women must bear, on average, fewer children than their mothers, or a population's level of fertility would rise sharply every generation.

The relation between family sizes of women and family sizes of children is analogous to several other relations in demography. For example, the mean size of a household when households are the unit of analysis is always less than the mean size of households when individuals are the unit of analysis. The schemes employed for calculating mean household size by most statistical offices, which treat each household as one unit, underestimate the size of household as experienced by members of the population. This distortion extends to the classification of households by other criteria as well. For example, only 38 percent of households in the United States in 1980 contained a child under age 17, but 59 percent of the U.S. population lived in a household containing a child. The reason for the discrepancy is that households containing children were, on average, 52 percent larger than the mean for all household types.

See also: *Childlessness; Fertility, Below-Replacement.*

BIBLIOGRAPHY

Bongaarts, John. 2001. "Household Size and Composition in the Developing World in the 1990s." *Population Studies* 55: 263–279.

Burch, Thomas K. 1972. "Some Demographic Determinants of Average Household Size: An Analytic Approach." In *Household and Family in Past Time,* ed. Peter Laslett. New York: Cambridge University Press.

King, Miriam, and Samuel H. Preston. 1990. "Who Lives with Whom? Individual versus Household Measures." *Journal of Family History* 15: 117–132.

Preston, Samuel H. 1976. "Family Sizes of Children and Family Sizes of Women." *Demography* 13: 105–114.

SAMUEL H. PRESTON

FAMILY SIZE INTENTIONS

There have been survey respondents—women or couples—perhaps predominant in some populations, that were unable or unwilling to report family size preferences. However, virtually all contemporary populations, and very likely all future ones, will consist primarily of persons or couples who strategize about family size. Clearly, declining family size preferences constitute a primary cause of fertility transition and will influence post-transition fertility levels. In societies undergoing fertility transition, observed fertility frequently exceeds stated preferences; in post-transition countries of the 1990s the opposite was true. The study of emerging and changing family size preferences and their relation to behavior provides clues to the nature of fertility decision-making and to the causes of fertility trends and differentials.

Conceptualization and Measurement

An initial distinction should be made between *one's own* family size preferences or goals and those deemed appropriate for the *average* or *typical* family. The latter concept, usually referred to as "ideal family size," assumes a set of time/place-specific norms or expectations regarding appropriate family size. A common survey item of the 1960s in the United States asked: What number of children do you consider ideal for the typical (American) family? Samples of U.S. women in the 1960s produced modal responses of "two" but substantial proportions chose "three" or "four" children.

The collection and use of data on the ideal family size item has diminished over time. Several reasons account for this waning interest. By the 1980s "two children" had become the predominant ideal family size response, but part of this convergence could be attributed to the widespread public perception that population growth could not continue and that an average of two children per woman was required for population stabilization. Also, the declining prevalence of two-parent families in the period from 1960 to 1990 (along with reduced agreement regarding what constituted "the typical family") exposed the contingent nature of family size norms. If appropriate family size depends on individual and couple characteristics (e.g., marital status, economic status), then useful survey questions need to make explicit the situational context. Finally, some have argued that family size norms would be better represented by questions that asked about a range of acceptable family sizes (e.g., what family size is too small? too large?).

One's own family size preferences are anchored in the life course, represented by upward sloping 45° life lines in Figure 1. Person *A* was age 15 in 1965 and was age 50 in 2000. Person *B* was born 25 years later than *A*, reached age 15 in 1990 and 25 in 2000. Let it be assumed that both women were interviewed in January 2000 (represented by a vertical line) and were asked about their past or "retrospective" fertility behavior (solid part of life line) and their future or "prospective" behavior (dashed part of line). Family size preferences are embedded in both retrospective and prospective life line segments.

Prospective Intent

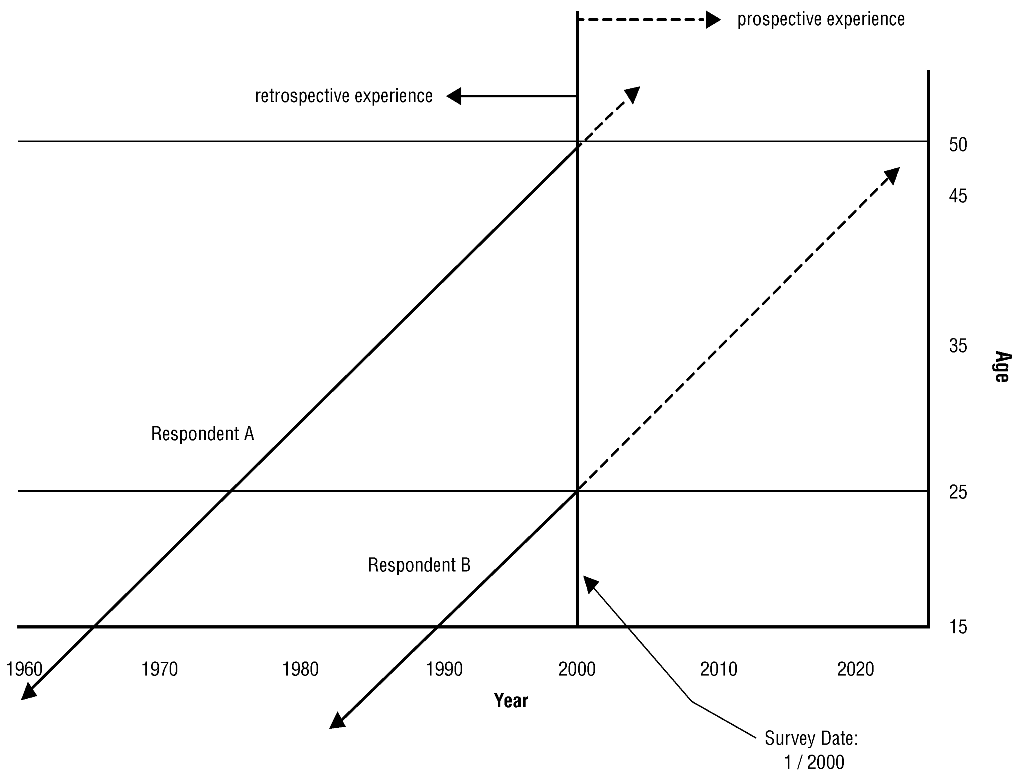
Commonly used prospective questions ask the respondent (for example, respondent *B* at age 25): Do you intend to have a (or another) child? (And if yes) "How many more children do you intend to have?" These questions raise two fundamental issues. The first is whether fertility intentions—or fertility expectations or fertility desires—should be of paramount, substantive interest. Intentions reflect the respondent's goals (what the respondent plans to do) and, as such, should be strongly linked to subsequent behavior in environments where fertility is controlled. In contrast, expectations invite (sometimes explicitly, but often implicitly) a consideration of impediments that might interfere with one's intentions (such as contraceptive failure or subfecundity) and produce an under-estimate or over-estimate of future fertility. Fertility desires require an even more hypothetical exercise that is linked closely to the concept of "demand for children" (the number of children one would intend if there were no subjective or economic costs to fertility control) and might be seen as a determinant (along with constraints and contingencies) of fertility intentions.

Empirical evidence indicates that many respondents do not detect the differences between these terms or are unable or unwilling to perform the implied conceptual tasks that distinguish them. Further, the demographic literature frequently refers to these questions as family size preferences and ignores the distinctions noted above. Nevertheless, following the admonition that one should ask respondents straightforward questions, intentions seem preferable. Intentions are knowable to the respondent, and thus measurable from respondent reports, and are conceptually important. Intentions are likely to be the stable and dominant component of responses to intended/expected/desired fertility questions. If one wants respondents to consider the additional contingencies implied by expectations or desires, then specific additional questions should be devised to supplement intention questions.

The second issue raised by this pair of questions (i.e., Do you intend a [or another] child? How many more?) is whether prospective intentions are best

FIGURE 1

Lexis Diagram Showing Individual Life Lines Intersected by a 2000 Survey



SOURCE: Author.

represented as a *fixed target* or as a *set of sequential decisions.* Prior to the 1960s, inquiries concerning fertility intentions were linked closely to a *fixed target* model (individuals or couples "formulate a desired completed family size and pursued this relative constant target throughout their reproductive life" [Lee, p. 205]). The fixed target model combined with reports of children already born allowed operationalization of *intended parity.* For example, person *B* in Figure 1 is 25 years of age at the time of the survey. Her intended parity is the sum of births to date and her reported intended additional births. Mean intended parity for cohorts has frequently been used to anticipate future fertility trends. The accuracy of forecasts based on intended parity depends on the predictive validity of reproductive intentions as explained below.

Fertility researchers have raised serious concerns about the fixed target model. Specifically, strong substantive arguments and substantial empirical work suggest that fertility decisions are better represented as a series of sequential decisions. Children are generally born one at a time, thereby imposing a set of birth intervals. These intervals allow for a set of sequential decisions or at least for reassessments of earlier decisions. Empirical evidence shows that respondents frequently do revise their intentions/behavior based on changed circumstances. Key to this sequential perspective are the claims that: some births may be normative (first and second) and others less so (third births); experience with prior births may affect the decision to have subsequent births; and some relevant factors change in unanticipated ways, and unanticipated factors can affect decisions. The distinction between fixed target and sequential models is important because it challenges whether a numerical intention (for example, two versus three additional children) has any behavioral consequence in abstraction from the current sequential decision (that is, to have another child).

Retrospective Intent

Turning to retrospective experience (i.e., solid lines in Figure 1), demographers have developed a standard procedure and terminology for identifying "wanted" and "unwanted births." Specifically, respondents are asked to recollect their fertility intention at the time of each pregnancy: "At the time you became pregnant did you: want to become pregnant at that time; want to have children in the future, but not now; or not want any additional children?" The first two responses are coded as wanted (although the second is termed a timing failure) and the third category as unwanted. For women who have completed childbearing (e.g., woman *A* in Figure 1), wanted fertility reflects women's family size preferences and unwanted fertility a component that could have been avoided by effective birth control. The unwanted component of fertility declines as effective contraception and abortion become widely available.

Additional Measures Derived from Birth Intentions

Prior discussion has focused on an individual life line or (its aggregate equivalent) a cohort. However, much fertility estimation is period-based—it answers the question: What is the level of fertility in a given year? The most commonly used/reported measure of period fertility is the total fertility rate, TFR (the number of births a woman would have if she experienced a given set of period age-specific fertility rates). A related concept is the "wanted total fertility rate": What would the TFR be if unwanted births were identified (as described above) and excluded? John Bongaarts in his work of 1990 proposes an alternative measurement based on more limited data. Specifically, using only prospective fertility intentions (asked in a 2000 survey) births in the previous year (1999 to 2000) are divided into wanted and unwanted. The key assumption is that, for each woman, all births to point *t* on a life line are wanted and all subsequent births are unwanted. Thus, if a woman wants more children in 2000, then a birth last year must have been wanted. In addition, each woman must have one "last wanted birth." Together these observations/assumptions allow calculation of the wanted total fertility rate (or its complement, the unwanted TFR, given by unwanted TFR = TFR − wanted TFR).

Fertility intentions also allow measurement of the "unmet need for contraception." If a sexually active woman intends no more children but is not using contraception, then she is at risk of an unwanted pregnancy (she has an unmet need for contraception). Important programmatic efforts aim to make contraception available to those in need. If large proportions of women have an unmet need for contraceptives, then unwanted conceptions will be common. Programmatic success could be measured by declines in unmet need (and fewer unwanted conceptions).

The Predictive Validity of Reproductive Intentions

Suppose that social, economic, and psychological variables are linked to fertility only through fertility intentions. In other words, all relevant factors affect intentions directly and intentions mediate these more distal effects. Indeed, numerous studies show that fertility intentions predict the subsequent behavior of individuals far better than do demographic and social indicators. However, evidence also clearly indicates a more complex process that produces patterned inconsistency between intentions and behavior. Specifically, some groups are better than others at predicting their future behavior; that is, there is an *interaction* of intent with covariates (e.g., O'Connell and Rogers 1983; Van de Giessen 1992). In addition, some subgroups/periods have higher fertility than others net of intentions, that is, there is a direct effect of group membership/period that bypasses the proximate intention variable (e.g., Thomson 1997; Schoen, Astone et al. 1999). The fact that fertility differences or changes are not always foreshadowed by different or changed intentions challenges the usefulness of intention data for fertility forecasts. In explaining the failure of 1970 intentions data to anticipate the fertility decline between 1970 and 1975, Charles F. Westoff and Norman B. Ryder reasoned that "respondents failed to anticipate the extent to which the times would be unpropitious for childbearing. . .the same kind of forecasting error that demographers have often made" (p. 449). Thus, intentions and other preference measures can provide clues to future trends and differences, but they should not be expected consistently to perform as reliable indicators of future individual or aggregate behavior.

Variation in the predictive validity of fertility intentions provides clues to the fertility decision-making processes. For instance, predictive validity increases if the time frame for the expected behavior is explicit. Consider a pair of twenty-five-year old U.S. women. Both intend to have a first child. But one intends a child soon (within two years) and the other intends to postpone the first birth for at least five years. Research shows that such women behave very differently in the short run (e.g., Rindfuss, Morgan, Swicegood 1988: Chapter 9). Thus, in addition to affirmative and negative responses (to "Do you intend another child?"), a viable strategy—and response—is "wait and see" or "not right now." A question asking if a child is intended in the next few years mimics the operative decision that women or couples make. Cross-national empirical evidence indicates that many women want to postpone the next birth (Lightbourne 1987). Postponement leaves open the possibility that births delayed may be foregone. For instance, substantial research indicates that most U.S. childlessness results from a series of decisions to postpone childbearing—rather than from stable childless intentions from a young age.

Despite credible arguments to the contrary, evidence indicates that aggregate preferences of women and men are quite similar (Mason and Taj 1987) and that couples frequently agree on fertility goals (Mason and Smith 2000; Morgan 1985). Nevertheless, consistency between intention and behavior is greater when partners agree (Thomson 1997; Schoen, Astone et al. 1999). Finally, predictive validity increases if one considers the respondents' level of certainty about their stated intention. Some respondents freely admit that they may change their mind or are uncertain whether they will have another child.

See also: *Childlessness; Family Planning Programs; Fertility, Below-Replacement; Sex Selection; Unwanted Fertility.*

BIBLIOGRAPHY

Bongaarts, John. 1990. "The Measurement of Wanted Fertility." *Population and Development Review* 16: 487–506.

———. 2001. "Fertility and Reproductive Preferences in Post-Transitional Societies." *Global Fertility Transition,* eds. Rodolfo. A. Bulatao and John. B. Casterline. New York: Population Council.

Lee, Ronald D. 1980. "Aiming at a Moving Target: Period Fertility and Changing Reproductive Goals." *Population Studies* 34: 205–226.

Lightbourne, Robert E. 1987. "Reproductive Preferences and Behavior." *The World Fertility Survey: An Assessment,* ed. J. Cleland and S. Chris. Oxford: Oxford University Press.

Mason, Karen. O., and Herbert L. Smith. 2000. "Husbands' Versus Wives' Fertility Goals and Use of Contraception: The Influence of Gender Context in Five Asian Countries." *Demography* 37(3): 299–311.

Mason, Karen. O., and Anju M. Taj. 1987. "Differences Between Women's and Men's Reproductive Goals in Developing Countries." *Population and Development Review* 13: 611–638.

Morgan, S. Philip 1985. "Individual and Couple Intentions for More Children: A Research Note." *Demography* 22: 125–132.

O'Connell, Martin., and Carolyn C. Rogers. 1983. "Assessing Cohort Birth Expectations Data from the Current Population Survey, 1971–1981." *Demography* 20: 369–384.

Rindfuss, Ronald R., S. Philip Morgan, et al. 1988. *First Births in America.* Berkeley, CA: University of California Press.

Ryder, N. B., and C. F. Westoff. 1971. *Reproduction in the United States.* Princeton, NJ: Princeton University Press.

Schaeffer, N. C., and E. Thomson. 1992. "The Discovery of Grounded Uncertainty: Developing Standardized Questions about Strength of Fertility Motivation." *Sociological Methodology* 22: 37–82.

Schoen, R., N. M. Astone, et al. 1999. "Do Fertility Intentions Affect Fertility Behavior?" *Journal of Marriage and the Family* 61: 790–799.

Thomson, E. 1997. "Couple Childbearing Desires, Intentions and Births." *Demography* 34: 343–354.

van de Giessen, H. 1992. *Using Birth Expectation Information in National Population Forecasts. National Population Forecasting in Industrialized Countries.* N. a. H. C. Keilman. Amsterdam: Swets and Zeitlinger.

van de Walle, E. 1992. "Fertility Transition, Conscious Choice and Numeracy." *Demography* 29: 487–502.

Westoff, C. F., and N. B. Ryder. 1977. "The Predictive Validity of Reproductive Intentions." *Demography* 14: 431–453.

S. Philip Morgan

FAMINE, CONCEPTS AND CAUSES OF

Famines usually have demographic causes as well as consequences, and the deaths that result from famines offer a ready means of ranking them. However, defining famine remains a controversial issue. Traditionally famines entailed both a decline in the food supply and excess mortality, but in the twenty-first century a looser definition encompassing periods of chronic hunger in which neither food availability decline (FAD) nor excess mortality is present holds sway. Even confining attention to "famines that kill" leaves room for ambiguity. On the one hand, famines that produce excess mortality usually only represent peaks in chronic or endemic malnutrition that renders "normal" mortality high. On the other hand, famine deaths are often difficult to distinguish from deaths caused by infectious diseases such as malaria and cholera. It follows that the dividing line between crises that reduce the resistance of the poor to disease and harvest shortfalls that result in literal starvation is not always clear-cut.

Why Famines?

Throughout history poor harvests resulting from ecological shocks often have been the proximate cause of famines. Well-known examples include the eruptions of the volcanoes Laki (Iceland in the 1780s) and Tambora (Indonesia in the 1810s); Phytophthora infestans, or potato blight (Europe in the 1840s); and the El Niño drought (Asia in the late 1870s). However, such exogenous shocks were neither a necessary nor a sufficient cause of famine. In sufficiently poor economies the yield variation of the staple crop or crops was enough to produce a famine every decade or two. Back-to-back or repeated harvest shortfalls such as those that occurred in Ireland in the 1840s, India in the 1890s, and China in 1958–1960 have tended to produce the worst famines. Major famines have rarely been the product of livestock deaths alone. The severity of such crises also depended on other factors, such as the effectiveness of relief, the quality of the bureaucracy, the size of the voluntary sector, and the threat or presence of warfare in the affected area.

However, for the economist T. R. Malthus overpopulation, which may be defined as a state in which a significant proportion of the population is close to the margin of subsistence, was the fundamental reason for famines. When in 1798 he described "gigantic inevitable famine" as nature's response of last resort, Malthus would influence both the policy and the analytical response to famines for a long time to come.

The connection between famine and overpopulation may be looser than Malthus asserted, but there can be little doubt that throughout history overpopulation has increased vulnerability to famine. The reason is obvious: Historically, those close to subsistence were in no position to save, trade down to more economical foods, or guard against attendant infectious diseases.

Amartya Sen (1981) and others claim that this Malthusian interpretation is less relevant to twentieth-century famines. Though not denying a role for harvest-induced reductions in food availability, Sen emphasizes the impact of market-induced shifts on the purchasing power, or "entitlements," of certain sectors of the population. Sen first applied this entitlements approach to the Great Bengal Famine of 1942–1943, arguing that hoarding and speculation on the part of producers and merchants at the expense of the landless poor, rather than a significant harvest shortfall *per se*, were responsible for the crisis. In this case misjudgments by producers forced prices higher than were justified by food availability and beyond the reach of the poor. Other studies point to the role of market failure in exacerbating famines in Bangladesh in 1974 and in Sudan and Ethiopia in the 1980s. Research on how markets function during famines remains thin, however. Meanwhile Sen's focus on shifting entitlements in the absence of FAD points to the difficulty of imagining *any* famine in which bigger transfers of purchasing power from the rich to the poor would not reduce mortality.

The Demographic Impact

Because famines have nearly always affected backward economies, their human toll is often difficult to measure. In the absence of civil registration, as in Ireland in the nineteenth century and in the Ukraine and China in the twentieth, the highest and lowest estimates of mortality sometimes are set by ideologues. Estimates of excess mortality in the Ukraine in the 1931–1932 famine range from 2 million to 8 million, whereas those of deaths from the Chinese Great Leap Forward famine range from 15 million to 43 million. Claims that the Great Leap famine was the largest in history gloss over uncertainties about its true toll and ignore estimates of 20 million to 30 million deaths from famine in China between 1876 and 1900 and a further 12 million to 20 million in India in the same period.

Alhough as many as 70 million people died of famine during the twentieth century, in relative terms famine-related mortality was lower than it had been in previous centuries. In Europe the retreat of famine has been a long process. Famine has not been a significant factor demographically in England since the sixteenth century or in France since the early eighteenth century, but much of Europe was subjected to famine in 1740–1741 and 1817–1819. In Ireland the famine of 1740–1741 killed proportionately more people than did the more famous potato famine of the 1840s. Europe's last major subsistence crisis was the Finnish famine of 1868.

In the twenty-first century, for the first time in history, only pockets of the globe, such as parts of Africa, Afghanistan, and North Korea, remain truly vulnerable to the threat of famine. For all the publicity attending modern famines (useful from a humanitarian aid standpoint), their demographic impact is minor. Although it would be naive to rule out more "political" famines in the future, there is little likelihood of population outstripping global food-producing capacity in the next generation or two.

Famines that kill more than a few percent of a country's population are unusual. Exceptions include the "haze famine" that killed one-fourth of Iceland's population in the wake of the eruption of Laki in June 1783 and the famine that killed the same proportion of the population of Cape Verde in the mid-1850s. However, those famines occurred in very small places. The Chinese famine of 1958–1960, so atrocious in absolute terms, killed at most 2 to 3 percent of the total population of China.

Throughout history most famine victims succumbed not to literal starvation but to infectious diseases. In Ireland in the 1840s, for example, only about one victim in ten died of starvation, broadly defined. Suppression of the immune system from malnutrition increased vulnerability to infectious diseases such as typhoid fever, cholera, and dysentery/diarrhea. Other deaths were attributable to a wide range of partially hunger-sensitive diseases. Famines kill the very young and the very old disproportionately, but those groups are also the most vulnerable in normal times. Women tend to be better at resisting malnutrition, mainly for physiological reasons. Births decline as a result of reductions in sexual activity and in women's capacity to bear children. When the worst of the crisis is over, deaths typically fall below trend for a year or two and births rise above it. This raises the conundrum of whether estimates of the demographic toll of famines that include averted births during famines should also include deaths averted and births induced in its wake. Migration may exacerbate famine by spreading infection (as in Finland in 1868); alternatively, it may act as a form of disaster relief by reducing the pressure on resources, as occurred in Ireland in the 1840s.

The changing role of medical science in reducing mortality from infectious diseases is an interesting issue. Long before the discoveries of the scientists Robert Koch and Louis Pasteur the risks associated with being near fever victims were well understood, though the mechanisms of contamination were not. Moreover, there was a long lag between scientific diagnosis and remedies such as penicillin and electrolytes. In the twentieth century there have been famines in which infectious diseases were the main killers (e.g., Bengal in the 1940s and Ethiopia in the 1970s) and famines in which they killed few people (e.g., Mykonos in 1942–1943 and the western Netherlands during the *Hongerwinter* of 1944–1945). The key seems to be whether infectious diseases are endemic in normal times: If they are, they bulk large when famine strikes.

Public Action

When threatened with famine, in the past the poor relied on compassion on the part of the ruling class and the fear of infection and social unrest. Rarely have such sentiments been enough. In the ancient world capital cities tended to be the best organized for famine relief. Christian ideology may have helped marginally because it called for the rich to be charitable. Although Malthus denied the right of the hungry citizen to subsistence, rulers have long implicitly acknowledged a responsibility to help. They employed a variety of strategies: the maintenance of public granaries, institutionalized care through poor laws, workfare, improvised soup kitchens, and migration schemes. Private charity has rarely been enough in times of severe harvest failure. The record suggests that particularly when a crisis persists, compassion fatigue sets in. In the twenty-first century international relief, both governmental and nongovernmental, supplements local efforts, but with the attendant danger that it shifts responsibility from local elites and oligarchs.

For those early disciples of Malthus who regarded famines as a providential response to overpopulation, public intervention risked leading to even worse famines later. In Ireland and in the Netherlands in the 1840s as in India in the late 1870s there was thus a tension between Malthusian ideology and measures that would minimize mortality. In practice public action was, and still is, often complicated by the problem of agency. Antisocial behavior is an inevitable concomitant of famine: Theft increases, and hospitality diminishes.

Informal systems of mutual help may work at first, but their effectiveness does not last. Concern with cheating is a prominent aspect of controversies about relief policy. The Irish experience in the 1840s is illustrative in this respect. Relief through a system of workfare was initially seen as the best way around such problems, but this was ill geared to help the physically weak and exacerbated the spread of infectious diseases. When it was replaced by food aid, the food was distributed in a non-resalable form in order to minimize abuse. Once the authorities deemed the crisis over, the onus shifted back to reliance on the workhouses established under the Irish poor law of 1838. In Ireland as elsewhere, worries about free riders ended up hurting the vulnerable. The choice between public works schemes and soup kitchens is still a matter of debate.

Post-Famine Adjustment

Malthus saw famine as a harsh remedy that "with one mighty blow level[ed] the population with the food of the world." There is no doubt that in the short run at least famines result in higher living standards for the majority of survivors. To the extent that famines reduce the population but leave largely intact the land endowment and physical capital, famines improve the lot of surviving workers relative to farmers and landowners. The impact on landowners may be intensified by the burden of relief spending. However, if the chaotic conditions that often precede famines prevent landowners from enforcing their property rights, they too may find their incomes rising once normality has been restored.

But are these "benefits" lasting? One consideration is that the gains in terms of higher wages and a higher land–labor ratio may be offset by the long-run impact of famine on the health of affected survivors. Another consideration is whether population growth tends to fill the demographic vacuum left by famine. Good examples are Finland in 1868 and France in the 1690s and 1700s, where the demographic dents made by major famines were repaired within a few years. The evidence is not unanimous, though: In pre–Black Death England in the wake of the agrarian crisis of the 1310s, in post-famine Ireland, and in Tokugawa Japan the demographic damage done by famine persisted. In Ireland the lack of a demographic "rebound" was due at least in part to an increasing resort to the preventive check through later and fewer marriages.

See also: *Food Supply and Population; Nutrition and Calorie Consumption.*

BIBLIOGRAPHY

Bowbrick, Peter. 1986. "A Refutation of Sen's Theory of Famine." *Food Policy* 11(2): 105–124.

Davis, Mike. 2000. *Late Victorian Holocausts: El Niño Famines and the Making of the Third World.* London: Verso.

Devereux, Stephen. 2000. "Famine in the Twentieth Century." Institute of Development Studies Working Paper No. 105, Brighton, Eng.: IDS.

Drèze, Jean, and Amartya K. Sen. 1989. *Hunger and Public Action.* Oxford: Oxford University Press.

Dyson, Tim. 1991. "The Demography of South Asian Famines." *Population Studies* 45(1): 5–25 and 45(2): 279–297.

Dyson, Tim, and Cormac Ó Gráda, eds. 2002. *Famine Demography: Perspectives from the Past and Present.* Oxford: Oxford University Press.

Garnsey, Peter. 1988. *Famine and Food Supply in the Graeco-Roman World.* Cambridge, Eng.: Cambridge University Press.

Hionidou, Violetta. 2002. "'Send Us Either Food or Coffins': The 1941–2 Famine on the Aegaean Island of Syros." In *Famine Demography: Perspectives from the Past and Present,* ed. Tim Dyson and Cormac Ó Gráda, eds. Oxford: Oxford University Press.

Lachiver, Marcel. 1991. *Les Années de Misère: La Famine au Temps du Grand Roi.* Paris: Fayard.

Lomborg, Bjørn. 2001. *The Skeptical Environmentalist: Measuring the Real State of the World.* Cambridge, Eng.: Cambridge University Press.

Lumey, L. H. 1998. "Reproductive Outcomes in Women Prenatally Exposed to Undernutrition from the Dutch Famine Birth Cohort." *Proceedings of the Nutrition Society* 57: 129–135.

Mokyr, Joel, and Cormac Ó Gráda. 2002. "Famine Disease and Famine Mortality: Lessons from the Irish Experience, 1845–1850." In *Famine Demography: Perspectives from the Past and Present,* ed. Tim Dyson and Cormac Ó Gráda. Oxford: Oxford University Press.

Ó Gráda, Cormac. 1999. *Black '47 and Beyond: The Great Irish Famine in History, Economy and Memory.*, Princeton, NJ: Princeton University Press.

———. 2001. "Markets and Famines: Evidence from Nineteenth Century Finland." *Economic Development and Cultural Change* 49(3): 575–590.

Pitkänen, Kari J. 1993. *Deprivation and Disease: Mortality during the Great Finnish Famine of the 1860s.* Helsinki: Finnish Demographic Society.

Ravallion, Martin. 1987. *Markets and Famines.* Oxford: Clarendon Press.

Riskin, Carl. 1998. "Seven Lessons about the Chinese Famine of 1959–61." *China Economic Review* 9(2): 111–124.

Sen, Amartya. 1981. *Poverty and Famines.* Oxford: Oxford University Press.

von Braun, Joachim, Tesfaye Teklu, and Patrick Webb. 1998. *Famine in Africa: Causes, Responses, and Prevention.* Baltimore: Johns Hopkins Press.

Watkins, S. C., and J. Menken. 1985. "Famines in Historical Perspective." *Population and Development Review* 11(4): 647–675.

Cormac Ó Gráda

FAMINE IN AFRICA

In the second half of the twentieth century, sub-Saharan Africa stood out as the region of the world with the slowest growth in agricultural production and the highest rate of population growth. Its population also suffers from the highest rates of undernutrition worldwide. The combination of a poorly nourished but rapidly growing population increases the region's vulnerability to food crises, both natural and man-made. Other factors, however, are needed to explain why periodic famines have struck Africa south of the Sahara in the twentieth century more frequently than other regions. Table 1 summarizes the recent African experience.

Context

Famines figure prominently in African history. John Iliffe has described famine conditions during the colonial period in eastern and southern Africa and Michael Watts has discussed the complex relationships between colonial policies and household production that produced food crises in northern Nigeria continuing into the 1970s. Many food crises in the past were unlikely to have been noticed by outsiders. An exception may have been the francophone countries of the Sahel, where routine reporting of food prices and epidemics were part of the centralized administrative system of the colonial period. In the twenty-first century, the chances of food shortages being noticed are much greater thanks to networks such as the Famine Early Warning System (FEWS) organized by the U.S. Agency for International Development (USAID). Many recent famines in Africa, as Joachim von Braun and others have documented, stem from wars that disrupted food production, distribution, and consumption systems. The food crises of the early 1970s that affected the whole Sahel region, however, seem to have been triggered by a series of exceptionally dry years in a period of longer-term reduction in annual rainfall amounts. Inter-annual rainfall variability increases as total amounts decline. Additional physical challenges to African food producers include tropical soils that are not conducive to high levels of perennial productivity. In the Sahel, cereals such as sorghum and millet contain much lower energy per unit of weight than maize, wheat, and other temperate climate cereals.

The challenges of the physical environment are compounded by under-capitalization of the agricultural sector and by institutional barriers such as land

TABLE 1

Major African Famines in the Later Twentieth Century

Region	Years
Nigeria (Biafra)	1968–1969
Sahel region	1969–1974
Ethiopia	1972–1974
Angola	1974–1976
Zaire (Bas Fleuve)	1977–1978
Uganda	1980
Mozambique	1982–1983
Sahel region	1982–1985
Sudan	1984–1985
Horn of Africa	1983–1985
Mozambique	1985–1986
Sudan	1988
Somalia	1988
Ethiopia/Horn of Africa	1989–1990
Liberia	1992–1993
Somalia	1992–1993
Sudan	1993
Angola	1993–1994
Liberia/Sierra Leone	1995–1996
Zaire/Congo	1997
Sudan	1998

SOURCE: von Braun, Teklu and Webb (1999), Table 1.1.

tenure and sharecropping arrangements that do not compensate individual farmers for productive improvements. Most Sahelian farmers rely heavily on manual labor and have very limited access to machinery even for plowing, seeding, or harvesting. In West Africa much of the cereal cultivation, especially rice, is in the hands of women, whose access to capital and loans is limited. Further, land is generally owned communally and variants of the open-field system still operate. Where available, land that is not in communal cultivation may be allocated to enterprising individuals by local leaders, but only for the time those individuals cultivate the field. In some communities, ethnicity and class restrict access to land, water, and the labor needed to farm. Probably most significant is the low level of development of commercial agriculture except in a few more favored areas. The small external market for millet and sorghum, and for the roots and tuber crops common in the forest belt, discourages the development of capital investments, ports, and communications to the interior.

Causes

The most common explanation of the causes of famine used to be ecological: The consumption needs of a growing population outstrip the capacity of local farming systems to produce food. The famine of the western Sahel in the early 1970s is a clear example of famine initiated by drought. The scholars von Braun, Tesfaye Teklu, and Patrick Webb have proposed a more complex model in which population growth and environmental changes contribute only to a small extent to food shortages. An important if understudied factor is the growth of the population of animals, particularly sheep and goats instead of cattle, that has contributed to rangeland deterioration and the relocation of pastoralists to increasingly marginal areas. In more recent case studies, including work by Alexander de Waal in Sudan, more emphasis is laid on institutional, organizational, and policy failures. Other precipitating causes of famine include civil wars and ethnic disputes. The low investment in roads and railways, which has been shown to prevent famine by allowing the speedy movement of food between markets, increases poor families' vulnerability to famine. Trade barriers (the constraints on some agricultural imports by the European Union, for example) and the penetration of North American agricultural exporters into African grain markets are additional factors contributing to inadequacies of domestic food production.

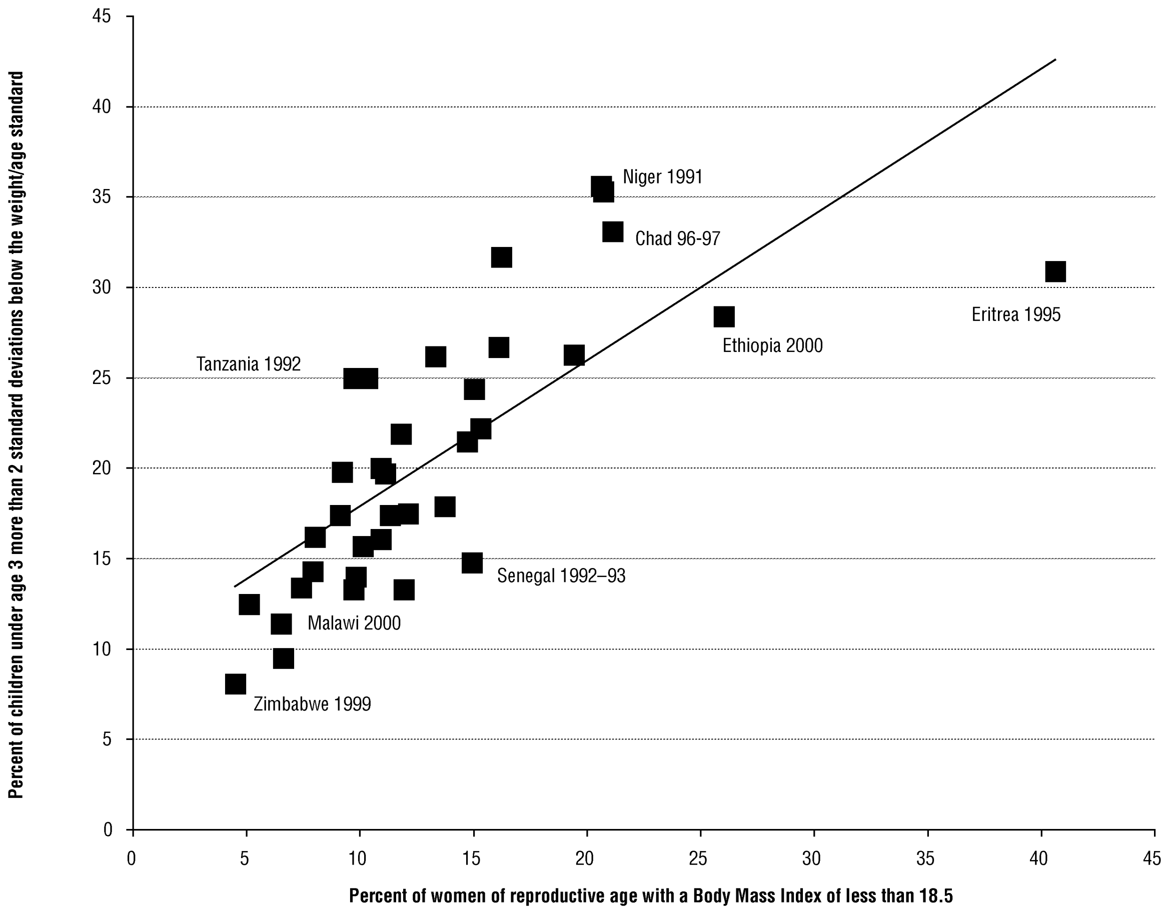
The economist Amartya Sen has mounted a strong challenge to the notion that famines are the result of absolute shortages of food. He argued that in most famines there is generally sufficient food, but some people lose the capacity to acquire food due to the collapse of the demand for their labor or the goods and services they produce. They thus lose their "entitlements" to purchase food, while others manage to retain control over dwindling food stocks. The people who are most affected are not the food producers themselves but those in the service trades in towns and cities whose customers, when times are hard, manage without the personal and professional services they offer.

Policy Responses

Sen's work has greatly influenced policies on food aid generally and on famine relief in particular. Although food is still sent to relieve famine in Africa, many donors now focus on restoring people's entitlements through food-for-work schemes or other forms of public works support. This response is based on the successful famine relief measures adopted in the Indian subcontinent, where massive government intervention has prevented a major famine since the Bangladesh famine of 1973. Jean

FIGURE 1

Indicators of Undernutrition among Children and Women in Selected African Countries



SOURCE: Data from the DHS survey data archive available at <www.macroint.org>.

Drèze and Sen have written extensively on the differing origins and policy responses in the Indian subcontinent and in Africa. The notion of food security is now well established and a variety of policies have been implemented to ensure that food is accessible to the poor and to vulnerable subpopulations through micro-credit enterprises and local food reserves. But many of the underlying causes of famine, including poor transport facilities and the undercapitalization of agriculture, have yet to be addressed. Bodies such as the International Livestock Research Institute in Kenya and Ethiopia, the West African Rice Development Association, and the International Institute for Tropical Agriculture as well as other members of the Consultative Group on International Agricultural Research (CGIAR) have made significant contributions to increasing the productivity of some important tropical food crops.

Effects

Disastrous mortality is the effect popularly associated with famine. Detailed studies such as Sen's work on the Bengal famine of 1943, however, show that most of the excess deaths attributable to famine occur not at the time of most acute food shortage but in the ensuing period. The general conclusion, stemming from work by de Waal on Darfur, Sudan from 1984 and 1985, is that famine is just one among many symptoms of social and economic disruption. The excess death rates are then seen largely as the result of a subsequent "health crisis" in which infectious and parasitic diseases cause the excess deaths.

This and the entitlements idea has led to extensive criticism of the food aid "industry" as an inappropriate means to relieve both short- and long-term hunger in poor countries. Rather than focusing on inadequacies of food availability, public attention is now directed more to the distributional effects of economic crises and their consequences—including famine.

Famines have periodically driven people off the land or have forced some reorganization of agriculture, generally away from pastoralism and into both subsistence and commercial agriculture. The urban bias in development has worked against attracting well-educated people and their capital into the agriculture sector. Westernization of the urban diet has reduced the demand for locally produced foodstuffs among those people able to pay the highest prices for food. Sub-Saharan Africa is thus now highly dependent on imported food.

The full implications of widespread undernutrition in Africa are impossible to gauge, but the effects of undernutrition in pregnancy are well known and contribute to the generally low birth weights and poor growth curves of African children. Large proportions of both women and their children are seriously undernourished in the Sahelian countries, Ethiopia, and Eritrea, and indicators of undernutrition also signal serious deficiencies in other African countries, as shown in Figure 1. Undernutrition and periodic starvation adversely affect both the physical and the mental development of children. Fecundity is not affected: even among poorly nourished women, total fertility rates as high as eight children have been recorded.

See also: *Food Supply and Population; Nomads; Nutrition and Calorie Consumption.*

BIBLIOGRAPHY

De Waal, Alexander. 1989. *Famine that Kills: Darfur, Sudan 1984–1985.* Oxford: Clarendon Press.

Drèze, Jean, and Amartya Sen. 1989. *Hunger and Public Action.* Oxford: Clarendon Press.

Iliffe, John. 1990. *Famine in Zimbabwe, 1890–1960.* Gweru, Zimbabwe: Mambo Press.

Mortimore, Michael. 1989. *Adapting to Drought: Farmers, Famines and Desertification in West Africa.* Cambridge, Eng.: Cambridge University Press.

Sen, Amartya. 1981. *Poverty and Famines: An Essay on Entitlement and Deprivation.* Oxford: Clarendon Press.

von Braun, Joachim, Tesfaye Teklu, and Patrick Webb. 1999. *Famine in Africa: Causes, Responses and Prevention.* Baltimore, MD: Johns Hopkins University Press for the International Food Policy Research Institute.

Watts, Michael. 1983. *Silent Violence: Food, Famine and Peasantry in Northern Nigeria.* Berkeley and Los Angeles: University of California Press.

Allan G. Hill

FAMINE IN CHINA

There is no complete record of periods of famine in China, but there is no dispute that there were many—although few that were countrywide. From early in China's history the development of physical and social infrastructure would have helped to minimize the effects of famine: irrigation canals and dikes were built to counteract the vagaries of the weather, and administrative measures were adopted to ensure reserve supplies of essential food items and to establish systems of food and seed rationing and distribution. Nevertheless, famine was plausibly one of the factors slowing the long-run increase of China's population to barely perceptible levels until the seventeenth century.

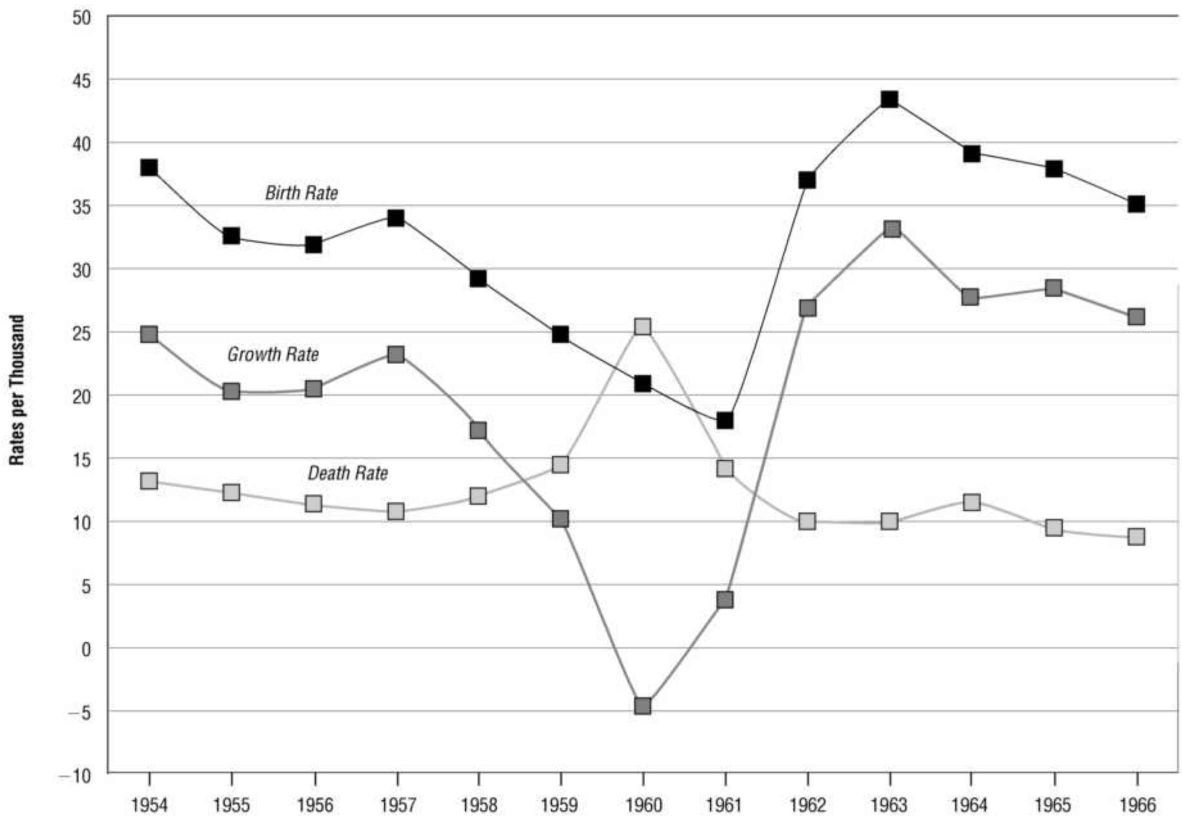
The faster rate of population growth observed over the subsequent two centuries occurred despite the destruction wrought by rebellions, banditry, invasion, and civil war. These events ended with the establishment of the People's Republic in 1949, and the pace of growth rose markedly: China's population doubled in the following half-century. Yet it is during this period that the most destructive famine of China's history occurred, the famine of 1958–1961, associated with the policy known as the Great Leap Forward.

Scale of the 1958–1961 Famine

One of the key programs of the new Communist regime was a far-reaching and comprehensive land reform. Peasants were organized in mutual aid teams,

FIGURE 1

Birth, Death and Growth Rates, China, 1954–1966



SOURCE: State Statistical Bureau of the People's Republic of China (1993). *China: Statistical Yearbook, 1993.* Beijing, China Statistical Information and Consultancy Service Center, pp.65–66.

and teams in turn were grouped into production cooperatives. In 1957, Mao Zedong embarked on the Great Leap, a radical industrialization program with the declared objective to overtake Great Britain in industrial production in 15 years. Labor-intensive development activities would make up for the lack of capital. Heavy industry would be given priority over the agricultural sector, and the agricultural production system would be transformed with modern technology. The peasant cooperatives were grouped into still larger collective units, termed People's Communes.

The results were catastrophic. Both industrial and grain production fell for three consecutive years, 1959–1961, and the standard of living dropped sharply. There were widespread food shortages and then famine. The crisis affected the whole country, but with varying severity across different regions. The demographic consequences were increased mortality, reduced fertility, a halting of population growth, and a surge in rural-to-urban migration.

China's death rate increased from 10.8 per thousand in 1957 to 25.4 in 1960, a rise of about 130 percent, then fell back to its pre-crisis level by 1962. In total, an estimated 29 million persons died as a direct result of the famine during the period 1958–1961. Twelve million of these (40%) were under the age of 10 years.

The birth rate decreased from 34.0 per thousand in 1957 to 18.0 in 1961, a drop of nearly 50 percent, then rebounded to 37.0 per thousand in 1962. The drop in births was the result of factors such as postponement of marriage, spousal separation, reduced fecundity, and increased spontaneous abortions and stillbirths. During the crisis period, there were about

33 million fewer births than there would have been under non-crisis conditions.

The combined effect of the increased death rate and the reduced birth rate was that the population growth rate during the crisis period decreased from 23.2 per thousand in 1957 to 4.6 in 1960. It rose again to 27.0 per thousand in 1962. (See Figure 1) Rural areas suffered most from the famine. There was considerable migration from affected rural areas to less affected areas, and particularly to the cities.

Causes of the 1958–1961 Famine

The main cause of the famine was an ill-conceived, over-ambitious development program that was carried out with insufficient means. Local cadres were not properly trained and lacked the experience to manage large agricultural production units. Collectivization of farming had weakened private incentives and sapped initiative, cutting the link between effort and reward. Cumbersome target-setting procedures and a four-tier administration (state, province, district, and commune), led to unrealistically high targets. To comply with the pressure to perform, cadres at various levels greatly overestimated or falsified output figures, for a time hiding the magnitude of the production failure from higher levels of the administration. Grain procurement by the government for export and to create reserve stocks thus continued and further aggravated the shortfall of grain supply at the local level. The crisis was deepened by natural disasters: drought, flood, excessive precipitation, plant diseases, and insect infestations affected many parts of the country, although some of these too were the consequence of faulty policies. Once the leadership became aware of the crisis, the Great Leap was swiftly abandoned. Subsequent changes in China's economic and administrative policies, notably the effective re-privatization of agriculture initiated by Deng Xiaoping in the 1970s, make repetition of a human-caused famine in China highly unlikely.

See also: *Communism, Population Aspects of; Food Supply and Population.*

BIBLIOGRAPHY

Ashton, Basil, et al. 1984. "Famine in China, 1958–61." *Population and Development Review* 10: 613–645.

Banister, Judith. 1984. "An Analysis of Recent Data on the Population of China." *Population and Development Review* 10: 241–271.

Calot, Gérard. 1984. "Données nouvelles sur l'évolution démographique Chinoise." *Population* 39: 807–835, 1,045–1,062.

Fairbank, John King. 1992. *China: A New History.* Cambridge, MA: Belknap Press.

Gernet, Jacques. 1996. *A History of Chinese Civilization,* 2nd edition. Cambridge, MA: Cambridge University Press.

Heilig, Gerhard K. 1999. *Can China Feed Itself? A System for Evaluation of Policy Options,* CD-ROM Vers. 1.1. Laxenburg: International Institute for Applied Systems Analyis.

Kane, Penny. 1988. *Famine in China, 1959–61: Demographic and Social Implications.* New York: St. Martin's Press.

Peng, Xizhe. 1987. "Demographic Consequences of the Great Leap Forward in China's Provinces." *Population and Development Review* 13: 639–670.

State Statistical Bureau of the People's Republic of China. 1993. *China: Statistical Yearbook, 1993.* Beijing: China Statistical Information and Consultancy Service Center.

Alphonse L. MacDonald

FAMINE IN IRELAND

The proximate cause of the Great Irish Famine (1846–1852) was the fungus *Phythophtera infestans* (potato blight), which reached Ireland in the fall of 1845. It destroyed about one-third of that year's crop and nearly all of the crop of 1846. After a season's remission it also ruined the harvest of 1848. These repeated shortfalls made the Irish famine more protracted than most. Partial failures of the potato crop were nothing new in Ireland before 1845, but damage on the scale wrought by the blight was utterly unprecedented. However, the famine would not have been so lethal if the population had been less dependent on the potato. Poverty had reduced one-third of the population to almost exclusive dependence on the potato for food. That, coupled with an inadequate response from the authorities, made the consequences of repeated failures devastating.

The Government's Response

The debate about relief measures in the press and in Parliament in the 1840s has a modern resonance. At first the government opted for reliance on the provision of employment through public works schemes. At their height in the spring of 1847 the public works employed 700,000 people, or one-twelfth of the entire population. These measures did not contain the famine, partly because they did not target some of the most needy, partly because the average wage was too low, and partly because they entailed exposing malnourished people (mostly men) to the elements during the worst months of the year. At their peak in early July 1847 the publicly financed soup kitchens that succeeded the public works program reached 3 million people daily. Mortality seemed to fall while they operated, though doubts remain about the effect of a diet of meal-based gruel on weakened stomachs.

The drop in food prices during the summer of 1847 prompted the authorities to treat the famine as a manageable local problem. The main burden of relieving the poor was placed on the workhouses established under the Irish poor law of 1838. Most of the workhouses were ill equipped to meet the demands placed on them, and about one-quarter of all famine mortalities occurred in them. Local histories highlight mismanagement and the impossible burden placed on local taxpayers, and the high overall proportion of workhouse deaths caused by contagious disease is an indictment of this form of relief. The very high mortality in some workhouses in 1850 and even 1851 provides evidence of the long-lasting character of the famine in some western areas. The aggregate sum spent on relief (about £9 million) was too small to make a significant dent in mortality.

Traditional accounts of the famine pit the more humane policies of Sir Robert Peel's Tories against the dogmatic stance of Sir John Russell's Whig administration, which took office in July 1846. That contrast is oversimplified. Although Peel was more familiar with Ireland's problems than were Whig ideologues such as Charles Wood, the crisis confronting him in 1845–1846 was mild compared to what was to follow. Moreover, Peel broadly supported the Whig line in opposition.

At the height of the crisis the policy adopted by the Whigs was influenced by Malthusian providentialism, the conviction that the potato blight was a divinely ordained remedy for Irish overpopulation. The fear that too much kindness would entail a Malthusian lesson not learned also conditioned both the nature and the extent of intervention.

The Effects of the Famine

The Irish famine killed about one million people, making it a major famine by world-historical standards. The death toll is approximate, since in the absence of civil registration excess mortality cannot be calculated directly. This estimate does not include averted births or allow for famine-related deaths in Britain and farther afield. Mortality was regionally very uneven. No part of Ireland escaped entirely, but the toll ranged from one-quarter of the population of some western counties to negligible fractions in Down and Wexford on the east coast. The timing of mortality varied too, even in some of the worst hit areas. In western Cork the worst was over by late 1847, but the effects of the famine raged in Clare until 1850 or even 1851. Infectious diseases rather than literal starvation were responsible for the largest proportion of the mortality. As in most famines, the elderly and the young were the most likely to die, but women proved marginally more resilient than men.

Like all famines, the Irish famine produced a hierarchy of suffering. The rural poor, landless or nearly landless, were the most likely to perish. Farmers faced an effective land endowment reduced by the potato blight and increased labor costs, forcing them to reduce their concentration on tillage. Landlords' rental income plummeted by as much as a third. Many medical practitioners and clergymen died of infectious diseases. Pawnbrokers found their pledges being unredeemed as the crisis worsened. Least affected were those firms and their workforces that relied on foreign markets for raw materials and sales. It is difficult to identify any significant class of "winners": except perhaps those grain merchants who grasped the opportunities offered by the trade in Indian meal when prices were still rising in the autumn of 1846 and in early 1847, lawyers who benefited from the deregulation of land transfers, and pastorally oriented farmers.

The Great Irish Famine was not just a watershed in Irish history but also a major event in global history, with far-reaching and enduring economic and political consequences. In Ireland it brought the era of famines to a brutal end. Serious failures of the potato crop in the early 1860s and late 1870s brought privation but no significant excess mortality. The famine also resulted in a higher living standard for survivors. Higher emigration was another by-product as the huge outflow of the crisis years generated its own "friends and neighbors" dynamic. Only in a few remote and tiny pockets in the west did population fill the vacuum left by the "Great Hunger," and then only very briefly. Whether by reducing the domestic market the famine led to the decline of certain industries remains to be established. Finally, although the introduction of new potato varieties offered some protection against *Phythophtera infestans* thereafter, no reliable defense would be found against it until the 1890s.

See also: *Trans-Atlantic Migration.*

BIBLIOGRAPHY

Bourke, Austin. 1993. *The Visitation of God? The Potato and the Great Irish Famine.* Dublin: Lilliput Press.

Donnelly, James S. 2000. *The Irish Potato Famine.* London: Sutton Publishing.

Gray, Peter. 1999. *Famine, Land and Politics: British Government and Irish Society 1843–50.* Dublin: Irish Academic Press.

Mokyr, Joel. 1985. *Why Ireland Starved: An Analytical and Quantitative History of the Irish Economy 1800–1850.* London: Allen & Unwin.

Ó Gráda, Cormac. 1999. *Black '47 and Beyond: The Great Irish Famine in History, Economy, and Memory.* Princeton, NJ: Princeton University Press.

———. 2001. "Famine, Trauma, and Memory." *Béaloideas* 69: 121–143.

Solar, Peter M. 1989. "The Great Famine Was No Ordinary Subsistence Crisis." In *Famine: The Irish Experience, 900–1900,* ed. E. M. Crawford. Edinburgh: John Donald.

Cormac Ó Gráda

FAMINE IN SOUTH ASIA

Famines have been a recurrent feature in the history of South Asia since the earliest recorded times. For example, the Mughal Empire experienced many such events in the sixteenth and seventeenth centuries, and famines may have occurred even more frequently after the empire's disintegration in the eighteenth century. A particularly severe famine occurred during the rule of the English East India Company in Bengal in 1770, when it was claimed that perhaps 10 million of Bengal's 30 million people died. Such figures must be regarded with great caution, but one can say that famines were common before the nineteenth century, were often severe, usually were precipitated by a failure of the monsoon rains, and together with endemic and epidemic diseases had a significant impact on the overall level of mortality.

The Response to Famine

Major famines continued to occur under East India Company rule in the first seven decades of the nineteenth century. Influenced by the writings of classical economists such as Adam Smith and David Ricardo, company administrators were often unsure how much they should intervene in food markets during times of famine. In addition, their opinions sometimes were influenced by Malthusian beliefs that spending resources on famine relief, and thus saving lives, might only exacerbate the region's population problem over the longer run. Consequently, the responsibility for famine relief during this period was often left to Indian princes, although limited relief measures and related efforts to improve and extend canal irrigation were increasingly undertaken by the British as the nineteenth century progressed.

In the period from 1876 to 1878 huge areas, particularly in southern India, were afflicted by monsoon failure and massive famine. The availability of early census and vital registration data has led to several estimates of excess mortality for this time, varying between 5 million and 8 million in a total population of perhaps 210 million. Such an enormous catastrophe attracted worldwide concern, was embarrassing to the British imperial authorities, and led to the establishment and recommendations of the Famine Commission of 1880. That commission's proposals included the formulation of "Famine Codes" to help local administrators deal with the threat of famine, the provision of guaranteed work at a subsistence wage for people affected by famine distress, and the provision of free famine relief for those deemed too feeble to work.

However, those proposals were not always implemented, and their existence failed to avert two more massive disasters in the 1890s. Estimates of excess mortality in British India from the famine of 1896–1897 vary between 2.5 million and 5 million, and the crisis of 1899–1900 may have led to between 2 million and 4.5 million deaths. In each of these major disasters of the late nineteenth century, epidemics of cholera, diarrheal diseases, and above all malaria broke out during the famines and caused the deaths of millions of starving people. The three famines were the reason that the size of South Asia's population remained fairly static during the 1870s and the 1890s.

Famine in the Twentieth Century

Partly because of the Famine Commission's recommendations, the first four decades of the twentieth century were comparatively free of major food crises. In 1943–1944, however, there was a serious famine in Bengal—then still under colonial rule—in which it is now known that there were about 2.1 million excess deaths in a total population of about 60 million. The immediate triggers of this event were complex, but as with many other food crises around the world during the early 1940s the occurrence of this famine cannot be viewed in isolation from the fact of world war. This was also the last famine in South Asia in which epidemic malaria played a major role in contributing to famine deaths.

After India and Pakistan gained independence in 1947, both the frequency and the severity of famines were greatly reduced. In no small part this has occurred because the region's countries have assumed responsibility for their own food security and health conditions. Also relevant has been the existence to varying extents of comparative press freedom and democratic government. However, in 1965–1966 there was a severe food crisis in the Indian state of Bihar in which there may have been considerable excess mortality, and in the early 1970s in the state of Maharashtra alone there were at least 70,000 excess deaths after the occurrence of severe and widespread drought. Other parts of the region, such as areas of Sri Lanka, were also affected by drought and food scarcity in the early 1970s.

However, probably the most serious famine to affect South Asia since 1947 was that in Bangladesh in the period 1974–1975. The extent of excess mortality resulting from this crisis is hard to gauge, but it seems likely to have been several hundred thousand. The occurrence of this famine cannot be viewed apart from the Bangladesh war of independence in 1971. Indeed, both in its causation and in its demographic consequences there are significant parallels between the 1943–1944 crisis in Bengal and that which hit much of the same region (i.e., Bangladesh) in 1974–1975.

The Twenty-First Century

At the beginning of the twenty-first century, provided that there continues to be relative sociopolitical stability and peace in the region, it is hard to see a major famine affecting the countries of South Asia in the foreseeable future. This is the case mainly because recent decades have seen economic diversification and growth, plus major infrastructural, epidemiological, and health improvements. Also, India, Bangladesh, Pakistan, and Sri Lanka all either hold relatively large stocks of food or have the capacity to purchase emergency supplies if the need arises. This conclusion should not obscure the fact that droughts and harvest failures still occur in the region and have the potential to cause some excess deaths, particularly among the poorest sectors of society. However, famines that cause large-scale devastation and mortality in South Asia appear to be things of the past.

See also: *Food Supply and Population.*

BIBLIOGRAPHY

Ambirajan, S. 1976. "Malthusian Population Theory and Indian Famine Policy in the Nineteenth Century." *Population Studies* 30(1): 5–14.

Dyson, Tim. 1991. "The Demography of South Asian Famines." *Population Studies* 45(1 and 2): 5–25 and 279–297.

Dyson, Tim, and Arup Maharatna. 1991. "Excess Mortality during the Bengal Famine: A Re-Evaluation." *Indian Economic and Social History Review* 28(3): 281–297.

———. 1992. "The Demographic Consequences of the Bihar Famine of 1966–67 and the Maharashtra Drought of 1970–73." *Economic and Political Weekly* 27(26): 1325–1332.

Maharatna, Arup. 1996. *The Demography of Famines—An Indian Historical Perspective.* Delhi: Oxford University Press.

TIM DYSON

FAMINE IN THE SOVIET UNION

This article discusses the three major famines that the Soviet Union experienced. It does not treat regionally-delimited food shortages and famines, which were numerous between 1917 and 1940, or the famine conditions that occurred during World War II, for example in the Leningrad blockade. Famines, of course, were also fairly frequent occurrences in the Tsarist Russian empire, especially in rural areas. The last important one took place in 1891–1892. However this was dwarfed by the famines of the Soviet era.

The first of the major Soviet famines struck between 1918 and 1921, following World War I and the civil war. By 1921 it covered all of Russia. It resulted from severe disorganization of the food supply combined with the consequences of compulsory requisitioning of harvests, a practice that began before the Revolution but continued and was enlarged after it, especially during the civil war. The Bolsheviks sought to ensure food supplies for the towns, where their strongest base of support lay, and for the army. The famine is estimated to have caused about 5 million deaths, either directly from starvation or in the epidemics that followed.

After some hesitation, at the end of June 1921 the Soviet authorities began a large famine relief campaign, helped by some international support from organizations such as the American Relief Administration and the International Committee of the Red Cross. By the end of 1922, although many regions were still suffering from malnutrition, the situation was returning to normal—aided by Lenin's decision to permit small-scale private commercial activity and by an easing of grain requisitions. The Bolsheviks used the famine as a pretext to confiscate church property.

The 1933 famine, the second of the three, was more catastrophic yet than the famine of 1918–1921 and differed in its origins and geographical concentration (Figure 1). It led to more than 6 million deaths, largely in Ukraine, the Lower Volga region, and in the North Caucasus, the main grain producing regions, and also in Kazakhstan, then with a large nomadic population. Its determinants were clearly political: it was the outcome of the forced collectivization of peasant farms, the harsh Stalinist policy of 1928–1929 that followed the less stringent years (1921–1927) of the New Economic Policy. Under the name of dekulakization, millions of peasants, both rich and less rich, were deported; many of them to remote frontier regions, and new collective farms (*kolkhoz*) were established. Many peasants destroyed their livestock rather than giving it to the collectives. Agricultural marketing systems broke down. The situation was worsened by Stalin's decision to continue and even expand the export of grain in order to finance the rapid industrialization envisaged in the second Five Year Plan. The level of forced grain requisitions took no account of the realities of production. The hostility of Stalin, Molotov, Kaganovich, and other Soviet leaders toward the peasants, suspected of hiding their harvest, led in 1931 to measures such as NKVD detachments or groups of workers from the towns being used to confiscate grain—even seed grain.

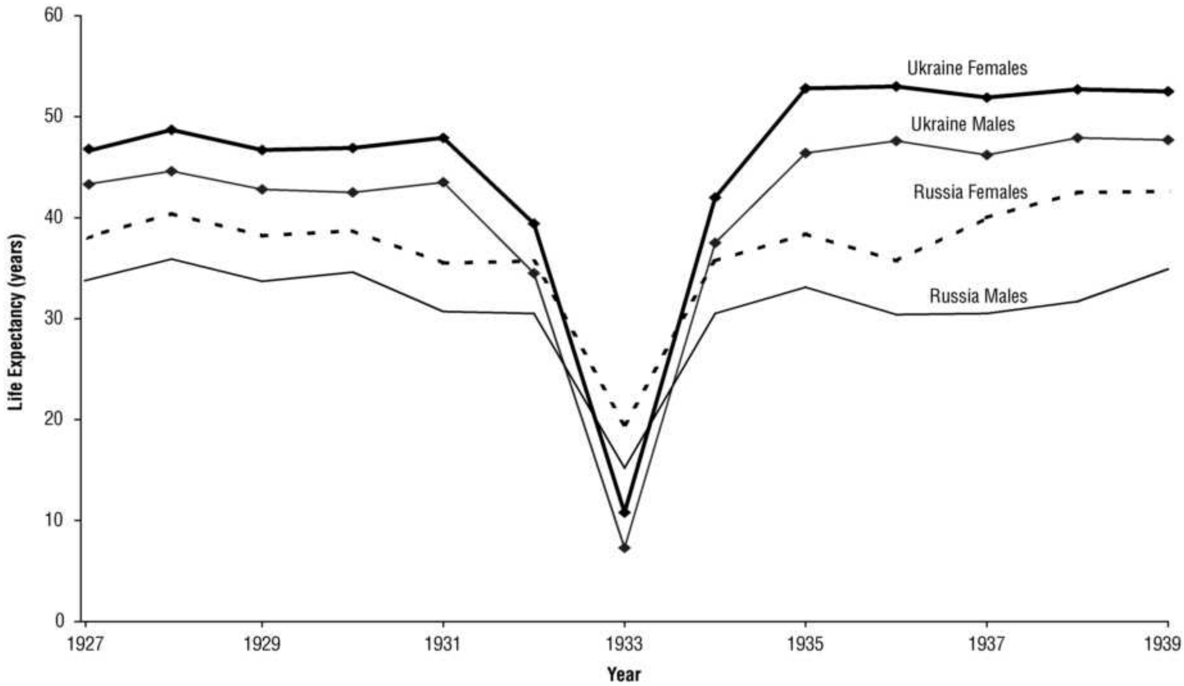
The pace of grain requisitions did not lessen even when the first signs of famine began to appear, during 1931 and in the summer of 1932. Ukrainian authorities, on the basis of Ukrainian NKVD or Communist party reports, attempted to alert Moscow officials to the looming catastrophe, but Stalin, after initially seeming to be concerned, chose instead to begin a violent attack against "peasant wreckers" and even "Communist staff wreckers." Other regions that traditionally produced a grain surplus—notably North Caucasus and Lower Volga—were similarly subjected to mass-collectivization, dekulakization, and requisitions.

In Kazakhstan, collectivization took the form of forced sedentarization of the nomadic people. This led to a large exodus to other countries, especially to the western regions of China where the population was ethnically similar, and to complete social disorganization among those who remained.

The peak of the famine was in March and April of 1933, when the number of deaths in some regions of Ukraine, Russia, and Kazakhstan were more than ten times normal levels. To avoid massive flows of

FIGURE 1

Life Expectancy at Birth in Russia and Ukraine, 1927–1939



SOURCE: Russia: Andreev et al. (1993). Ukraine: Vallin et al. (2002).

migrants, Stalin forbade people to move, a measure enforced by the NKVD. Cases of cannibalism were recorded.

The official Soviet position denied the existence of this famine. It was forbidden to write about it. The only response of the Soviet authorities was to supply seeds for the summer 1933 crop in Ukraine and other areas, thereby helping to end the calamitous consequences of the Stalinist approach to governing the country.

The third and last major Soviet famine followed World War II. Its immediate cause was failure of the 1946 harvest, the result of a drought affecting the western regions of the country. But the deeper origins were in part the same as those of the 1933 famine. After the privations of the war, people were very weak and sensitive to any new shortages. But Stalin wanted to continue to export grain, as well as supplying towns and the army. Compulsory procurements of grain and other foodstuffs from the collective farms were raised beyond the limits of feasibility. The result was about 1 to 1.5 million deaths from starvation or disease.

See also: *Communism, Population Aspects of; Ethnic Cleansing; Forced Migration.*

BIBLIOGRAPHY

Adamets, Serge. 2003. *Guerre civile et famine en Russie: le pouvoir bolchévique et la population face à la catastrophe démographique, 1917–1923.* Paris: Institut d'Études Slaves.

Andreev, Evgenij, Darskij, Leonid, and Khar'kova, Tatiana. 1998. *Demograficheskaya istoriya Rossii: 1927–1959.* [The Demographic History of Russia: 1927–1959]. Moscow: Informatika.

Blum, Alain. 1994. *Naître, vivre et mourir en URSS, 1917–1991.* Paris: Plon.

Vallin, Jacques, Meslé, France, Adamets, Serguei and Pyrozhkov Serhii. 2003. "A New Estimation of

Ukrainian Losses during the 30's and 40's Crises." *Population Studies* Vol. 3.

Wheatcroft, Stephen. 2001. "O demograficheskikh svidetel'stvakh tragedii sovetskoi derevni v 1931–1933gg." ["About demographic evidence of the tragedy of the soviet villages in 1931–1933"], In *Tragediya Sovetskoi Derevni: Kollektivizatsiya i raskulachivanie, Dokumenty i Materialy,* Vol. 3: *Konets 1930–1933,* ed. I. Zelenin, V. Danilov, L. Viola, R. Manning, R.W. Davies, S. G. Wheatcroft, et al. Rosspen: Moscow. pp. 866–887.

Wheatcroft, Stephen, and Robert Davies. 2002. "Soviet Famine of 1932–33 and the Crisis in Agriculture" In *Challenging Traditional Views of Russian History,* ed. Stephen Wheatcroft. Palgrave: Macmillan. pp. 69–91.

Alain Blum

FARR, WILLIAM

(1807–1883)

William Farr, a physician by training, was the most prominent expert in vital statistics in Great Britain in the nineteenth century. After completing his medical studies in London and in Paris, where he became a disciple of Dr. Pierre-Charles-Alexandre Louis and his *méthode numérique,* Farr set up a practice as a pharmacist in 1833. He contributed a chapter to John Ramsey McCulloch's *A Statistical Account of the British Empire* (1837), showing his skill in presenting and interpreting vital statistics but arguing that the government still had too little knowledge about diseases to be successful in reducing mortality. This was the origin of one of his lifelong concerns: improving data on the cause of death.

Farr joined Britain's General Register Office (GRO) in 1839 as Compiler of Abstracts and became Statistical Superintendant some years later. From 1840 to 1880 he seems to have been the key person behind all the reports issued by the GRO, including the *Annual Reports* to Parliament. As early as 1839 he proposed a classification of causes of death on the basis of illness location in the body. At the first international conference on statistics (1855), he presented a new proposed classification in competition with the Swiss physician and medical statistician Marc-Jacob d'Espine. Great Britain used the first of Farr's schemes for its statistics until 1860 and the second until 1880.

Farr constructed life tables for England and Wales for 1841, 1838–1844, and 1851. The technical innovations he introduced included a formula to derive life-table survival rates from mortality rates and the use of standardized mortality rates. In 1880 he published a sort of reproduction table but did not arrive at the notion of the reproduction rate. For Britain's censuses he added new categories of occupations and disabilities.

Farr participated in many commissions dealing with sanitary reforms, notably for the armies affected by diseases in the Crimea and India. He was a Fellow of the Royal Society, president (1871–1873) of the Statistical Society of London, and the recipient of other forms of academic recognition but never became, as he had hoped, Registrar General.

See also: *Bertillon, Jacques; Causes of Death; Demography, History of; Disease, Concepts and Classification of; Life Tables.*

BIBLIOGRAPHY

Hamlin, Christopher. 1998. *Public Health and Social Justice in the Age of Chadwick. Britain, 1800–1854.* Cambridge, Eng.: Cambridge University Press.

Humphrey, Noel, ed. 1885/1975. *Vital Statistics: A Memorial Volume of Selections from the Reports and Writings of William Farr,* ed. Sanitary Institute of Great Britain. London: Scarecrow.

Stone, Richard. 1997. *Some British Empiricists in the Social Sciences 1650–1900.* Cambridge, Eng.: Cambridge University Press.

Wall, Richard. 1974. *Mortality in Mid 19th Century Britain.* Heppenheim/Bergstrasse, Germany: Gregg International, D.C. Heath.

Woods, Robert, and Nicola Shelton. 1997. *An Atlas of Victorian Mortality.* Liverpool, Eng.: Liverpool University Press.

Wrigley, E. Antony, and Roger Schofield. 1981. *The Population History of England, 1541–1871: A Re-*

construction. Cambridge, Eng.: Cambridge University Press.

Patrice Bourdelais

FECUNDITY

Fecundity is the physiological capability of a woman, man, or couple to reproduce, that is, to produce a live birth. Unless both partners are fecund, no birth can occur. In contrast, *fertility* is the actual reproductive output of an individual, couple, or group. Considerable confusion results from the fact that in French and other Romance languages, the meanings of fecundity and fertility are reversed; for example, the French *fécondité* is equivalent to the English fertility and the French *fertilité* is equivalent to the English fecundity. English-speaking physicians also use fertility to mean fecundity. Confusion also exists because demographers have defined fecundity as the capacity to reproduce but have defined *fecundable* as the capacity to conceive, and *fecundability* as the per-cycle probability of conception, regardless of whether that pregnancy results in a live birth.

Whereas fertility can be directly observed and measured, fecundity cannot. Demographers, statisticians, and epidemiologists have developed techniques for indirectly estimating the incidence of sterility (the inability to produce a live birth), for directly estimating the incidence of fetal loss, and for estimating conception probabilities by cycle day of intercourse. The measures of sterility, fecundability, and conception probabilities necessarily pertain to a couple and not to an individual.

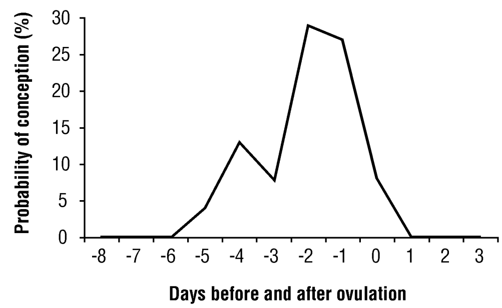
Logically, fecundity depends on a sequence of events. The female must produce an egg capable of being fertilized, the male must produce sperm that can fertilize the egg, fertilization must occur, the fertilized egg must survive to implant in the uterus, and—once implantation has occurred—the pregnancy must result in a live birth. Successful progression along this sequence can be influenced by many factors.

Age

Fecundity varies among individuals and couples of a given age. The fecundity of groups declines with the aging of women as increasing percentages of women become sterile because they are unable to become pregnant and due to fetal loss. This increase is modest through the 30s and rises sharply thereafter until virtually all women are sterile at about age 50. It is plausible that the fecundity of individual women also declines with age, although that decline is likely to be less pronounced before a rather rapid loss in reproductive capacity is experienced. In contrast, fecundity of males does not appear to decline until well after age 50. The risk of fetal loss rises with age only from the mid-30s or early 40s. There is considerable heterogeneity in the risk of fetal loss—some women are highly prone whereas others are not—thereby creating heterogeneity in fecundity.

FIGURE 1

Recognizable Conception Probabilities by Cycle Day, Relative to Day of Ovulation



SOURCE: Wilcox, Dunson, Weinberg, Trussell, Baird (2001).

Intercourse and Pregnancy-Related Factors

Among ovulating women having intercourse, whether a particular cycle will result in pregnancy depends on the frequency and timing of intercourse. If intercourse does not occur in a fairly narrow time segment extending from five days before ovulation to the day of ovulation, then the risk of pregnancy is exceedingly low (Figure 1).

The more often intercourse occurs within this time segment, the more likely it is that pregnancy will occur; however, the maximum probability is surprisingly small, only about 40 percent. (The maximum probability of conception from a single intercourse optimally timed within a cycle is about 30 percent.) This per-cycle probability of conception, technically known as fecundability (introduced by the Italian demographer and statistician Corrado

Gini in 1924), can be directly estimated without reference to conception probabilities by cycle day among regularly menstruating women not using contraception; a typical value would be about 20 percent among young women. Even when the timing and frequency of intercourse are held constant, fecundability can be reduced by both involuntary and voluntary factors. It is reduced by irregular ovulation around menarche and menopause, lactation (both because ovulation is suppressed and—when ovulation is resumed—because of a decreased likelihood of successful implantation), by smoking, by the sexually transmitted infections chlamydia and gonorrhea (due to tubal scarring), by strenuous physical activity among women, by extreme malnutrition, probably as women get older (at least above age 40), and by use of contraception. Worldwide, the most important of these would be contraception in countries in which deliberate birth control is widespread. When this is not the case, lactation can be an important factor reducing fecundability. Elective abortion reduces fecundity worldwide to a far greater extent than fetal loss.

Sexually Transmitted Diseases

Sexually transmitted infections have major effects on fecundity (and fertility) in certain populations. Syphilis is an important cause of fetal loss among women with primary or secondary infections and may be an important factor contributing to low fertility among certain tribal groups in Burkina Faso and the Central African Republic. Untreated pelvic inflammatory disease caused by chlamydia and gonorrhea is a major cause of tubal scarring and sterility. The low fertility characteristic of Central Africa (a belt extending from the west coast of Cameroon and Gabon through northern Congo into southwest Sudan) in the 1950s and 1960s was attributed to a high prevalence of gonorrhea, long before the additional role of chlamydia was recognized. In sub-Saharan Africa, gonorrhea and chlamydia are still common infections. Widespread in equatorial regions, yaws and pinta, while not sexually transmitted, are closely related to syphilis and are also treatable with penicillin. Mass penicillin campaigns against gonorrhea (New Guinea), yaws (Martinique), and yaws and pinta (Cameroon, Burkina Faso, Congo, and Zambia) were followed by substantial increases in fertility. It is possible that improved diagnosis and treatment of sexually transmitted infections in sub-Saharan Africa as a component of AIDS prevention programs will also result in increased fecundity.

Nutrition

A link between nutrition and fertility has been postulated as a relatively simple explanation for variations in marital fertility in populations that do not use contraception. It is suggested that the lower the nutritional status of a population, the lower the fecundity and hence fertility. Chronic malnutrition probably does result in a delay in menarche, but the reduction in fecundity among adolescents resulting from that delay is unlikely to have an important effect on fertility. When food supplies are so short that there is outright famine and starvation, fecundity and hence fertility are sharply reduced. But when malnourishment is chronic and food intake is above starvation levels, there does not appear to be an important nutrition–fertility link.

The Future

In the not so distant future, the use of current and new technologies in reproductive biology and genetics could greatly modify the situations described above, rendering the infecund fecund.

See also: *Fertility, Age Patterns of; Fertility, Proximate Determinants of; Infertility; Natural Fertility; Spontaneous Abortion.*

BIBLIOGRAPHY

Bongaarts, John, and Robert G. Potter. 1983. *Fertility, Biology, and Behavior.* New York: Academic Press.

Leridon, Henri. 1977. *Human Fertility: The Basic Components.* Chicago: The University of Chicago Press.

Menken, Jane, James Trussell, and Ulla Larsen. 1986. "Age and Infertility." *Science* 233(4771): 1389–1394.

Pressat, Roland. 1985. *The Dictionary of Demography,* ed. Christopher Wilson. Oxford: Basil Blackwell.

Silver, Lee M. 1998. *Remaking Eden: How Genetic Engineering and Cloning Will Transform the American Family.* New York: Avon Books.

Trussell, James, and Chris Wilson. 1985. "Sterility in a Population with Natural Fertility." *Population Studies* 39: 269–286.

Weinberg, Clarise R., Beth C. Gladden, and Allen J. Wilcox. 1994. "Models Relating the Timing of Intercourse to the Probability of Conception and the Sex of the Baby." *Biometrics* 50: 358–367.

Wilcox, Allen J., David B. Dunson, Clarise R. Weinberg, James Trussell, and Donna Day Baird. 2001. "On the Assessment of Post-Coital Contraceptives." *Contraception* 63(4): 211–215.

JAMES TRUSSELL

FEMINIST PERSPECTIVES ON POPULATION ISSUES

Although feminists differ among themselves on many issues, most feminist activists share a commitment to equal rights and resources for women and men. Scholars of gender study the social forces that affect gender inequality. Many of them have pointed out that traditional scholarship in the social sciences, including demography, often ignores gender inequalities or assumes that they are "natural." Because of their critical attention to gender inequality, gender scholars are often referred to as feminist. Both groups of feminists—scholars and activists—have influenced policy debates, moving the issues of women's reproductive health and empowerment closer to the center of development and population policies.

Feminist Activists and Population Policy

Policy debates about population and related debates about economic development, environmental degradation, and inequalities of class, race, nation, and gender raise the issue of women's empowerment. Population policy raises the specific issue of reproductive rights. Feminist activists have made strenuous efforts to ensure that women's empowerment and reproductive rights have a central place in these policy discussions.

Feminists have always been divided on the importance of birth control to women's liberation. Early feminists such as Annie Besant (1847–1933) in England and Emma Goldman (1869–1940) and Margaret Sanger (1883–1966) in the United States were pioneers in the birth control movement. However, most U.S. suffragists at the start of the twentieth century dissociated themselves from birth control, believing that its advocacy was too controversial and might hurt their principal goal of gaining women the right to vote. In later years feminist activists in affluent nations supported access to contraception to allow women and couples to limit fertility, believing that this would improve women's lives and status.

The time and energy women spend in child rearing is a major factor limiting women's participation in employment, politics, and other public roles, and one way to reduce this burden is to have fewer children. (Another way is to increase men's participation in child rearing, but changing men's roles has proved difficult.) In recent decades women's access to legal abortion has been a key feminist issue in the United States.

Some feminists in industrialized countries (the North) have aligned themselves with activists in the population control and environmental movements who see population growth as an important world problem in its own right, threatening the environment and prospects for economic development in the South. These positions sometimes have caused disagreements between Northern and Southern feminists. Feminist activists in the South are often unconvinced that population growth is a high-priority problem. Like many others in their countries, they emphasize the role of poverty, underdevelopment, and unequal distribution of resources between the North and the South as key causes of high fertility rather than seeing high fertility as a major cause of poverty and economic backwardness. This difference of emphasis parallels a debate in the North's environmental movement about whether excessive resource consumption in the North or overpopulation in the South is the more significant problem.

Southern feminists also have been critical of the implementation of population policies, arguing that programs in many countries distributed contraceptive supplies and services with little regard for the health of the women who used them and were evaluated by the number of users or the reduction in fertility rather than by the health and satisfaction of program clients. They are particularly critical of any pressure on women to use birth control. Some regard the affluent northern emphasis on curbing southern fertility as racist or, at best, an excuse not to alter the distribution of resources between the North and the South.

This difference between northern and southern feminists mirrors the interaction of gender with other axes of privilege that arise in within-nation debates on population issues. For example, African-American, Native American, and Puerto Rican women in the United States, though favoring women's access to birth control, have deemphasized high nonmarital birth rates as a critical problem, preferring a policy emphasis on decreasing racism in health systems and employment, improvement of the social safety net, and state provision of universal access to health services. They are more troubled by women being unable to find the resources to raise children decently than by the prospect of women having too many children.

Feminists and the Cairo Agenda

Despite these differences in emphasis, most feminists are united in wanting reproductive freedom and reproductive health services, broadly defined, available to women as a basic human right even when this is resisted by men in their families or by political and religious leaders. The United Nations International Conference on Population and Development in Cairo in 1994 saw the formation of an important coalition between southern and northern feminists. This world forum was a high point of feminist influence on international population policy. Many governments, international agencies, and influential nongovernmental bodies were persuaded of the instrumental value of women's empowerment (in the form of access to education and jobs and more control over all aspects of their lives) in decreasing fertility and promoting sustainable economic development. Beyond this instrumental approach, northern and southern feminists together were influential in winning support for language declaring women's rights and empowerment to be goals in their own right, not only means to stabilize population size. The conference document, known as the Cairo Agenda, supports family planning programs but denounces coercion or numerical targets for contraceptive practice or number of births. Moreover, Principle 4 of the Program of Action states:

> Advancing gender equality and equity and the empowerment of women, and the elimination of all kinds of violence against women, and ensuring women's ability to control their own fertility, are cornerstones of population and development-related programmes.

Southern feminists concerned with reproductive health seek to improve maternal and child health programs, including family planning; offer treatment for reproductive tract infections, sexually transmitted diseases, HIV, and breast cancer; make abortion available; discourage female genital mutilation; and provide sex education that contributes to a satisfying sex life for women that is free from coercion by men. The Cairo document, with its broad language, may make it more likely that some of the resources already committed to population programs will be used to achieve these goals.

Feminist Critiques of the New Home Economics

Feminist scholarship has been strongly critical of much of the "new home economics," the application of microeconomic theory to household behavior that is associated particularly with the work of the economist Gary Becker. Models in this tradition typically ignore issues of distribution within the family, assuming that the family "head" acts altruistically toward other family members and that each family acts to maximize a single utility function. They interpret marriage as an institution that allows men and women to capitalize on the efficiencies of specialization, with husbands engaging in market production for earnings while wives engage in child rearing and other production in the household.

As wage levels rise for both men and women, so does the opportunity cost of having a child and having a woman stay home to rear it. Neoclassical economists believe that higher wage levels lead families to shift to lower fertility, higher female employment, and more purchased child-care services. In Becker's view this also lowers the gains from specialization, which are a major motivation for marriage; therefore, increases in women's wages will lower marriage rates.

How have feminists responded to the new home economics? On the positive side they see it as an advance to recognize household production as real work, unlike the viewpoint of traditional labor economics. Indeed, they would want to follow this recognition to its logical consequence: adding household production to national accounts so that nations keep records on the total product of both their market and household economies rather than including only production involving cash exchange.

However, in many other respects feminists have been critical of the new home economics, particularly in its ignoring of male power over women in the family and society. Some men beat and rape their wives, laws are made and enforced by largely male bodies, major religions teach that women should "submit" to their husbands, a double standard of sexuality is common, and in some poor nations women and girls eat less and receive less schooling and health care than do men and boys, to the detriment of their health and longevity. The image of an altruistic male head who takes all family members' preferences into account disguises the realities of male dominance.

Gender scholars argue that men's greater access to money gives husbands power over their wives. They point out that women can ill afford to argue with their husbands when the husband controls resources in the family and when their economic alternatives if they leave a marriage are grim. In this view the specialization that economists might characterize as "efficient" and productive of "joint gains" disadvantages women relative to men in terms of how material well-being and decision-making power are distributed within families. Some economists are incorporating this perspective in formulating bargaining models of the household, drawing on game theory. Gender scholars argue that men's higher earnings result in part from sex discrimination in labor markets.

Men's power in the family is determined not only by access to money but by a combination of social, cultural, and political forces, including social norms that mandate that women should defer to men's authority, peer group norms among men that valorize sexual conquest and harass women who try to enter "men's" jobs, preferential investment in boys' education, employers' discrimination against women, and low funding of public support for single mothers. These broad social factors constitute and perpetuate gender inequality in the family and other arenas of life.

Many gender scholars agree with Becker that rising wage opportunities for women generally increase women's employment and reduce fertility. However, they point out another consequence ignored in Becker's perspective: When women have more control over a family's money, more is spent on children. Hence, empowering women may contribute to economic development through improvements in the health and capabilities of the next generation. Conversely, in settings where men receive more of the benefits and women pay more of the costs of rearing children, men may push their wives to have more children and there may be more gender specialization than women would prefer.

Feminist Perspectives on Low Fertility

Although patriarchy may encourage high fertility in poor countries, some gender scholars argue that in affluent nations aspects of the remaining gender inequality now have the opposite effect, contributing to continued fertility decline below the replacement level. Two types of gender role change would diminish gender inequality: Women could increase their participation in traditionally male activities (e.g., wage labor), and men could increase their participation in traditionally female activities. In fact, change in gender roles is highly asymmetric: Both material incentives and social norms encourage women to take on traditionally male pursuits much more than they encourage men to do more housework and care for young children. Women continue to bear more of the costs of raising children. Without changes in men's participation in child rearing, women may continue to reduce the number of children they have or raise children on their own.

Most child-care work—both the unpaid care of children at home and paid jobs such as child-care worker, teacher, nurse, and counselor—is done by women. The time women spend at home reduces their future earnings and pension entitlements as well as lowering their power within a marriage. When done in the market, child-care work has low pay relative to its educational requirements. The usual neoclassical economic explanation of wage differentials net of human capital is that at the margin the intrinsic satisfaction of helping people must compensate for the lack of pay for the worker. Gender scholars believe that this is only part of the explanation. They suggest that gender bias may pervade the labor market at many levels: Care work pays less because of crowding (women are kept out of "male" occupations) and because employers have a blind spot when it comes to the value of work done by women. Those who most need care (children, the sick, and the elderly) are often not able to pay much for this service. However, its social importance is undeniable: It increases the capabilities of recipients (their physical, mental, and emotional health and skills), benefiting both their own well-being and that of many of the people the recipients interact with, making them better parents, workers, and neighbors.

Because markets will not compensate caregivers for these diffuse public goods, feminist scholars have argued that there is a similar rationale for supporting all caregiving work as there is for state support of education. However, such additional claims on state budgets conflict with demands for limiting the size of the public sector. In nations in both the North and the South state payment of the salaries of care workers such as teachers and health workers, as well as the public safety net that provides a minimum income for those doing care work at home, has been challenged by politicians who believe the public sector should be downsized and markets should be expanded. In the South service cuts made under neoliberal structural adjustment policies have often fallen hardest on women. In the North state provision of income to single mothers is under challenge, although income and medical support for the elderly remains uncontroversial and takes up a large share of nonmilitary spending. The affluent countries have collectivized a major traditional benefit of having children while keeping the major cost of children—the opportunity cost of time—private. The extent to which the state collectivizes the costs (including opportunity costs) of rearing children may well affect both women's well-being and their fertility. A feminist perspective offers important insights into these and similar demographic dimensions of public policy.

See also: *Evolutionary Demography; Family Bargaining; Gender; Reproductive Rights; Sanger, Margaret; Women's Status and Demographic Behavior.*

BIBLIOGRAPHY

Agarwal, Bina. 1995. *A Field of Her Own: Gender and Land Rights in South Asia.* Cambridge, Eng.: Cambridge University Press.

Becker, Gary. 1991. *A Treatise on the Family.* Cambridge, MA: Harvard University Press.

Bergmann, Barbara. 1986. *The Economic Emergence of Women.* New York: Basic Books.

Dixon-Mueller, Ruth. 1993. *Population Policy and Women's Rights: Transforming Reproductive Choice.* Westport, CT: Praeger.

Dwyer, Daisy H., and Judith Bruce. 1988. *A Home Divided: Women and Income in the Third World.* Stanford, CA: Stanford University Press.

England, Paula. 1992. *Comparable Worth: Theories and Evidence.* New York: Aldine de Gruyter.

England, Paula, and Michelle Budig. 1998. "Gary Becker on the Family: His Genius, Impact, and Blind Spots." In *Required Reading: Sociology's Most Influential Books,* ed. Dan Clawson. Amherst: University of Massachusetts Press.

England, Paula, and George Farkas. 1986. *Households, Employment, and Gender: A Social, Economic, and Demographic View.* New York: Aldine de Gruyter.

England, Paula, and Nancy Folbre. 1999. "The Cost of Caring." *Annals of the American Academy of Political and Social Sciences* 561: 39–51.

Ferber, Marianne, and Julie Nelson, eds. 1993. *Beyond Economic Man: Feminist Theory and Economics.* Chicago: University of Chicago Press.

Folbre, Nancy. 1994. *Who Pays for the Kids? Gender and the Structures of Constraint.* London: Routledge.

Grown, Caren, Diane Elson, and Nilüfer Çagatay, eds. 2000. *Growth, Trade, Finance and Gender Inequality.* Special Issue of *World Development.*

Hartmann, Betsy. 1995. *Reproductive Rights and Wrongs: The Global Politics of Population Control and Contraceptive Choice,* revised edition. Boston: South End Press.

Hodgson, Dennis, and Susan Cotts Watkins. 1997. "Feminists and Neo-Malthusians: Past and Present Alliances." *Population and Development Review* 23: 469–523.

Ironmonger, Duncan S. 1996. "Counting Outputs, Capital Inputs, and Caring Labor: Estimating Gross Household Product." *Feminist Economics* 2: 37–64.

Kabeer, Naila. 2001. "Family Bargaining." *International Encyclopedia of the Social and Behavioral Sciences* 8: 5314–5319. London: Elsevier.

Lundberg, Shelly, and Robert Pollak. 1996. "Bargaining and Distribution in Marriage." *Journal of Economic Perspectives* 10: 139–158.

O'Connor, Julia S., Ann Shola Orloff, and Sheila Shaver. 1999. *States, Markets, Families: Gender, Liberalism and Social Policy in Australia, Canada, Great Britain and the United States.* Cambridge, Eng.: Cambridge University Press.

Presser, Harriet B., and Gita Sen, eds. 2000. *Women's Empowerment and Demographic Processes.* Oxford: Oxford University Press.

Riley, Nancy E. 1997. "Gender, Power, and Population Change." *Population Bulletin* 52: 1–48.

Sen, Amartya. 1990. "More Than 100 Million Women Are Missing." *New York Review of Books* December 20, pp. 61–66.

Sen, Gita, Adrienne Germain, and Lincoln C. Chen, eds. 1994. *Population Policies Reconsidered: Health, Empowerment, and Rights.* Boston: Harvard University Press.

United Nations. 1994. "Programme of Action" of the 1994 International Conference on Population and Development, Cairo, Egypt, October 18. A/CONF.171/13. New York: United Nations.

Paula England

FERTILITY, AGE PATTERNS OF

For biological and social reasons, the probability of a woman's having a child in a given time interval is strongly influenced by her age. The age pattern of fertility of a woman's cohort (that is, the group of women born at the same time) represents the sequence of births and inter-birth intervals over that cohort's reproductive life span. However, the data needed to calculate cohort age patterns of fertility may be obtained only from special sample surveys or population registers. Period age-specific fertility rates, which are derived from data that are more widely available, relate the annual number of births to women of a particular age group (usually one-year or five-year age groups) within the reproductive age range (15 to 49) to the mid-year population size of that age group. (Age-specific fertility rates may also be computed for men, although that is infrequently done.) The set of such period rates for a given time necessarily refers to many different cohorts. The sum of those rates is the (period) total fertility rate. The percentage contributions of age-specific fertility rates to the total fertility rate describe the age pattern of fertility. Because the age-specific fertility rates are not affected by the age composition of the population, they are suitable for comparing age patterns of fertility between populations and over time. Monitoring the age patterns of fertility is important for understanding fertility levels and trends.

Fertility Age Patterns

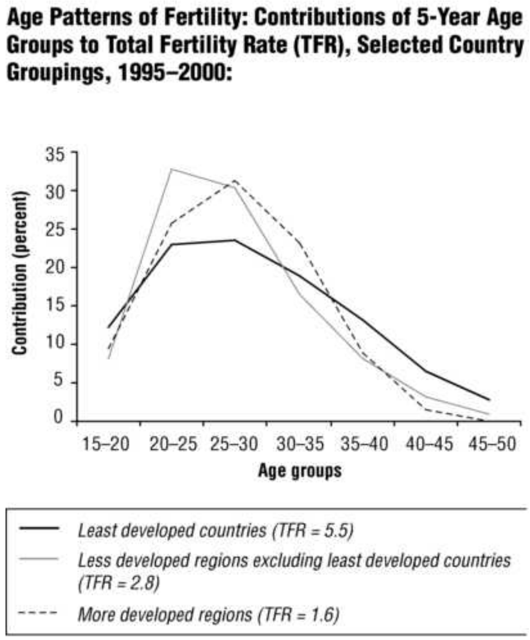
High fertility is associated with childbearing starting early and continuing until the late reproductive years. However, since women in high-fertility populations typically keep bearing children as long as they remain fecund, the age pattern of fertility is relatively flat. Fertility transition occurs through decreases of fertility at both ends of the reproductive life span, resulting in a more convex age pattern. The decrease of fertility at younger ages is often the result of rising ages at marriage, whereas fertility declines at the older ages primarily because of an increasing propensity to limit family size. The balance of these two trends is context-specific and leads either to "aging" or to "rejuvenation" of the age pattern of fertility.

Age Patterns and the Fertility Transition

Different age patterns of fertility are illustrated in Figure 1 for three groups of countries that in the late 1990s were at different stages of the fertility transition. In the pre-transitional least-developed countries (most of them in sub-Saharan Africa) the total fertility rate averages 5.5 children per woman, 40 percent of which is contributed, on average, by women of age 30 and older. For other developing countries that are progressing through the fertility transition, with total fertility rates averaging 2.8 children per woman, this share drops to 30 percent. In the developed countries, where the demographic transition has been concluded and average total fertility rates are 1.6 births per woman, the share has risen again, to 35 percent.

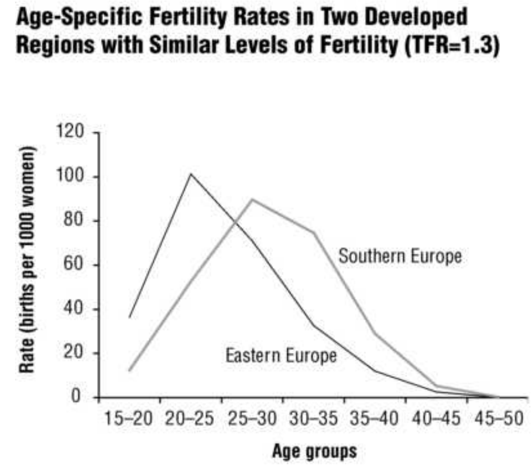
Fertility often decreases more at older ages than at younger ages during the early stages of the fertility transition, thus resulting in a lowering of the mean age at childbearing and rejuvenation of the fertility pattern. This happened in most developed countries from the late nineteenth century until the 1970s. At the early stages of the fertility transition, a similar

FIGURE 1



SOURCE: United Nations Population Division (2000).

FIGURE 2



SOURCE: United Nations Population Division (2002).

pattern of change was typical for many developing countries of south central and Southeast Asia and Latin America and the Caribbean. Declines in fertility at young ages due to increasing age at marriage initially had a smaller impact on total fertility in comparison to the effects of stopping behavior among older women.

At the later stages of the fertility transition, the balance of these two influences typically shifts, resulting in an increase in the average age of childbearing. In northern Africa and several western Asian countries, the greater part of the fertility decline from the high levels of the 1970s or 1980s to the intermediate or low levels of the 1990s was caused primarily by rising age at marriage, which in the absence of extramarital fertility led to later childbearing.

In the developed countries, fertility decline to replacement level was achieved mostly through a decreasing incidence of high-parity births to relatively older women. Faster decreases of fertility at older ages outweighed the effect on the average age of childbearing of the increasing age at first birth. As a result, the age pattern of childbearing rejuvenated. But the trends toward a younger age pattern of fertility reversed in most developed countries since the 1980s. The aging of age patterns of fertility was especially pronounced in the 1990s. Below-replacement age patterns of fertility are characterized by low levels of fertility among young women (women in their twenties) because of postponement of childbearing until the early and even late thirties and by the fact that large proportions of women stop having additional children after one or two. The shift toward such a pattern has caused the average age at childbearing to rise: Data for around the year 2000 show fertility typically peaking in the age interval from 25 to 29 years; in some countries the peak is in the age group from 30 to 34. In Eastern Europe, however, the age at first birth traditionally was and has remained lower than in other developed regions; consequently, the age pattern of fertility there is young, with the highest fertility in the age group 20 to 24, as shown in Figure 2.

Significance of Age Patterns

Aging of childbearing has an important impact on fertility levels and trends. When childbearing starts before age 20, as is typical in developing countries, the period available for childbearing lasts for approximately 24 years and the period of high fecundity (lasting until around age 35) is 17 to 18 years long. Shortening of the childbearing period in women's lives is an important determinant of persistent below-replacement fertility in many developed and an increasing number of developing countries. In fact, although earlier menarche lengthens the fecund life span, postponement of first births until around age 30 shortens the effectively used fecund period to 12 years and the effectively used period of high fecundability to just 5 to 6 years. When young women postpone births and subsequently try to make up these postponed births in their late 30s or beyond, they are often confronted with increasing likelihood of failure to conceive. Thus, shifts in the schedule of childbearing toward older age depress fertility levels.

See also: *Adolescent Fertility; Mortality, Age Patterns of; Natural Fertility.*

BIBLIOGRAPHY

Hinde, Andrew. 1998. *Demographic Analysis.* New York: Oxford University Press.

Lesthaeghe, Ron, and Paul Willems. 1999. "Is Low Fertility a Temporary Phenomenon in the European Union?" *Population and Development Review* 25(2): 211–228.

Rallu, Jean-Louis, and Laurent Toulemon. 1994. "Period Fertility Measures: The Construction of Different Indices and their Application to France, 1946–89." *Population: English Edition* 6: 59–96.

United Nations Population Division. 2000. "Fertility Trends Among Low Fertility Countries." *Population Bulletin of the United Nations* 40/41: 35–125.

———. 2000. *World Population Prospects: The 2000 Revision.* CD-ROM Sales No. E.01.XII.3. New York: United Nations.

Serguey Ivanov
Vasantha Kandiah

FERTILITY, BELOW-REPLACEMENT

Below-replacement fertility is defined as a combination of fertility and mortality levels that leads to a negative population growth rate, hence a declining population size, in a closed stable population. Equivalent definitions of the term, still with reference to a closed stable population, include: the number of deaths exceeds the number of births; the absolute number of births declines over time; the life-expectancy is below the inverse of the crude birth rate; and the net reproduction rate (NRR) is below one. As the reference to the NRR indicates, *replacement* is most conveniently interpreted for a single-sex (female) population: replacement then means that one female generation replaces itself in the next generation. This condition is satisfied if 1,000 newborn female babies—that is to say, their survivors—give birth to 1,000 female babies over their lifetime; or, equivalently, if 1,000 women at age 15 have female births over their lifetime in numbers that yield 1,000 women survivors at age 15 in the next generation.

The most common measure of fertility, the period total fertility rate (TFR), refers, however, to a two-sex population: it includes both male and female births. TFR indicates the number of births women would have, on average, if during their reproductive lifetime they experienced the age-specific fertility rates observed in a given period (such as a year) in the absence of mortality. It is evident from the definitions above that the TFR, by itself, does not provide an unambiguous definition of below-replacement fertility. Yet a TFR of 2.1 is often referred to as the replacement level fertility. It is in fact a good approximation to replacement level under conditions of very low mortality. The value 2.1 reflects the fact that the sex ratio at birth (the ratio of male births to female births) is about 1.05 in most human populations. Thus replacement of the population would require that, in the complete absence of mortality, women on average have 2.05 children (i.e., 1,000 women would have to have 1,000 female births and 1,050 male births). The small difference between 2.1 and 2.05 allows for the effect of mortality—a good enough approximation, as noted above, in very low mortality populations. In such populations, then, a TFR below 2.1 is below-replacement fertility. But when mortality is higher, below-replacement fertility may be present even though TFR are levels considerably higher than 2.1. How much higher will depend primarily on the overall level of mortality and, to a lesser but not negligible extent, also on the precise age pattern of mortality and fertility. The following are the replacement levels for TFRs associated with various levels of $\mathring{e}_0$ (life expectancy at birth)—a good summary index of the overall level of mortality—and an average age of maternity of 29 years. Each of these combinations yields

TABLE 1

Replacement-Level Total Fertility Rates at Various Levels of Mortality

$\mathring{e}_0$ (years)	TFR
25	5.21
35	3.83
45	3.08
55	2.61
65	2.30
75	2.11
80	2.06

SOURCE: Coale and Demeny (1983).

stable populations with a zero rate of population growth (see Table 1).

TFR values lower than those indicated imply stable populations with negative growth rates. If the shortfall is substantial, the rate of population decline in the stable state will be rapid. For instance, a TFR of 1.3 implies an annual decline of the population size by approximately 1.5 percent in a stable population with very low mortality levels. Such a decline implies a reduction of the birth cohort by 50 percent and a halving of the population size every 45 years. Small TFR differences become increasingly important when fertility is lower: a difference of 0.3 between a total fertility rate of 1.0 and 1.3 is approximately equivalent, in terms of stable population growth rates, to the more than threefold greater difference between a total fertility rate of 3.2 and 4.2 in high fertility contexts (assuming low mortality in both instances).

If a population is not stable but has an age distribution shaped by fluctuating past fertility and/or mortality levels, the above definitions of below-replacement fertility are no longer equivalent. Replacement in the period sense—that is, a zero difference between births and deaths occurring in a given calendar year—depends strongly on the prevailing age structure of the population. A period TFR of 2.1 (assuming low mortality) may then be associated with a surplus of births over deaths if women of childbearing age represent an unusually high share of the population (compared to the share in the stable population implied by the prevailing fertility and mortality) and a surplus of deaths over births if women of childbearing age are underrepresented. Similarly, replacement in a cohort sense depends on the long-term trend in TFR levels. Thus, temporary shortfalls of period fertility from replacement level can be consistent with full cohort replacement if there is sufficient subsequent recovery in period fertility. The common, if casual, use of TFR interprets the eventual average fertility a cohort would experience if subject to the current period fertility pattern during its life-course as not just an indicator of the current level of fertility but as implying also its long-term continuation. Hence familiar statements are often used such as "Italian women in the late 1990s have 1.2 children." Such interpretations of the period TFR may, however, be misleading as the ultimate cohort experiences could turn out to be substantially different. In particular, the characteristic postponement of childbearing in many low fertility countries leads to tempo effects that reduce measures of period fertility below the level that would have been observed in the absence of timing changes. In addition, rapid fertility declines and/or delays imply that the period parity distribution is out of equilibrium, with an over-representation of women at higher parities; this condition further depresses period measures such as the TFR due to compositional effects.

Patterns of Below-Replacement Fertility

Fertility at or above replacement levels has prevailed for most of human history: by definition, it was necessary for human survival. As a long-term average, fertility must have been slightly above replacement. Above, since human numbers were growing; slightly, because average long-term growth was very slow. Nevertheless, below-replacement fertility is not a new phenomenon. Many human populations did become extinct in the remote and not so remote past. In almost every such case the main driving force was a high mortality rate that raised the level of fertility that would have been required for population replacement much above the actually prevailing fertility level. However, as mortality (up to the end of the childbearing years) increasingly came under control, fertility behavior became the key determinant of population growth. Low fertility strategies were initially adopted by some subpopulations, such as the bourgeoisie in nineteenth-century Europe, but the practice gradually spread also to other social classes. Despite this spread, overall fertility levels, reflecting still high mortality risks, remained relatively high. For instance, the lowest national fertility level at the beginning of the twentieth century was in France, which had a TFR of 2.79.

Total fertility levels below two, unambiguously below replacement, became common in many countries of the West in the period between World War I and II. This raised considerable concern about depopulation, even though population growth still continued, as the age distribution, reflecting past demographic conditions, temporarily delayed the onset of a decline in population numbers. After World War II, fertility levels rose significantly, creating the unexpected baby boom. But by the late 1950s in the United States and in the early 1960s in much of Europe, the trend reversed and fertility fell rapidly. By the end of the twentieth century, virtually all developed countries and a few developing countries exhibited below-replacement fertility and fertility levels in an increasing number of other developing countries were approaching a TFR of 2.1. The formerly quite distinct fertility regimes of the developed and the developing worlds have become increasingly similar.

Several features of this situation are particularly striking. First, the spread of below-replacement fertility to formerly high-fertility countries occurred at a remarkably rapid pace: The global convergence of fertility indicators has been quicker than the convergence of many other socioeconomic characteristics. Second, earlier notions that fertility levels may naturally stabilize close to replacement level have proven incorrect. In the early 1990s, for instance, fertility levels in Italy and Spain sank below a TFR of 1.3—an unprecedentedly low level for a national population. At the end of the 1990s there were 14 countries in Southern, Central, and Eastern Europe with TFRs of 1.3 or less. Several other countries, such as Germany, Japan, and South Korea, had TFRs not much above 1.3. Third, there has been a remarkable divergence in the fertility levels of developed countries. For instance, the TFR in the United States rose from a trough of 1.74 in 1976 to levels slightly above 2.05 in the late 1990s. Similarly, TFR levels in the Netherlands, Denmark, France, and several other countries have recovered and stabilized at between 1.7 and 1.9. This divergence of fertility levels in developed countries has been accompanied by a shift or even a reversal of many formerly observed associations between fertility and other demographic and social behaviors. For instance, the cross-sectional correlations in OECD countries (member countries of the Organisation for Economic Co-operation and Development) of fertility levels with the first marriage rate, the proportion of births outside marriage, and the female labor force participation rate have reversed during the period from 1975 to 1999. At the end of the 1990s, divorce levels seemed no longer to be negatively associated with fertility levels in Europe. Hence, there have been crucial changes in the relationships of fertility to its traditional determinants—such as marriage, divorce, leav ing home, and female labor force participation. A high prevalence of marriage and long-term partnerships is no longer associated with higher fertility in cross-sectional comparisons among European countries.

This reversal in cross-sectional associations between fertility and related behaviors is in part due to the different demographic factors driving fertility change. Initially, the decline toward low fertility has been strongly related to stopping behavior—that is, to a reduction in higher parity births. More recently, the postponement of fertility—particularly the postponement of first births—has emerged as a crucial determinant of differences in fertility levels among developed countries. For instance, during the period 1980 to 1999 the period mean age at first birth increased from 25.0 to 29.0 years in Spain and from 25.7 to 28.7 years in the Netherlands; in the United States it has increased from 22.0 years in 1972 to 24.9 in 2000. This postponement affects fertility levels through two distinct mechanisms. First, the tempo-distortions described earlier contribute to reduced period fertility levels. (These reductions may be absent or substantially muted in cohort fertility.) Second, delays in childbearing also affect parity progression probabilities because women start being at risk of higher parity births only at later ages.

Determinants of Below-Replacement Fertility

In light of these demographic factors leading to low fertility, explanations must differentiate between contexts where the primary response of individuals to changing socioeconomic circumstances is stopping behavior and contexts in which the primary response is postponement of births. In the former case, the key issue is what determines the demand for children and hence the quantum of fertility (the lifetime number of births per woman or its period equivalent calculated for synthetic cohorts). The frameworks used for explaining fertility decline during the demographic transitions are largely applicable in answering that question. For instance, theories of fertility variously relate reductions in the quantum of fertility to increased child costs, a reversal of intergenerational wealth flows, increased levels of education (especially for females), higher opportunity costs of time due to increased opportunities of female labor force participation, fertility-friendly population policies, and other factors affecting incentives for women or couples to have children. In general, it can be said that countries with below-replacement fertility share an institutional and socioeconomic context that favors an overall low quantum of fertility. In addition, there is evidence that the emergence and persistence of low fertility is also due to the diffusion of low fertility norms and value orientations. This explanation has been particularly emphasized in theorizing about the so-called second demographic transition, in which demographic change in developed countries since the 1970s has been closely linked to ideational shifts toward more postmodern, individualistic, and post-materialistic value orientations. As a consequence, both acceptability and practice of cohabitation, out-of-wedlock childbearing, and divorce have increasingly spread through young cohorts along with desires for low fertility; these desires were achieved by the availability of effective contraception.

The factors explaining the emergence of below-replacement fertility over time can differ significantly from country to country. For example, as shown by Kohler and his colleagues in 2002, a rise in childlessness (as calculated in period terms) is not a primary driving force leading to very low fertility levels in Southern, Central, and Eastern European countries. Childlessness, however, does constitute an important factor in Germany and Austria. This suggests that even in situations characterized by fertility well below replacement level, biological, social, and economic incentives are generally strong enough to make most women (or couples) want at least one child, and that high levels of childlessness in some countries are likely due to special institutional factors that favor a polarization of fertility behavior toward either childlessness or relatively high fertility.

The reasons for the postponement of childbearing in many developed countries seem to be twofold. First, several factors make late childbearing a rational response to socioeconomic changes. These factors include increased incentives to invest in higher education and labor market experience, and economic uncertainty that may be particularly acute in early adulthood. Second, social interaction effects are likely to reinforce individuals' desire to delay childbearing in response to socioeconomic changes. These interaction effects are a result of social learning and social influence in the decision processes about the timing of fertility, and can also be caused by feedback in the labor and marriage market that make late fertility individually more rational the later the population age-pattern of fertility is. As a consequence of these interaction effects, a delay of childbearing follows what may be called a postponement transition. This is a behavioral shift that shares many characteristics with the earlier fertility transition in Europe and contemporary developing countries: It occurs across a wide range of socioeconomic conditions; once initiated, it results in a rapid and persistent delay in the timing of childbearing; and it is likely to continue even if the socioeconomic changes that initiated the transition are reversed.

In summary, therefore, the emergence and persistence of below-replacement fertility is related to three distinct transition processes: The (first) demographic transition leading to parity-specific stopping behavior within marriage; the second demographic transition resulting in ideational changes and in the rise of non-marital family forms; and, most recently, the postponement transition toward late childbearing regimes. As a consequence of the still ongoing postponement transition, the extent to which specific socioeconomic and institutional contexts accommodate late childbearing has emerged as an essential determinant of cross-country variation in fertility levels. In particular, the delay of childbearing is usually associated with substantially increased investments in female education and labor market experience prior to parenthood—investments that increase the opportunity costs of childbearing in terms of wages foregone. The extent to which these increased opportunity costs affect the quantum of fertility appears to be strongly influenced by the degree of compatibility between childbearing and female labor force participation. Countries with below replacement fertility show marked differences in this regard and these differences are reflected in the degree to which fertility falls short of replacement level. Countries with low compatibility between female labor force participation and childbearing, such as Italy and Spain, exhibit substantially delayed childbearing and especially large reductions in completed fertility.

The Future of Below-Replacement Fertility

Given the socioeconomic and institutional conditions that favor generally low fertility, it is difficult to foresee any widespread tendency for fertility levels in Europe or other developed countries to return to levels persistently above a TFR of 2.1. Many additional countries are likely to experience below-replacement fertility in the near future, and a TFR of 2.1 does not constitute a natural endpoint to the fertility decline. The feasibility of widespread, safe, and reliable childbearing above age 35 that could counteract some of the effects of late-starting motherhood on total fertility, is at best weakly supported by the medical literature, and there are no signs that the process of postponement of childbearing to later ages will come to a halt in the near future.

There are some mechanisms that could potentially lead to a reversal of below-replacement fertility. The quantum and desired level of fertility could be increased by improvements in the economic situation, especially for young adults, and by social policies that provide increased incentives for having children—for example, improved child-care provision, better access to labor markets for women with children, and increased income transfers to families with children. Homeostatic forces may emerge that increase the quantum of fertility as rapid fertility declines lead to substantially reduced relative cohort sizes. When these small cohorts begin higher education, or begin to enter the labor and housing markets, they are likely to encounter substantially more favorable conditions than their older predecessors in large cohorts experienced, and this could lead to an earlier onset and higher level of fertility. This fertility-enhancing effect of small cohort sizes, first proposed by American economist and demographer Richard Easterlin in the context of the U.S. baby boom may be particularly potent in countries in which fertility has fallen far below replacement level.

See also: *Childlessness; Family: Future; Family Policy; Population Decline; Population Policy; Second Demographic Transition.*

BIBLIOGRAPHY

Bongaarts, John, and Griffith Feeney. 1998. "On the Quantum and Tempo of Fertility." *Population and Development Review* 24(2): 271–291.

Brewster, Karin L., and Ronald R. Rindfuss. 2000. "Fertility and Women's Employment in Industrialized Nations." *Annual Review of Sociology* 26: 271–296.

Caldwell, John C. 1982. *Theory of Fertility Decline.* New York: Academic Press.

Coale, Ansley J., and Paul Demeny. 1983. *Regional Model Life Tables and Stable Populations,* 2nd ed. New York: Academic Press.

Easterlin, Richard A. 1980. *Birth and Fortune: The Impact of Numbers on Personal Welfare.* Chicago: University of Chicago Press.

Foster, Caroline. 2000. "The Limits to Low Fertility: A Biosocial Approach." *Population and Development Review* 26(2): 209–234.

Gauthier, Anne H. 1996. *The State and the Family: A Comparative Analysis of Family Policies in Industrialized Countries.* New York: Oxford University Press.

Kohler, Hans-Peter, Francesco C. Billari, and José Antonio Ortega. 2002. "The Emergence of Lowest-low Fertility in Europe during the 1990s." *Population and Development Review.* 28(4): 641–680.

Morgan, Philip S., and Rosalind B. King. 2001. "Why Have Children in the 21st Century? Biological Predispositions, Social Coercion, Rational Choice." *European Journal of Population* 17(1): 3–20.

Teitelbaum, Michael S., and Jay Winter. 1985. *The Fear of Population Decline.* London: Academic Press.

Vallin, Jacques, and Graziella Caselli. 2001. "Le remplacement de la population." In *Démographie: Analyse et synthèse,* ed. G. Caselli, J. Vallin and G. Wunsch, pp. 403–420. Paris: PUF–INED.

van de Kaa, Dirk J. 1987. "Europe's Second Demographic Transition." *Population Bulletin* 42(1): 1–59.

Wilson, Chris. 2001. "On the Scale of Global Demographic Convergence 1950–2000." *Population and Development Review* 27(1): 155–172.

HANS-PETER KOHLER
JOSÉ ANTONIO ORTEGA

FERTILITY, NONMARITAL

In nearly all developed countries the proportion of infants that are born to women who are not married increased dramatically in the last decades of the twentieth century. In most cases this is true across all age groups of childbearing women. Behind these trends, however, there are substantial differences in patterns of nonmarital fertility and in the implications for children born to these women. Some of the important dimensions of interest include whether or not the parents of the child are cohabitating at the time of the birth and whether nonmarital childbearing is concentrated among teenagers or those with less education or particular ethnic or other groups in the population.

National Patterns of Nonmarital Fertility

As of 1998 the Scandinavian countries had the highest proportion of births to nonmarried mothers—over half of all births in Sweden and more than 60 percent in Iceland (see Figure 1). The proportion in the United States was approximately one-third, just below the United Kingdom and just above Canada. Southern European countries tend to have low rates: in Italy and Greece, for example, less than 10 percent of births were nonmarital. Japan stands out with its nearly zero rate.

The large majority of nonmarital births in Scandinavian countries are to cohabitating couples. Cohabitation and nonmarital rates generally go hand in hand. However there are exceptions such as Britain, with higher levels of nonmarital childbearing than cohabitation, and the Netherlands and Germany, with high levels of cohabitation and low rates of nonmarital births. In the United States less than half the births to unwed mothers are to cohabitating couples, but this proportion has been increasing.

Nonmarital Fertility in the United States

In the early 1970s about one-half of nonmarital births in the United States were to teenagers but by the mid-1990s, more than two-thirds were to women aged 20 and older. Figure 2 shows the trends in rates over time. The big increase from 1970 onward is in the rates for women 20 to 24; the rates for women 25 to 29 (not shown) have also risen but not by as much. Accompanying this trend has been a rise in the proportion of nonmarital births that are second or higher-order births. By the end of the period these made up one-half of all nonmarital births; indeed about one-quarter of all nonmarital births were third or higher-order births.

In the United States, patterns of nonmarital fertility differ by race. In the mid-1990s about one-third of first births were outside marriage; among blacks this proportion was more than 80 percent. The nonmarital birth rates for Hispanics are even higher than those for blacks. The biggest increases in rates since the mid-1970s have been among white women and this has narrowed the differences between blacks and whites. Since 1995 the rates for non-Hispanic white women have been stable while the rates for black women have continued to decrease.

In the late 1990s, the mean age at first nonmarital birth was approximately 21 for both black and white women. The probability of having a second nonmarital birth varies by race. Among black women who had a first nonmarital birth, more than 60 percent have a second nonmarital birth; among white women the corresponding percentage is 35 to 38 percent. Altogether, in 1999, for white women nonmarital births accounted for 27 percent of all their births; for black women, 69 percent; and for Hispanic women, 42 percent.

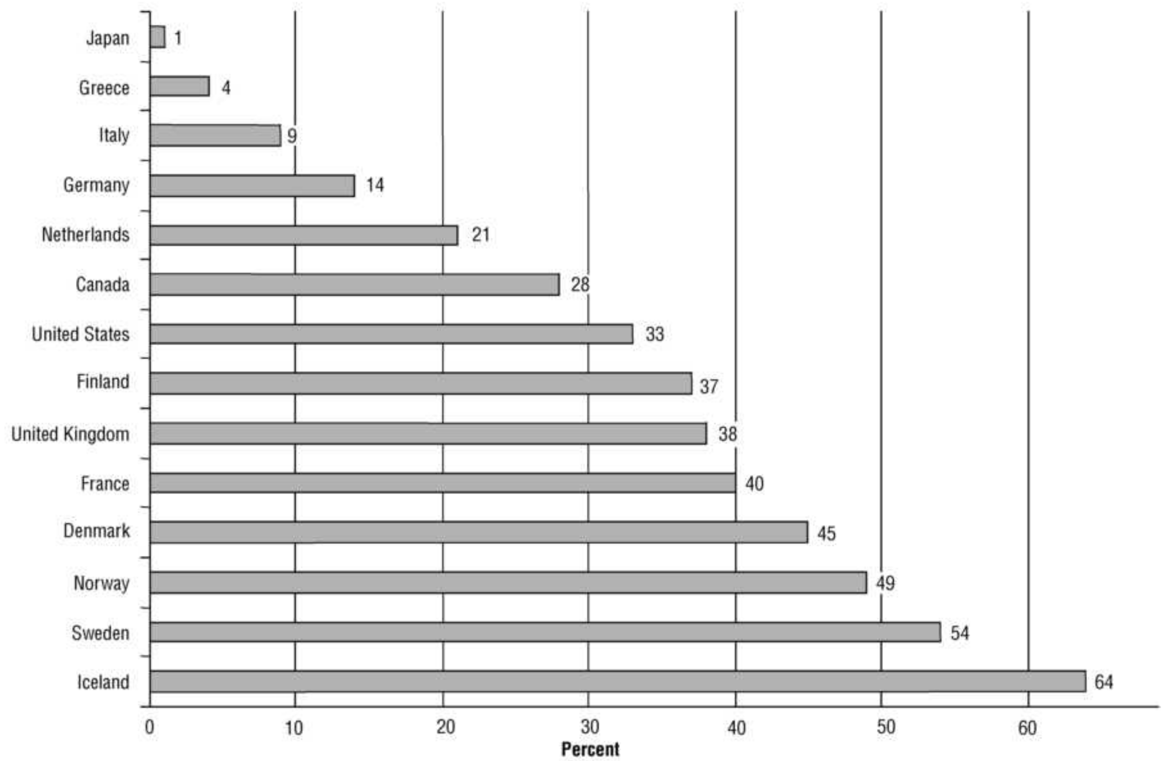
Rates differ across states or districts and cities within the United States: as of 1999, Washington, DC, had the highest proportion of nonmarital births, at 62 percent. Mississippi, Louisiana, and New Mexico also have rates far above the national average which, as is shown in Figure 1, was 33 percent. Utah has the lowest rate, 17 percent. Most of these differences are thought to reflect the racial/ethnic composition of the populations of these areas.

Economic and Demographic Causes of Nonmarital Childbearing

Various explanations for these patterns have been proposed, some emphasized by demographers, others by economists. According to demographers (see Ventura and Bachrach 2000), the factors underlying the U.S. trends, for example, are an increase in age at marriage, which increases the pool of women able to have nonmarital births; a decline in the birth rate among married women; and an increase in the rate of births among unmarried women of all ages. The fact that nonmarital birth rates and the proportion of births that are nonmarital have increased in most developed countries has led demographers such as Larry Bumpass to argue that these trends reflect so-

FIGURE 1

Births to Nonmarried Women as Percentage of All Births, Selected Developed Countries, 1997–1998



SOURCE: Ventura and Bachrach (2000).

cial forces such as increased rates of labor force participation of women, high levels of sex outside of marriage, and high rates of divorce. According to economists, on the other hand, factors that lead a woman to have a child out of wedlock include a low probability of finding an attractive partner (that is, eligible men with good earnings prospects are scarce); the ability to provide for oneself or draw on support from social service programs; the minimal stigma attaching to such behavior—for example, if the woman's mother had had a nonmarital birth or if the behavior was prevalent in the community; high rates of divorce; and the high costs of contraception or avoiding a pregnancy. These factors are linked to characteristics, such as individual schooling, that increase the ability to provide for oneself. Upchurch, Lillard, and Panis, in their work of 2002, go beyond these models and focus on the effects of life course events such as education, marriage, divorce, and childbearing within marriage. They find, for example, that school attendance itself is likely to reduce nonmarital childbearing, perhaps because it raises the value of time, or perhaps because those in school have better access to contraceptives.

Trends in Nonmarital Childbearing

It is clear that the general trend over recent decades has been toward an increasing proportion of nonmarital births in nearly all developed countries. A far greater proportion of nonmarital births take place in cohabitating unions. A far greater proportion are to women in the working and middle classes. Nonmarital childbearing is clearly much more mainstream than a few decades ago.

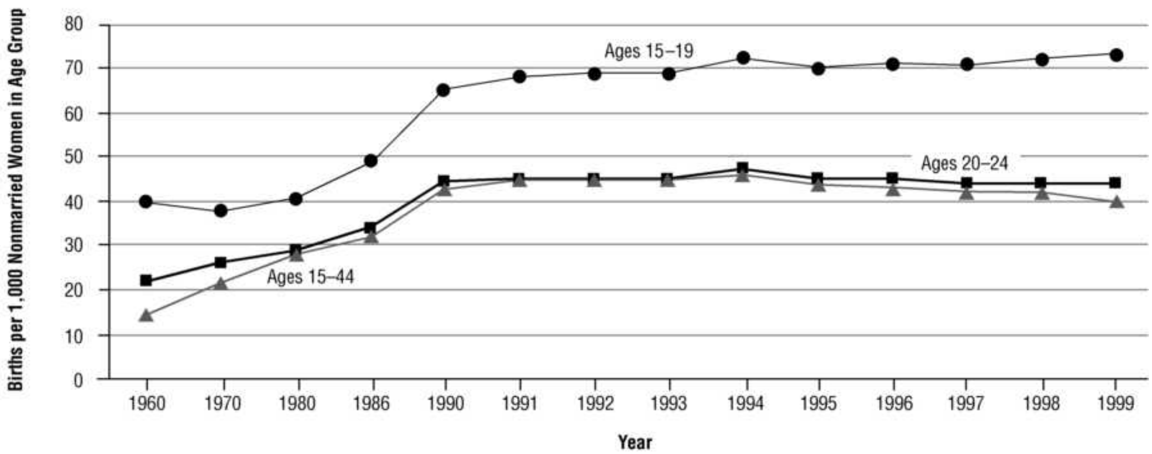
See also: *Cohabitation; Family: Future; Marriage.*

BIBLIOGRAPHY

Upchurch, Dawn, Lee Lillard, and Constantijn Panis. "Nonmarital Childbearing: Influences of

FIGURE 2

Nonmarital Birth Rates, Selected Age Groups, United States, 1960–1999



SOURCE: *Child Trends Facts at a Glance* (August 2001).

Education, Marriage and Fertility." *Demography* 39(2): 311–329.

Ventura, Stephanie J., and Christine A. Bachrach. 2000. "Nonmarital Childbearing in the United States, 1940–99." *National Vital Statistics Reports* 48(16).

Wu, Larry, Larry Bumpass, and Kelly Musick. 2001. "Historical and Life Course Trajectories of Nonmarital Childbearing." In *Out of Wedlock: Causes and Consequences of Nonmarital Fertility,* ed. Larry Wu and Barbara L. Wolfe. New York: Russell Sage Foundation.

INTERNET RESOURCE.

Child Trends Facts at a Glance. August 2001. <http://www.childtrends.org/PDF/FAAG2001.pdf>.

BARBARA L. WOLFE

FERTILITY, PROXIMATE DETERMINANTS OF

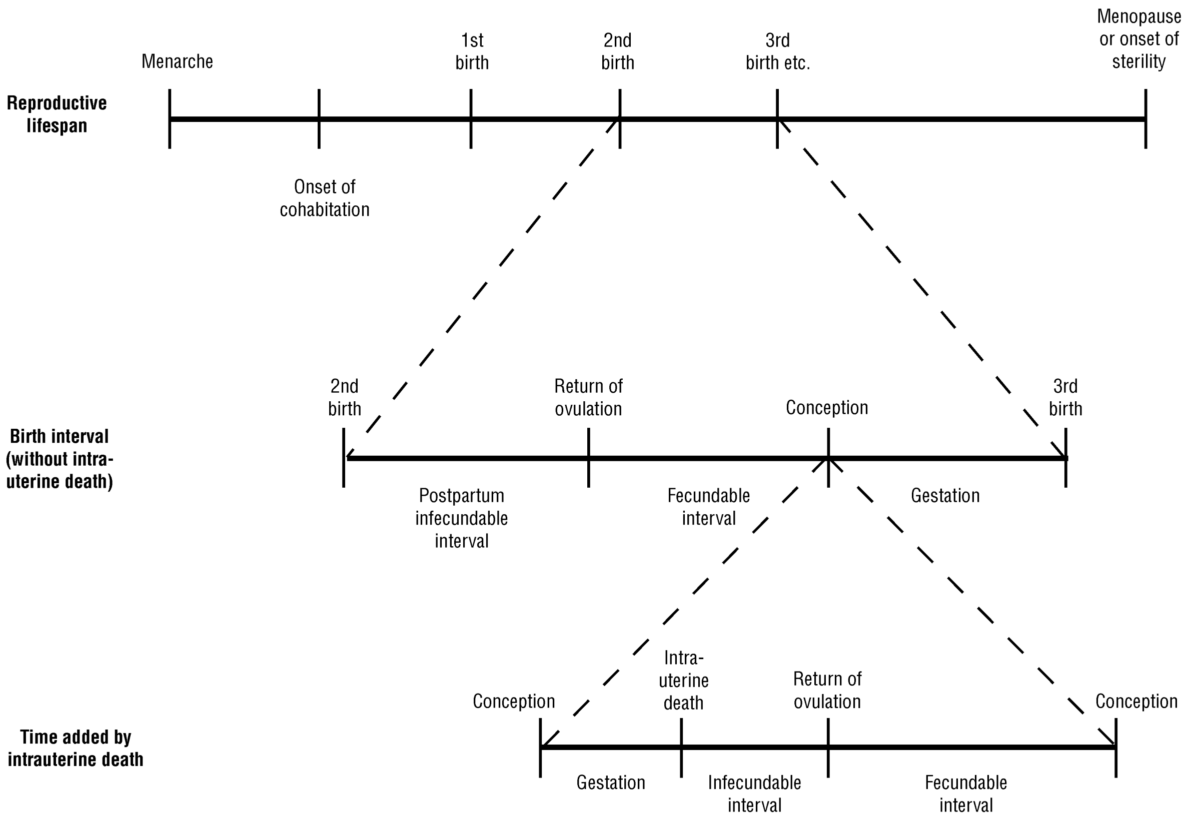
The proximate determinants of fertility are the biological and behavioral factors through which the indirect determinants—social, economic, psychological, and environmental variables—affect fertility. The distinguishing feature of a proximate determinant is its direct connection with fertility. If a proximate determinant, such as contraceptive use, changes, then fertility necessarily changes also (assuming the other proximate determinants remain constant), while this is not necessarily true for an indirect determinant of fertility such as income or education. Consequently, fertility differences among populations and trends in fertility over time can always be traced to variations in one or more of the proximate determinants. The following simple sequence summarizes the relationships among the determinants of fertility.

Social, economic, psychological, environmental variables → Proximate determinants → Fertility

These relationships were first recognized in the mid-1950s when Kingsley Davis and Judith Blake defined a set of proximate determinants that they called the "intermediate fertility variables." John Bongaarts and Robert C. Potter defined a somewhat different set of proximate determinates in the late 1970s and early 1980s, greatly simplifying the task of construct-

FIGURE 1

Events Determining the Reproductive Life Span and the Rate of Childbearing



SOURCE: Bongaarts and Potter (1983).

ing models of human reproduction. This set will be presented here.

Proximate determinants are easily identified by examining the events that most immediately affect the duration of the reproductive period and the rate of childbearing during that period (see Figure 1). The potential reproductive years start at menarche, a woman's first menstruation. Actual childbearing in virtually all societies, however, is largely limited to women in socially-accepted sexual unions such as marriage. Since, with few exceptions, first cohabitation takes place some time after menarche, this delay reduces the number of years available for reproduction. If exposure to the possibility of conception is maintained, childbearing can continue until the onset of permanent sterility, which takes place at or before menopause.

While in a sexual union and fecund, women reproduce at a rate inversely related to the duration of the birth interval: short birth intervals are associated with a high birth rate and vice versa. In the absence of intrauterine mortality, the duration of a birth interval is determined by three time components. The first is the postpartum infecundable interval from birth to the first postpartum ovulation. During this period women are unable to conceive. The second is the fecundable interval (also called the ovulatory interval, or the waiting time to conception) from the first ovulation to conception. During this period women are able to conceive if they have sexual intercourse. The duration of this interval is determined by the monthly probability of conception, which is in turn determined by the level of *fecundability* (the monthly conception probability in the absence of contraception) and by the effectiveness of any contraception practiced. The third time component is a full-term pregnancy interval of nine months. In the event that an intrauterine death occurs, whether spontaneous or induced, the birth interval is lengthened by additional components: the shortened pregnancy is followed by a very brief infecundable period and an additional fecundable period (Figure 1).

This overview of the reproductive process identifies the following proximate determinants:

onset of cohabitation and union disruption;

onset of permanent sterility;

the duration of postpartum infecundability;

fecundability;

use and effectiveness of contraception;

spontaneous intrauterine mortality; and

induced abortion.

The first two of these factors determine the duration of the reproductive period, and the latter five determine the rate of childbearing.

Onset of Cohabitation and Union Disruption

In recent decades cohabitation before marriage or without marriage has become increasingly common, but in most societies marriage remains the main form of socially-sanctioned cohabitation. The mean age for women at first marriage varies widely among populations. In traditional societies in Asia and Africa, first marriage often takes place relatively soon after menarche. In contrast, the mean age at first marriage or cohabitation in a number of European populations is near 25 years. The timing of first marriage is correlated with the prevalence of permanent celibacy; populations with a high age at marriage tend to have high proportions of women who never enter a union and vice versa.

Patterns of union disruption have changed considerably over time. While divorce was historically uncommon worldwide until recent decades, it has increased rapidly in developed countries. In the developed world, a relatively large proportion (in a few cases more than one-third) of all marriages end in divorce. The fertility impact of divorce is minimized by the rapid remarriage of the majority of divorced women of reproductive age. Widowhood was historically an important cause of union disruption in all countries, but its prevalence has declined with the level of mortality. For example, in India in 1901, 46 percent of women had been widowed by age 45. In contrast, in the twenty-first century only a few percent of women in the developed world experience widowhood during their reproductive years.

The mean age at onset of cohabitation, the prevalence of permanent celibacy, and the rate of union disruption are the main determinants of the average proportion of reproductive years women are exposed to the possibility of childbearing. In populations with early and universal cohabitation, the proportion of the potential reproductive years lost is typically one-fifth or less, but this proportion can approach one-half in populations with late onset of cohabitation and a high incidence of permanent celibacy.

Onset of Sterility

Menopause, the complete cessation of menstruation, marks the end of the potential childbearing years. In the United States and western Europe, an individual woman's age at menopause can range from less than 40 to near 60, with averages around 50. Only a few studies have been made in developing countries, and because of various methodological problems including recall errors and age misreporting, it is not clear whether a substantial difference in mean age of menopause exists between the populations of developing and developed countries.

Postmenopausal women are definitely sterile, but the onset of sterility can occur several years before menopause. Menstrual cycles become increasingly irregular in the years before menopause, presumably reflecting a rising incidence of anovulatory cycles. A high risk of spontaneous intrauterine mortality also contributes to reduced fecundity among women over age 40. In addition to these sterility factors for women, there is some sterility (but of lower frequency) among their male partners. The resulting couple sterility is estimated to reach 50 percent when women are in their early forties. This early age of onset of sterility is consistent with observations of a mean age at last birth of around 40 years in many populations that do not practice contraception.

Postpartum Infecundability

The duration of the anovulatory interval after a birth is usually estimated from the delay in the return of menstruation—the interval of postpartum infecundability is assumed to equal the duration of postpartum amenorrhea. This assumption is apparently quite accurate when applied to the average interval in a population, although in some women the first ovulation precedes the first menstruation. It is now well established that the duration and pattern of breastfeeding are the principal determinants of the duration of postpartum amenorrhea. In the absence of breastfeeding the menses return shortly after birth, with average amenorrhea durations of 1.5 to 2 months. As the duration of breastfeeding increases, so does the amenorrhea interval. A woman experiences approximately one additional month of amenorrhea for each two-month increment in breastfeeding duration. With long lactation, mean amenorrhea intervals from one to two years are observed in developed as well as in developing countries. Several studies, comparing entire populations or subpopulations between countries, have documented high levels of correlation between breastfeeding and amenorrhea durations. On the individual level the correlation between lactation and amenorrhea intervals, while still highly significant, is somewhat lower. The most plausible explanation for this, aside from measurement error, is that women differ not only with respect to the duration of breastfeeding, but also with respect to the type and pattern of breastfeeding. Women who fully breastfeed have a lower probability of resumption of menses than women whose infants receive supplemental food such as fluids by bottle or solids. The inhibiting effect of breastfeeding on ovulation and menstruation, as well as the differential impact according to the type and pattern of breastfeeding, are believed to be the result of a neurally-mediated, hormonal reflex system stimulated by the child's sucking the breast nipple.

Fecundability

Fecundability equals the monthly probability of conceiving among women who menstruate regularly but do not practice contraception. Typical average fecundability levels among young cohabiting partners range from 0.15 to 0.25, depending primarily on frequency of intercourse. Lower values are found at higher ages and longer durations of cohabitation. This monthly conception probability is substantially less than 1.0 because fertilization can only take place during a short period—approximately two days—around the time of ovulation in the middle of a menstrual cycle. In addition, some cycles are anovulatory and a substantial proportion (perhaps a third) of fertilized ova fail to implant, or are spontaneously aborted in the first two weeks after fertilization. These aborted fertilizations are usually not counted as conceptions in the demographic literature because they cause little or no disruption in the menstrual cycles and women are often unaware of such brief pregnancies. Levels of fecundability around 0.2 imply that many women do not conceive for a number of months even if they have regular intercourse. Typical average delays to conception range from five to ten months.

Contraception

The prevalence of contraception varies widely among populations. The percent of cohabiting women of reproductive age currently using contraception ranges from near zero in a number of developing countries with high fertility, to above 75 in a number of developed countries. The use of contraception affects fertility because it decreases the risk of conception. The effectiveness of contraception is measured as the percent of reduction in fecundability. For example, a contraceptive with an effectiveness of 90 percent used by a group of women with a fecundability of 0.2 will yield an actual monthly probability of conception of 0.02. Contraceptive effectiveness depends on the method as well as on the motivation and knowledge of the user. In developed countries, the effectiveness of modern methods such as the birth control pill and the intrauterine device (IUD) is more than 95 percent, and the effectiveness of conventional methods such as the condom, diaphragm, or spermicides is around 90 percent. Those levels are believed to be lower in developing countries, but reliable information about effectiveness in these populations is virtually nonexistent.

Spontaneous Intrauterine Mortality

It has proven difficult to make estimates of the risk of intrauterine mortality. Retrospective reports of pregnancy histories of individuals are known to be deficient because of recall errors, but estimates based on prospective studies also vary. This is in large part due to the difficulty in obtaining accurate reporting of intrauterine deaths in the early months of pregnancy, when it may not be easy to distinguish between a delayed menstruation and an early spontaneous abortion. The most carefully designed studies estimate that about 20 percent of conceptions will not end in a live birth (not including embryonic deaths occurring before the first missed menstruation). Nearly half of these spontaneous abortions occur before the third month of pregnancy. This estimate of 20 percent is an average for women of all ages. The risk of intrauterine mortality is lowest in the mid-reproductive period and much higher than average for women in their late thirties and forties. The available evidence does not suggest large differ-

TABLE 1

Rating of Proximate Determinants, with Respect to Sensitivity of Fertility and Variability among Populations

Proximate Determinants	Sensitivity of Fertility to the Determinant	Variability among Populations	Overall Rating
1. Onset of cohabitation and union disruption	+ + +	+ + +	+ + +
2. Onset of permanent sterility	+ +	+	+
3. Postpartum infecundability	+ +	+ + +	+ + +
4. Fecundability	+ +	+ +	+ +
5. Contraception	+ + +	+ + +	+ + +
6. Spontaneous intrauterine mortality	+	+	+
7. Induced abortion	+ +	+ + +	+ + +

+ + + = High; + + = Medium; + = Low or absent.

SOURCE: Adapted from *Studies in Family Planning* 13 (1982).

ences in the risk among societies. However, the probability of a stillbirth (an intrauterine death after the 28th week of gestation) is around 4 percent of conceptions in some poor countries, while it is only about 1 percent in the most developed countries. The reasons for this difference have not been determined conclusively, but health and environmental factors presumably play an important role.

Induced Abortion

Deliberate interventions to terminate pregnancies have been practiced throughout recorded history. In the mid-1990s, the proportion of pregnancies ended by induced abortion ranged from near zero in some countries to more than one-half in some parts of Eastern Europe. The availability of simpler medical techniques, assurance of personal safety, and ease of access have recently increased in many countries. Even where these conditions are not present, as in much of the developing world, the determination to avoid childbirth may lead women to resort to induced abortion.

Analyzing Fertility Levels

Each of these seven proximate determinants directly influences fertility, and together they determine the level of fertility. In studies of fertility levels or differentials it is generally not necessary to devote the same effort to analyzing and measuring each of the proximate determinants because they are not of equal interest. Two criteria can be applied to select the proximate determinants that deserve most attention. The first is the sensitivity of the fertility rate to variation in a determinant; it is relatively uninteresting if large variation produces only a minor change in fertility. The second criterion is the extent of a determinant's variability among populations or over time. A relatively stable determinant can contribute little to explaining either trends or differentials.

In Table 1, the seven proximate determinants are given an approximate rating for these two criteria. Studies with reproductive models (such as the 1983 study by Bongaarts and Potter) show that fertility is least sensitive to variations in the risk of spontaneous intrauterine mortality, and most sensitive to changes in the proportions of women in union and the prevalence of contraception. Variability is lowest for onset of sterility and risk of spontaneous intrauterine mortality. The overall rating, based on both criteria, indicates that four proximate determinants—onset of cohabitation, postpartum infecundability, contraception, and induced abortion—are the most important for the analysis of fertility levels and trends.

See also: *Blake, Judith; Contraception, Modern Methods of; Contraceptive Prevalence; Davis, Kingsley; Fecundity; Induced Abortion: Prevalence; Infertility; Spontaneous Abortion.*

BIBLIOGRAPHY

Bongaarts, John. 1978. "A Framework for Analyzing the Proximate Determinants of Fertility." *Population and Development Review* 4(1): 105–132.

Bongaarts, John, and Robert C. Potter. 1983. *Fertility, Biology, and Behavior: An Analysis of the Proximate Determinants.* New York: Academic Press.

Davis, Kingsley, and Judith Blake. 1956. "Social Structure and Fertility: An Analytic Framework." *Economic Development and Cultural Change* 4(3): 211–235.

Stover, John. 1998. "Revising the Proximate Determinants of Fertility Framework: What Have We Learned in the Past 20 Years?" *Studies in Family Planning* 29(3): 255–267.

Wood, James W. 1994. *Dynamics of Human Reproduction: Biology, Biometry, Demography.* New York: Aldine de Gruyter.

John Bongaarts

FERTILITY CONTROL, INDIRECT MEASUREMENT OF

Knowledge of the extent and effectiveness of intentional control of fertility is important in understanding population trends and in theorizing about fertility transitions. Evidence regarding fertility control has played an important role in a long-running debate about contemporary family planning programs.

On one side of the debate, the "continuity" school stresses that intentional fertility control has been known and practiced much earlier than the onset of the demographic transition and certainly well before the initiation of any family planning program. The "discontinuity" school argues that even in the nineteenth century, many populations existed in a pre-rational mode with respect to fertility behavior.

According to the "continuity" school the fertility transition was dominantly triggered by a change in mortality rates and external socio-economic conditions, which lowered the number of births couples wanted. According to the "discontinuity" school, the fertility transition was initiated by the diffusion of the idea that fertility behavior should be brought into the realm of conscious choice.

Members of the "continuity" school were skeptical about the effectiveness of family planning programs in the absence of changes in mortality rates and socio-economic circumstances. Members of the "discontinuity" school were skeptical about any approach that did not directly address people's mindsets. The debate between the two schools was quickly translated into questions about the extent of fertility control and whether or not it was mainly characterized by stopping or spacing.

Information about fertility control practices in contemporary populations is routinely collected by surveys that ask individuals to report on their current and past personal experience. Where it is infeasible to conduct such surveys, it is nevertheless possible to employ indirect methods to obtain some information regarding the extent and nature of deliberate fertility regulation. These are statistical techniques that yield population-level measurements concerning "control," essentially by comparing the pattern of fertility observed in the population of interest with the pattern of a "natural-fertility" population, i.e. one in which fertility control was not practiced. (The population of interest is referred to as the "target" population; the natural-fertility population is termed the "model" population.) This article describes the principal indirect methods of estimating the extent and character of fertility limitation.

Two polar types of fertility limitation are termed *perfect stopping* and *pure spacing.* In the case of perfect stopping, all couples have no more children after they initiate fertility control. Pure spacing behavior occurs when all couples who are ever going to limit their fertility begin control before the birth of their first child. In real populations, neither of these extremes ever occurs. Perfect stopping does not happen because of contraceptive failure. Pure spacing is not observed because some couples desire a first birth as soon as possible after marriage.

Early Approaches

David V. Glass and Eugene Grebenik, in a British census report, developed a "statistical model for the study of desired and achieved family size" (Glass and Grebenik, p. 270), a by-product of which was estimates of the extent of use of fertility control. Their estimator derived from the comparison of two tabulations of women by the number of children they had borne (called parity distributions). Each pair of distributions compared women who had married in a specified age range and were observed (still married) at or beyond the end of the childbearing agespan. Glass and Grebnick's target populations were the married women observed by the 1946 family census of Great Britain, and their chosen (non-controlling) models were the corresponding current- and marriage-age groups recorded by the 1911 census of Ireland as residing in rural areas—specifically, outside the highly urbanized county boroughs.

Glass and Grebenik's approach assumed that couples practice stopping behavior—that is, they begin to control their fertility after reaching a certain number of children ever born, or parity, presumed to be their desired family size. Before that point, couples proceeded from parity to parity according to the parity progression rates of the model population. When they initiate control, their parity progression rates become the rates of the model population multiplied by the fraction $(1-p)$, where p is the probability of having an additional birth at each parity once "family limitation" has begun. Their procedure produced the first indirect measures of the extent of fertility control as a step in the estimation of "desired and achieved family size."

Coale's *M* and *m* and Extensions

Ansley J. Coale, like Glass and Grebenik, apparently came to his indirect measure on his way to another goal. In a 1971 article entitled "Age Patterns of Marriage," Coale devoted little more than a page to his key equation:

$$m(a) = M \cdot n(a) \cdot e^{m \cdot v(a)}$$

where $m(a)$ is age-specific marital fertility at age a, $n(a)$ is the age-specific marital fertility of Hutterites during the period from 1921 to 1930, and M, m, and $v(a)$ are parameters. (The Hutterites, a small religious community located in border regions of midwestern Canada and the United States, are frequently taken by demographers to illustrate a natural fertility population.) The parameter M is the ratio of marital fertility at ages 20 to 24 to Hutterite marital fertility at that age, and m measures "the extent to which control of fertility causes a systematic deviation from the age pattern of natural fertility" (Coale, p. 207).

When $m = 1$, the marital fertility schedule diverges from the Hutterite pattern by roughly the average proportional deviation observed in the 43 age-specific marital fertility schedules reported by the United Nations in its *Demographic Yearbook* for 1965. This implicitly defines the age-specific parameter, $v(a)$. Coale and T. James Trussell made statistical refinements in the method of obtaining these parameters in 1974 and 1978. Coale's approach yields a measure that may be interpreted as reflection of the effects of fertility control, but it provides no estimate of the extent to which the target population engaged in family limitation.

In 1979 Warren C. Sanderson used both parity distributions and the Coale specification for the marital fertility schedule to investigate the evolution of fertility control in the native born white population of the United States from the beginning of the nineteenth century onwards. The parity distributions are those for all women who had ever been married, and were observed at or after the end of the childbearing age-span.

Sanderson denoted $F(q)$ to be the mean fertility of the fraction q of the population with the highest number of children ever born, with $F(1)$ being the mean fertility of the entire cohort. Sanderson then defined a particular value of q, q^*, implicitly from the equation:

$$F(q^*) = B_n/\phi,$$

where B_n is the mean fertility of the population in the absence of fertility limitation, and ϕ is the proportion of couples who are physiologically capable of bearing a child. B_n depends on Coale's M and m parameters and on the age distribution of marriage. Under plausible conditions, $(1 - q^*)$ is a measure of the extent of fertility control.

Cohort Parity Analysis

Cohort parity analysis (CPA) is the name given to an analytic approach to measuring the extent and character of fertility regulation from marriage-age and marriage-duration specific parity distribution data. Paul A. David, Sanderson, and their coauthors developed the methodology, describing it in a series of articles in the 1980s.

Like the Glass and Grebenik procedure, CPA is based on a comparison of parity distributions and treats couples who have ever initiated family limiting behavior as "controllers." CPA also allows for the possibility that couples could initiate fertility reducing behaviors prior to the parity at which they ultimately stop. Unlike Glass and Grebenik, CPA does not assume that people only begin practicing fertility control when they attain their desired family size.

In the CPA framework, couples who do not initiate control proceed upward through the parity distribution according to the model (natural-fertility) parity progression rates. Once controlling behavior has started, all that is known is that parity progression rates must be below those of the model population. CPA does not assume that control is maintained continuously after it is initiated; for example, it allows for the possibility that a couple may use contraception after marriage for three years, again for two years following the birth of their first child, and then continuously after the birth of their second child.

A lower bound on the proportion of cohorts who are practicing birth control is calculated from the target and model populations, and is compared with the level that would result in the population from perfect stopping behavior. A corresponding upper bound on the extent of fertility limitation, similarly calculated, is that which would result were those who controlled to have engaged in pure spacing behaviors. The upper and lower bound estimates are efficient in the sense that, within the CPA framework, there can be no lower upper bound and no higher lower bound.

Because CPA can be applied to cohorts who have not yet completed their childbearing, it is especially useful for studying family limiting behavior among younger couples. David and Sanderson made use of this advantageous property of CPA in a study of fertility control among the married women residing in Ireland's urban areas in 1911. This revealed that not only that there had been a significant amount of family limitation during the preceding decades, but that the extent of control among cohorts of younger women at lower durations of marriage exceeded that among the older women who had reached the end of their childbearing span.

Assessment of the Main Approaches

The two main approaches to estimating the extent of birth control are Coale's M and m method and cohort parity analysis. Each has its critics and its defenders.

A drawback in Coale's methodology is that it rests solely on the shape of the target age-specific fertility schedule, so that decreases in the level of age-specific marital fertility at young ages (resulting from "spacing") must show up as reductions in the level of M, not increases in the index of the intensity of control, m. Yet there is ample evidence of the occurrence of such decreases in M in populations undergoing the fertility transition, implying that measured changes in m alone understate gains in the extent of control.

Barbara S. Okun, who appraised both methods in a 1994 article, reported that Coale's m remained close to zero even in populations where 40 percent of married couples were exercising effective fertility control. Further, m was insensitive to changes in the extent of control when such control was low, and large changes in control often registered only as small changes in m.

Okun's main criticism of CPA is that the bounds found on the extent of control are highly sensitive to the choice of model distribution. Hence, errors in estimated proportions of controllers would arise when an inappropriate model distribution was used. An inappropriate model distribution is one that is derived from a population that differs from the target population in dimensions that are not considered to be fertility control, but which nevertheless affect fertility. The duration of breastfeeding is often thought to be one such factor. Similarly, in a 1996 article, Okun, Trussell, and Barbara Vaughan criticized CPA on the grounds that the method overstates the gain in the extent of control when the population on which the model parity distribution is based (improperly) contains some controllers. Sanderson subsequently addressed these criticisms by providing a test that helps avoid the use of inappropriate model parity distributions. He also demonstrated formally that CPA lower bounds remain lower bounds, even when the model distribution (inappropriately) includes some controllers.

See also: *Estimation Methods, Demographic; Fertility, Age Patterns of; Natural Fertility.*

BIBLIOGRAPHY

Coale, Ansley J. 1971. "Age Patterns of Marriage." *Population Studies* 25: 193–214.

Coale, Ansley J., and T. James Trussell. 1974. "Model Fertility Schedules: Variations in the Age Structure of Childbearing in Human Populations." *Population Index* 40: 185–258 (Erratum, *Population Index* 41: 572).

David, Paul A., et al. 1988. "Cohort Parity Analysis: Statistical Estimates of the Extent of Fertility Control." *Demography* 25: 163–188.

David, Paul A., and Warren C. Sanderson. 1987. "The Emergence of a Two-Child Norm among American Birth Controllers." *Population and Development Review* 13: 1–41.

———. 1988. "Measuring Marital Fertility Control with CPA." *Population Index* 54: 691–713.

———. 1990. "Cohort Parity Analysis and Fertility Transition Dynamics: Reconstructing Historical Trends in Fertility Control from a Single Census." *Population Studies* 44: 421–455.

Glass, David V., and Eugene Grebenik. 1954. "A Statistical Model for the Study of Desired and Achieved Family Size." In *The Trend and Pattern of Fertility in Great Britain: A Report on the Family Census of 1946*. London: H. M. Stationery Office.

Okun, Barbara S. 1994. "Evaluating Methods for Detecting Fertility Control: Coale and Trussell's Model and Cohort Parity Analysis." *Population Studies* 48: 193–222.

Okun, Barbara S., James Trussell, and Barbara Vaughan. 1996. "Using Fertility Surveys to Evaluate an Indirect Method for Detecting Fertility Control: A Study of Cohort Parity Analysis." *Population Studies* 50: 161–171.

Sanderson, Warren C. 1979. "Quantitative Aspects of Marriage, Fertility, and Family Limitation in Nineteenth Century America: Another Application of the Coale Specifications." *Demography* 16: 339–358.

INTERNET RESOURCE.

Sanderson, Warren C. 2000. "A Users' Guide to the Joys and Pitfalls of Cohort Parity Analysis," Presented to the Stanford Institute for Economic Policy Research Conference, *History Matters: Technology, Population and Institutions*, June 3–5, at Stanford University. <http://www.siepr.stanford.edu>.

PAUL A. DAVID
WARREN C. SANDERSON

FERTILITY MEASUREMENT

This article provides a nontechnical account of the principal indexes used by demographers to gauge the level of fertility of a population. For each measure the main advantages and disadvantages are also noted.

Crude Birth Rate

The simplest indicator of the fertility of a population in a given year is the number of births that year divided by the average size of the population during the year. There is nothing special about the one-year period, but if births are measured over a different period (still in units of years), consistency in comparisons requires that the denominator be the average population over the period times the length of the period—more strictly, the number of "person-years" lived by the population during the period. By convention, the resulting fraction is applied to a standard-sized population of 1,000. The result is the crude birth rate: the number of births per 1,000 population per year. The adjective *crude* is used because none of the structural characteristics of the population that might affect the number of births that occur in the time period, such as the age distribution or the composition by sex, is taken into account, only the total population size. The rate can be simply calculated as a fraction in which the numerator is the number of live births in the population in a year—say, beginning January 1—and the denominator is the midyear (July 1) population, approximating the "average" size of the population over the year.

Thus, from the Institut de la Statistique et des Études Économiques, for France in 2000, see Item 1 from the Formula Table.

The crude birth rate is most often calculated for a single year, although in order to smooth out year-to-year fluctuations published estimates often give an average rate over several years—typically a five-year period. Crude birth rates below about 15 per 1,000 are usually regarded as low; those above about 35 are high. Examples of extreme values are 9 for Spain in 2000 and 52 for Kenya in the 1970s.

Pros. The crude birth rate requires less detailed data than other fertility measures and data that are more likely to be available for a very recent period. It is needed for the calculation of the rate of natural increase (the crude birth rate minus the crude death rate) and the population growth rate (the rate of natural increase plus the net migration rate).

FORMULA TABLE

Examples of Calculation of Birth and Fertility Rates

ITEM 1: BIRTH RATE FRANCE, 2000

$$\textit{Crude Birth Rate} = \frac{\textit{Births in 2000}}{\textit{Total Population, July 1, 2000}} = \frac{778{,}900}{58{,}891{,}913} = 0.0132 = 13.2 \textit{ per } 1{,}000$$

ITEM 2: GENERAL FERTILITY RATE, TURKEY, 1998

$$\textit{General Fertility Rate} = \frac{\textit{Births in 1998}}{\textit{Midyear female population, aged 15–49}} \times 1000 = \frac{1{,}338{,}800}{17{,}184{,}000} \times 1000 = 77.9$$

ITEM 3: AGE-SPECIFIC FERTILITY RATE, FRANCE, 1998

Age-Specific Fertility Rate for Age Group 20–24

$$= \frac{\textit{Births in 1998 to women, aged 20–24}}{\textit{Number of women aged 20–24 at midyear}} = \frac{113{,}895}{1{,}923{,}902} = 0.0592 = 59.2 \textit{ per } 1{,}000$$

ITEM 4: MARTIAL FERTILITY RATE, UNITED STATES, 2000

$$\textit{Marital Fertility Rate} = \frac{\textit{Births to married women, aged } 15\text{–}49}{\textit{Number of married women, aged } 15\text{–}49} = \frac{2{,}711{,}771}{35{,}968{,}000} = 0.0756 = 75.4 \textit{ per } 1{,}000$$

SOURCE OF DATA: Institut de la Statistique et des Études Économiques; Council of Europe (2000); National Center for Health Statistics and U.S. Census Bureau (2002).

Cons. The crude birth rate is affected by vagaries in the age and sex distribution and by other structural characteristics of the population, such as those resulting from a past baby boom or particularly heavy immigration. An example of such a country would be a Gulf state of the Middle East that has experienced significant immigration of males of working age. In such a case the crude birth rate may be artificially low because the total population contains an unusually high number of males. In addition, the crude birth rate does not provide any insight into individual-level childbearing behavior.

General Fertility Rate

The general fertility rate is similar to the crude birth rate except that it uses a more restricted denominator, the female population of childbearing age, ages 15 to 49. For Turkey in 1998, see Item 2 in the Formula Table.

Pros. The general fertility rate provides a somewhat more refined measure of fertility than the crude birth rate and requires knowledge of only the total number of births and the total female population, ages 15 to 49. In most countries, the female population of childbearing age is about one-fourth of the country's total population, so that the advantage over the crude birth rate is not a great one. When the age-sex structure of the population has been skewed in some way, such as by migration, however, the general fertility rate is often preferable.

Cons. This rate will be skewed somewhat by the distribution of women *within* the childbearing ages, affecting country-to-country comparisons slightly. As with the crude birth rate, it provides no insight into childbearing behavior. The general fertility rate is not as widely used as other measures.

Age-Specific Fertility Rates

Age-specific fertility rates (also called age-specific birth rates) are similar to the crude birth rate but are calculated for specific age groups of women of childbearing age. The range of childbearing ages is conventionally considered to be ages 15 to 49 (sometimes 15 to 44 is used), and a full set of age-specific fertility rates would span this interval—usually either in single-year age groups or, more commonly, in five-year groups: 15 to 19, 20 to 24, . . . , 45 to 49. (Rarely, age-specific fertility rates are also calculated for men.) The numerator of the rate is the number of live births to women in the specific age or age group during a given period and the denominator is the average population of women in that age or age group during the same period. For convenience, age-specific fertility rates are usually presented as rates per 1,000. See Item 3 in the Formula Table for an explanation of the calculations.

Pros. Age-specific fertility rates enable analysis of the pattern of fertility by age of women and analysis of changes in the timing of childbearing. Comparisons between consecutive years may, for example, indicate that women are delaying childbearing and the onset of family formation. Age-specific fertility rates are required for calculation of fertility measures such as the total, gross, and net reproduction rates. They are also required as an input in cohort-component population projections.

Cons. Age-specific fertility rates require detailed data on the number of births by age or age group of mother and data on the number of women of childbearing age by age or age group, data that are seldom available in developing countries. Age-specific fertility rates cannot be directly used to calculate population growth rates or natural increase rates.

Marital Fertility Rates

Marital fertility rates can be calculated either for the full range of reproductive ages (15 to 49 or 15 to 44) or as age-specific rates. The numerator is usually taken as the total number of births to women in the specified age range, regardless of the marital status of the mother; the denominator is the number of currently married women in the specified age range. With the large increase in fertility outside of legal marriage that has occurred in many industrialized countries (with many births occurring in consensual unions or to cohabiting couples), the usefulness of marital fertility rates may be seriously compromised. For that reason, it may be desirable to restrict the numerator to births that occur within legal marriage and to also calculate complementary nonmarital fertility rates. The calculated example is, in fact, based on marital births only. See Item 4 in the Formula Table, using data for the United States in 2000.

Pros. Marital fertility rates enable analysis of marital fertility and the pace and timing of childbearing that occurs within formal marriage, analysis that cannot be performed with other fertility measures.

TABLE 1

Example of Calculation of the Total Fertility Rate, Ethiopia, 2000

Age	Births by age of mother	Number of women	Age-specific fertility rate ×1,000
	(1)	(2)	(1)/(2) × 1,000
15–19	357,390	3,249,000	110
20–24	673,684	2,761,000	244
25–29	601,128	2,277,000	264
30–34	468,472	1,889,000	248
35–39	292,983	1,601,000	183
40–44	132,500	1,325,000	100
45–49	26,784	1,116,000	24
Sum of 5-year age-specific rates (× 1,000)			1,173
Sum of single-year age-specific rates (× 1,000)			5,865

$$\textit{Total Fertility Rate} = \sum_{15}^{49} \textit{Single-year age-specific fertility rates}$$

$$= 5 \times \sum_{15\text{–}19}^{45\text{–}49} \textit{Five-year average age-specific fertility rates}$$

$$= 5 \times 1{,}173 \textit{ per } 1{,}000 = 5{,}865 \textit{ per } 1{,}000 = 5.87$$

SOURCE: Author's example calculated from figures in: Central Statistical Authority [Ethiopia] and Orc Macro; *Ethiopia Demographic and Health Survey 2000* (2001). Addis Ababa, Ethiopia and Calverton, MD: Central Statistical Authority and Orc Macro.

Cons. Marital fertility rates require detailed data on births by age group of mother and possibly by marital status of mother, and on women by age and marital status, data that are seldom available in developing countries. While this rate provides the ability to analyze marital fertility, increases in nonmarital fertility result in only a partial picture of childbearing trends.

Total Fertility Rate

The total fertility rate (TFR) at a given time (technically referred to as the period total fertility rate) is the average number of children a woman would bear in her life if she experienced the age-specific fertility rates prevailing at that time. A closely related measure is the cohort total fertility rate—the average number of children borne by women in an actual birth cohort over their reproductive lives. The period total fertility rate is used much more frequently than the cohort total fertility rate and is always meant when the abbreviation TFR is used without further specification.

Period total fertility rate. The TFR for a given year is calculated by summing the age-specific fertility rates for that year over the range of reproductive ages. Each single-year age-specific fertility rate measures the "risk" that a woman of that age would have a child during the year in question; the sum of those risks equals the number of children a hypothetical woman experiencing those risks would have at the end of her reproductive life. If the age-specific rates are averages for five-year age groups of women, the sum of the age-specific rates must be multiplied by five, as in the example, for Ethiopia in 2000, in Table 1.

The TFR is often discussed in terms of "replacement-level" fertility, or the number of children that women, on average, must produce in order for a population to ultimately reach a stationary state ("zero population growth" position)—neither growing nor declining in size. A value of 2.1 is often cited as replacement-level fertility. The ".1" is required because there are approximately 5 percent more boys born than girls and because not all women survive throughout their childbearing years. The value of 2.1, however, is valid only for countries with low mortality (high life expectancy). In countries with high mortality, that is, when survival rates from birth to maturity are low, a replacement-level TFR is much higher; it can be as high as 3.0.

Pros. The TFR has the immediate intuitive interpretation as the number of children that the average woman will bear in her lifetime. That number can be gleaned only very roughly from other measures. (For example, a crude birthrate of 50 per 1,000 in a country with a normal age-sex distribution means that women on average bear about seven children each; a crude birthrate of 15 would mean about two children.)

Cons. The TFR for a given year does not indicate how many additional children an average woman of any selected age will actually have over her remaining reproductive lifetime. It would do so only if the age-specific fertility rates of that year remained constant over the woman's lifetime. When age-specific fertility rates are changing, such as when women are delaying births from their 20s to their 30s, age-specific fertility rates—and thus the TFR—would be depressed for a time and then rise again when women begin to have children at the older age. Hence the TFR may be a poor measure of the completed fertility of women at or near the end of their childbearing years and also a poor predictor of the completed fertility of women at early phases of their reproductive career.

TABLE 2

Example of Calculation of the Gross Reproduction Rate, Ethiopia, 2000

Age	Female births by age of mother	Number of women	Age-specific fertility rate (female births)
	(1)	(2)	(1)/(2) × 1,000
15–19	174,337	3,249,000	54
20–24	328,626	2,761,000	119
25–29	293,233	2,277,000	129
30–34	228,523	1,889,000	121
35–39	142,919	1,601,000	89
40–44	64,634	1,325,000	49
45–49	13,065	1,116,000	12
Sum of 5-year age-specific rates for female births (× 1,000)			572

$$\textit{Gross Reproduction Rate} = 5 \times \sum_{15\text{–}19}^{45\text{–}49} \textit{Five-year-average age-specific fertility rates for female births}$$

$$= 5 \times 572 \text{ per } 1{,}000 = 2{,}860 \text{ per } 1{,}000 = 2.86$$

SOURCE: Author's example calculated from figures in: Central Statistical Authority [Ethiopia] and Orc Macro; *Ethiopia Demographic and Health Survey 2000* 2001. Addis Ababa, Ethiopia and Calverton, MD: Central Statistical Authority and Orc Macro.

Cohort total fertility rate. The cohort total fertility rate can be calculated in a manner similar to the period total fertility rate, but the calculation can be completed only for women who have already passed through their childbearing years. This rate is based on the actual fertility of an age cohort of women—that is, a group of woman born in the same period, usually a five-year period. (For example, women who were born from 1975 to 1980 are the 1975–1980 cohort.) Cohort fertility rates can be calculated for each five-year period as women pass through their childbearing years and summed to give their completed cohort fertility up to particular ages, such as 20, 25, 30, and so on. For the 1975–1980 birth cohort, the cohort total fertility rate could be calculated only when the youngest of the group pass 50, in the year 2030.

Pros. The cohort total fertility rate allows a precise description of the actual childbearing experience of specific birth cohorts of women. As a measure of reproduction it is superior to estimates made from questions on "children ever born" in censuses and

TABLE 3

Example of Calculation of the Net Reproduction Rate, Ethiopia, 2000

Age	Age-specific fertility rate (female births)	Average person-years lived in age interval ($_5L_x/l_0$)	Effective age-specific fertility rate (net of mortality loss)
	(1)	(2)	(1) × (2)
15–19	54	3.94514	211.7
20–24	119	3.85859	459.3
25–29	129	3.75919	484.1
30–34	121	3.64764	441.3
35–39	89	3.52358	314.5
40–44	49	3.38643	165.2
45–49	12	3.23766	37.9
			Sum 2,114.0
		Net Reproduction Rate (NRR) =	2.11

SOURCE: Author's example calculated from figures in: Central Statistical Authority [Ethiopia] and Orc Macro; *Ethiopia Demographic and Health Survey 2000* 2001. Addis Ababa, Ethiopia and Calverton, MD: Central Statistical Authority and Orc Macro.

surveys because it does not omit the childbearing experience of women who died before the time of the census or survey.

Cons. This measure requires detailed data on births by age of mother and data on women by birth cohort over a long period, data not often readily available for developing countries. Total cohort fertility can be calculated, by definition, only at the conclusion of a cohort's childbearing years.

Gross Reproduction Rate

The gross reproduction rate (GRR) for a particular year is the average number of daughters that a woman would have if she experienced over her lifetime the age-specific fertility rates of that year. In that it refers only to the number of daughters born to women, not the total number of children, it is a special case of the (period) total fertility rate; in most circumstances (unless the sex ratio at birth is highly unequal) the GRR equals roughly half the TFR.

An example—for Ethiopia in 2000—is given in Table 2.

Pros. The gross reproduction rate, like the total fertility rate, translates other measures of fertility into a clear result: in this case, the number of daughters that a cohort of women is likely to produce in their lifetimes.

Cons. This rate adds little information to the TFR, which is a more widely used measure. The GRR, like the TFR, may be affected by changes in the timing of births even when the total number of lifetime births per woman is not changing.

Net Reproduction Rate

The net reproduction rate (NRR) measures the *effective* fertility in a population, taking account not only of births but also of the fact that not all women born will survive to their own reproductive years. The NRR is the average number of daughters of reproductive age that a woman would have if she experienced over her lifetime the prevailing age-specific rates of fertility and if her daughters experienced the prevailing rates of mortality. If the age schedules of both fertility and mortality for a population remained constant, the net reproduction rate would be a measure of generational replacement. For example, if NRR = 1.5, the next generation would be 50 percent larger than the present generation; if NRR = 0.8, it would be 20 percent smaller. For any population, therefore, the NRR can be taken to indicate the underlying tendency of the population to increase or decrease based on its current fertility and mortality patterns, abstracting from the effects of its current age structure.

An NRR = 1.0 means that each woman in a population will, on average, replace herself exactly in the next generation. For the existing level of mortality, fertility would be precisely at replacement level.

Calculation of the net reproduction rate requires estimates of the female survival rate from birth to each reproductive age or age group, values that would be given in the appropriate female life table. In life-table notation, the average survival rate from birth to age x is L_x / l_0 or, for survival to a five-year age group, $_5L_x / 5\ l_0$. An example for Ethiopia is given in Table 3.

Pros. The NRR precisely measures the reproductivity of a population by taking into account the level of fertility and the likelihood that women will survive from birth to each childbearing age.

Cons. The NRR requires detailed data on fertility and female life-table values up to age 50.

Parity Progression Ratios

A parity progression ratio is the proportion of women of a given "parity" (i.e., who have had that

TABLE 4

Example of Calculation of Parity Progression Ratios for Women Born from 1896 to 1900, France

Number of births *(i)*	Number of married women who have had at least *i* births (N_i)	Parity Progression Ratio $(P_i = N_{i+1} / N_i)$
0	1,094,785	0.824
1	901,785	0.690
2	622,447	0.590
3	367,129	0.588
4	216,047	0.605
5	130,802	0.628
6	82,185	0.625
7	51,391	0.635
8	32,645	0.628
9 or more	20,500	

Note: Data are from 1946 Census.

SOURCE: Pressat, Roland (1972).

particular number of live births) who go on to have at least one *additional* child during the course of their remaining childbearing years. This measure is often calculated for married women only.

In the example shown in Table 4, the first parity progression ratio, P_1 (indicating the probability of progressing from parity 0 to parity 1) is calculated by dividing the total number of married women who had at least one child (901,785) by the total number of married women (1,094,294).

Pros. The parity progression ratio allows detailed analysis of family formation and childbearing patterns for a given cohort of women. It is useful for comparisons with other birth cohorts or between the same birth cohorts in different countries.

Cons. The parity progression ratio can be used only to study childbearing patterns among women who have completed their childbearing years and requires detailed data on children ever born from a census or survey.

See also: *Mortality Measurement; Population Dynamics.*

BIBLIOGRAPHY

Bogue, Donald J., Eduardo E. Arriaga, and Douglas L. Anderton, eds. 1993. *Readings in Population Research Methodology, Volume 3. Fertility Research.* Chicago: United Nations Population Fund and Social Development Center.

Coale, Ansley J., and Paul Demeny. 1983. *Regional Model Life Tables and Stable Populations,* 2nd edition. New York: Academic Press.

Council of Europe. 2000. *Recent Demographic Developments in Europe 2000.* Strasbourg: Council of Europe.

National Center for Health Statistics and U.S. Census Bureau. 2002. *Births: Final Data for 2000.* Hyattsville, MD: National Center for Health Statistics and U.S. Census Bureau.

Pressat, Roland. 1972. *Demographic Analysis: Methods, Results, Applications.* Chicago: Aldine Atherton, Inc.

Shryock, Henry S., Jacob S. Siegel, et al.. 1976. *The Methods and Materials of Demography,* Condensed Edition. New York: Academic Press.

Weeks, John R. 2002. *Population, an Introduction to Concepts and Issues.* Belmont, CA: Wadsworth Publishing Company.

CARL HAUB

FERTILITY TRANSITION, SOCIOECONOMIC DETERMINANTS OF

To understand the amazing decline in fertility—the average number of births per woman—in modern times, it is necessary to begin with an examination of high fertility in traditional societies. Fundamentally, fertility was high, typically around five to seven births per woman, because of high death rates. Without high fertility, most societies would have experienced population decline and eventual disappearance. The necessity of high fertility for the survival of the community does not imply that most persons had a conscious awareness of the relationship. Rather, the desire for high levels of childbearing was woven into the cultural fabric and the social institutions of traditional societies.

In addition to strong cultural inducements for marriage and childbearing, the well-being of the family in traditional societies was dependent on having several children who survived to adulthood. Families were the primary economic units as well as reproductive unions. Children were a valued source of household labor and were also the preferred means to guarantee the old-age security of parents. In societies without formal schools, mass media, and modern transportation, family relationships and interactions were the center of social and cultural life. Larger extended families provided more companionship, a wider circle of trust, more protection in times of trouble, and a higher status for patriarchs and matriarchs than did smaller families.

The population problem in traditional societies was maintaining some sort of rough balance between births and deaths. If population decline could threaten community survival, a long period of increasing population numbers would likely outpace the expansion of food and other resources. Although population growth averaged close to zero over long stretches of human history, there were periods during which population size increased across generations. In many cases, out-migration to frontier regions reduced population pressure, but all too frequently it was crisis mortality that brought population numbers back in line with subsistence levels.

These episodes of famine, plague, and war were labeled by the English economist T. R. Malthus (1766–1834) as positive checks, which he thought were inevitable, given the tendency for populations to grow faster than the means of subsistence. The only way to avoid these dismal cycles of demographic growth and implosion, Malthus argued, was through preventive checks, of which the only acceptable variants were moral restraint that encouraged celibacy and the postponement of marriage. Malthus was pessimistic, however, that moral restraint would be sufficient to avert positive checks because of the underlying "passion between the sexes." Malthus was partially right. His pessimistic scenario of expansion and decline did characterize the population dynamics of many premodern societies, although periods of growth could be accommodated for decades or even centuries, depending on the technology of production, the possibilities for long-distance trade, and the size of the frontier. Moreover, plagues, famines, and wars often followed their own dynamics, independent of population size and growth.

The major failing of Malthus's argument, however, was to not notice that even high fertility of five to seven births per woman was well below the maximum number of births (some 15 or 16) that might occur if there were no restraints on childbearing. In all societies, fertility (or infant survival) is held in check in varying combinations by delayed age at marriage, by some proportion of the population never marrying, by long periods of breast-feeding (which suppresses ovulation), and by cultural proscriptions that affect the frequency and timing of sexual intercourse. Folk methods of birth control together with abortion and infanticide would often have also played a role. Such practices, especially delayed age at marriage, reduced fertility in many traditional western European societies by the eighteenth and nineteenth centuries to levels of only four to five births per woman—in circumstances in which the probability of survival to adulthood may have averaged only around 50 percent. The variations in "high fertility" across societies and over time suggest that fertility was regulated in response to socioeconomic conditions and ecological constraints, although most couples may not have been consciously controlling family size.

The major turning point in world demographic history, and the conclusive break from Malthus's predicted cycle, was the sustained declines in fertility that began in France and North America early in the nineteenth century and elsewhere in western European countries around 1880 and that led to small families that averaged about two births per couple by the third decade of the twentieth century. Demographers label a fertility rate of about two births per woman as replacement-level fertility because two children, in the contemporary context of low mortality, are sufficient to replace their parents in the next generation. The transition from high to low fertility was not only an unprecedented demographic revolution but also a cultural revolution with profound implications for the definition of the family and the adult roles of women and men. Modern societies are still in the process of adapting old (and creating new) institutions and gender roles in the wake of the relatively recent transition to low fertility.

About a hundred years after the beginnings of fertility declines in western Europe—declines that with varying delays soon also spread to the rest of that continent—a similar process began in the developing countries of Asia, Latin America, and Africa. This second wave of fertility transitions began soon after the end of World War II in Japan and in the late 1960s and early 1970s in a few other East Asian countries and small island societies. By the 1990s, fertility declines had begun in almost every part of the globe, including areas of persistently high fertility in South Asia and sub-Saharan Africa. Although most of these fertility transitions were still in process and some had far to go by the early twenty-first century, a generalized low-fertility world was in sight. Replacement-level fertility was achieved in some East and Southeast Asian countries in the 1980s and 1990s, and the United Nations assumed (in its medium variant projection series) that almost all developing countries would have below-replacement-level fertility or below replacement fertility by the middle of the twenty-first century.

Demographic Transition Theory

The theoretical task of explaining modern fertility transitions as a consequence (or a delayed consequence) of declines in mortality and of the socioeconomic changes that have transformed rural agrarian societies into modern industrial societies has been the central question of the scientific field of demography. Although some of the basic ideas can be traced back to the first half of the twentieth century and the works of Warren Thompson (1887–1973), Adolphe Landry (1874–1956), and Kingsley Davis (1908–1997), Frank W. Notestein (1902–1983) wrote the classic statement of demographic transition theory in 1953. The central thesis of the theory was generally presented as a three-stage model: the first stage consisting of pretransition societies characterized by high fertility and mortality; a second transitional stage, consisting of societies with declining mortality and, after a lag, declining fertility; and a third and final stage, consisting of posttransitional societies, which lave low mortality and fertility. Although sometimes framed as more of a descriptive account of what has happened, demographic transition theory, as presented by Notestein, was a sophisticated interpretation of how fertility declined in response to declining mortality, the reduced role of the family in economic organization, the growing independence of women from traditional roles, and the shift from customary behavior to calculative rationality spurred by popular education.

Until the 1970s, the theory of the demographic transition was almost universally accepted by demographers and was widely disseminated in introductory textbooks through stylized graphs and an interpretation of declining fertility in response to the modern forces of industrialization, urbanization, and literacy. These processes had occurred in many Western countries during the nineteenth and twentieth centuries and were presumed to be on the near-term horizon of many developing countries. Relative to other theories in the social sciences, demographic transition theory represented one of the most ambitious and convincing interpretations of the momentous social changes of modern times.

The general formulation of demographic transition theory, sometimes summarized as a list of independent variables associated with urbanization, industrialization, and modernity, was often an inadequate guide to cumulative empirical research. Because the many indicators representing the key causal forces were considered interchangeable (and because the unit of analysis was at best vaguely defined), many of the specific hypotheses of the theory, such as the changing cost of children in rural and urban environments, were rarely differentiated from the broader story about industrialization and urbanization. The net result was that in spite of a proliferation of empirical studies, often with contradictory results, relatively few refinements were made to demographic transition theory.

There were, however, two major essays, published by Davis in 1963 and by Ansley Coale (1917–2002) in 1974, that marked major advances from the standard formulation of demographic transition theory. Davis's "theory of change and response in modern demographic history" aimed to broaden the scope of the theory to include, in addition to declines in marital fertility (the standard empirical focus), the variety of ways that populations respond to population pressure (because of declining mortality) in a context of possibilities for socioeconomic mobility. Although declines in mortality and progress toward modernization typically reduce marital fertility (through increasing use of contraception and higher rates of abortion), Davis noted that postponement of marriage, increasing rates of celibacy, and out-migration were also part of the demographic repertoire of adaptation to population pressure. Davis suggested that the timing of the onset and the pace of fertility declines vary across societies (and regions in a society) depending on the relative weights of these responses. Although there have been a few empirical tests of Davis's hypotheses, his "systems approach" to demographic theory is more admired than empirically addressed.

Based on his observations of the varied patterns of fertility decline in late-nineteenth- and early-twentieth-century Europe, Coale suggested that fertility declines were affected not only by socioeconomic change but also by the cultural context of the society. In an influential formulation he specified three preconditions for fertility decline (summarized by others as "ready, willing, and able"): (1) "fertility must be within the calculus of conscious choice," (2) "reduced fertility must be advantageous," and (3) "effective techniques of fertility reduction must be available" (Coale 1973, p. 65). Demographic transition theory had primarily focused on the second precondition, namely that there must be a perceived socioeconomic gain to motivate couples (women) to want fewer children. Presumably, changes in reproductive motivations would follow from industrialization, urbanization, and other changes in social institutions that lower the economic advantages (or increase the costs) of children.

The first and third preconditions noted by Coale point to factors that had been largely taken for granted by demographers—factors that are irrelevant if the second condition is not satisfied and readily forthcoming if it is. By fertility being within the calculus of conscious choice, Coale meant there must be social legitimation for the idea of fertility regulation before most couples will act in ways that challenge traditional values of having a large family. This assumption is supported by the 1986 finding of Ron Lesthaeghe and Chris Wilson that secularization (measured by voting for nonreligious political parties) was a very important determinant of the timing of fertility decline, net of economic factors, across provinces in Europe. In deeply traditional societies with few external influences beyond the family and religious authorities, couples may not think there are any choices to be made. The third precondition is that couples know how to regulate fertility. The presence of knowledge of fertility limitation in a society does not mean that all (or even most) couples actually knew how to practice fertility control. With the massive diffusion of information about birth control and the contraceptive supplies and services distributed through family planning organizations and private channels in most contemporary societies, Coale's first and third preconditions are probably less consequential for the modern wave of fertility transitions than they were for the earlier transitions.

Alternative Theories of Fertility Decline

In the 1970s and 1980s, two streams of demographic research directly challenged the hegemony of demographic transition theory. The first was the surprising findings from the Princeton European Fertility Project, initially noted in a 1979 article by John Knodel and Etienne van de Walle and later discussed in detail in the project's 1986 summary volume by Coale and Susan Cotts Watkins. Although the European Fertility Project was envisaged as an empirical test of transition theory on its original home ground, the results showed that the pace of fertility decline across provinces and regions of Europe was only modestly correlated with the socioeconomic variables that figured so prominently in the standard theory. Instead, the patterns and pace of fertility decline appeared to be more associated with regions that shared common languages and culture than with regions sharing common socioeconomic features.

The second challenge to demographic transition theory came from the results of comparative analyses of data from the World Fertility Survey (WFS) project. The WFS project consisted of cross-sectional studies of individual-level correlates of fertility behaviors, attitudes, and contraceptive practice in dozens of developing countries around the globe. Although these studies showed that, in general, fertility was correlated in the expected direction with female education, urban residence, and other socioeconomic variables, the relationships were often modest and many exceptions could be found. Following on these findings and the research of Lesthaeghe, John Cleland and Chris Wilson wrote a bold essay, published in 1987, that questioned the empirical validity of demographic transition theory and suggested that an alternative model of culture and fertility, labeled ideational theory, would be a more appropriate theoretical framework. Ideational theory holds that cultural values are the primary influence on fertility. In some cases, cultural values supporting high fertility may be only slowly (and partially) eroded by socioeconomic changes. In other situations, cultural values that shape fertility behavior can change rapidly with the diffusion of ideas independently of socioeconomic change.

There has also been a proliferation of other new theories and accounts of modern fertility transitions. One of these is John C. Caldwell's theory of intergenerational wealth flows. Caldwell posits that mass education and Westernization (values communicated through the mass media and cinema) have popularized the idea of "child-centered" families that reduce the flow of wealth, services, and other valued resources up the generational ladder. Because these changes have made children less valuable, there are fewer incentives to have large families. Another, very influential, theoretical direction was suggested by the application of microeconomic theory to household decision-making regarding choices to have children. And Richard Easterlin has attempted to integrate the economic and sociological approaches to fertility change in a model that takes account of the demand for children, the "supply" of children, and the cost of fertility regulation.

Although there are many insightful ideas and considerable intellectual excitement in the new theoretical literature on fertility transitions, it is sometimes hard to tell what is fundamentally new and what is merely the repackaging of earlier ideas. Karen Oppenheim Mason cogently argued in 1997 that much of the debate on the causes of fertility transitions is in fact concerned with variations in the proximate conditions that influence the timing of fertility declines, and that there is broad agreement over the long-term historical factors, especially mortality decline, that have led to fertility transitions. The portrayal of demographic transition theory as a universal model of modernization and fertility decline is probably too general and vague, but there is a considerable body of evidence that socioeconomic development has been more influential in shaping historical and contemporary fertility declines than many critics have acknowledged.

There are, of course, considerable variations in the timing of the onset and the pace of fertility declines across populations, and across groups and regions within populations, and these variations are often associated with cultural and linguistic factors. The influences of socioeconomic and ideational factors need not, however, be considered as opposing hypotheses, but rather as complementary elements of an integrated theory of fertility change. Fertility, and population growth more generally, clearly respond to societal pressures that threaten the survival and well-being of human communities. Although there is much evidence that socioeconomic development is associated with fertility change in many (but perhaps not all) societies, there is ample room to consider additional hypotheses for other social and cultural factors that influence demographic change in varied circumstances. Observing the rapid spread of fertility transition to almost every region and country, at highly varied levels of socioeconomic development, Cleland concluded in 2001 that declines in mortality are the most likely common cause.

The impact of public intervention, particularly family planning programs, on fertility trends continues to be debated. The conventional wisdom, initially proposed in the classic 1976 study by Ronald Freedman and Bernard Berelson, is that the combination of vigorous family planning efforts and a favorable socioeconomic setting produce conditions most likely to lead to lowered fertility. Nevertheless, the task of sorting out the independent and joint effects of setting and policy has been remarkably elusive. The initiation of family planning programs tends to be an inherent part of the process of development itself, and it is difficult to obtain independent empirical assessments of each. Successful governments tend to have effective public programs, including well-managed family planning programs. Within countries, family planning clinics are not distributed randomly but are typically placed in areas of high fertility. Thus, the bivariate (two-variable) association between proximity to family planning services and level of fertility is usually positive. The results of more complex multivariable models are heavily dependent on initial assumptions and the analytical formulations: Several studies show only modest effects of family planning programs; others have reported more positive assessments.

The end of fertility transition was never defined beyond the general expectation that low fertility would approach the replacement level (around two children per couple) within some modest range of fluctuation. This has generally been the case in the United States: The total fertility rate (births per woman) dropped slightly below two births per woman in the mid-1970s, and then rose slightly to around two in the 1990s. In Europe, however, fertility continued its downward descent and by the late 1990s was well below the replacement level and showing no sign of rising. In some eastern and southern European countries in the early twenty-first century, average fertility, as measured by the period total fertility rate (the number of children a woman would eventually bear if current fertility rates persisted) appeared to be approaching one child per couple. One school of thought holds that this is a temporary phenomenon, driven primarily by poor economic conditions and a temporary rise in the average age of childbearing. If fertility is merely being postponed and most couples will eventually have two births, then in the early twenty-first century period measures of fertility are not an accurate prediction of the future. Indeed, survey data on fertility expectations show that most women in industrial societies still want to have two children. But other observers believe that the costs of childbearing (socially and economically) are so high in modern industrial societies that below-replacement fertility is likely to continue indefinitely, with the prospect of declining population size.

Conclusions

The first fertility transitions began in the nineteenth century, and average fertility levels reached about two births per woman in a few western European countries in the early decades of the twentieth century. At the dawn of the twenty-first century, the dominant trend is of a global fertility transition throughout the developing world and a sudden drop to below-replacement-level fertility in many European countries. At first glance, these trends suggest the conclusion that modern fertility transitions are among the most dramatic social changes in human history, yielding a new demographic metabolism that is remolding the character of the family and gender roles.

On the other hand, it is possible to interpret modern fertility transitions as corrective adjustments that are returning the human population to a stationary state where, over the long term, the number of births is approximately equal to the number of deaths. Even with high fertility, most families in premodern societies were of modest size because of high mortality. According to this perspective, the dominant demographic change of the last century is not the decline of fertility, but the rapid increase in population during the transition from the general stability of high morality and fertility to the emerging balance of low mortality and fertility. After several centuries of rapid social change and accelerating demographic growth, the world population reached approximately 1.6 billion in 1900. During the fateful twentieth century, the population of the world grew fourfold to the once barely plausible number of 6 billion in the year 2000. Even with continued slowing, the momentum of population growth is likely to add an additional 2 or 3 billion to the global total by the middle of the twenty-first century. The implications of this era of growth on the human condition and Earth's resources are only slowly being understood.

Both of these apparently different perspectives are valid, and together they suggest why it is so difficult to explain modern fertility transitions. There is no single path that has been common to all the societies that have experienced (or are currently experiencing) declines in fertility. Although population pressure from declining mortality may be the most common factor across societies, there are wide societal variations in the pace of socioeconomic development, the relative role of government and private markets, cultural traditions and gender stratification, and the strength of family planning programs. As Freedman suggested in 1979, there is likely to be a variety of conditions that are "sufficient" to lead to lowered fertility. With further study of these variant conditions and their fertility outcomes, past and future, there is the prospect of creating a simpler, but more comprehensive theory of fertility transition as the central element in understanding world demographic history.

See also: *Coale, Ansley Johnson; Culture and Population; Davis, Kingsley; Demographic Transition; Development, Population and; Freedman, Ronald; Homeostasis; Landry, Adolphe; Mortality-Fertility of Relationships; Notestein, Frank W.; Thompson, Warren S.*

BIBLIOGRAPHY

Bongaarts, John, and Susan C. Watkins. 1996. "Social Interactions and Contemporary Fertility Transitions." *Population and Development Review* 22: 639–682.

Bulatao, Rodolfo A., and John B. Casterline, eds. 2001. *Global Fertility Transition,* Supplement to Volume 27 of *Population and Development Review.* New York: Population Council.

Caldwell, John C. 1982. *Theory of Fertility Decline.* London: Academic Press.

Cleland, John, and Chris Wilson. 1987. "Demand Theories of the Fertility Transition: An Iconoclastic View." *Population Studies* 41: 5–30.

Coale, Ansley J. 1973. "The Demographic Transition Reconsidered." In *International Population Conference,* Vol. 1. Liège, Belgium: International Union for the Scientific Study of Population.

———. 1974. "The History of the Human Population." In *The Human Population: A Scientific American Book.* San Francisco: Freeman.

Coale, Ansley J., and Susan Cotts Watkins, eds. 1986. *The Decline of Fertility in Europe.* Princeton, NJ: Princeton University Press.

Davis, Kingsley. 1945. "The World Demographic Transition." *Annals of the American Academy of Political and Social Science* 237: 1–11.

———. 1963. "The Theory of Change and Response in Modern Demographic History." *Population Index* 29: 345–366.

Easterlin, Richard A. 1978. "The Economics and Sociology of Fertility: A Synthesis." In *Historical Studies of Changing Fertility,* ed. Charles Tilly. Princeton, NJ: Princeton University Press.

Freedman, Ronald. 1979. "Theories of Fertility Decline: A Reappraisal." *Social Forces* 58: 1–17.

Freedman, Ronald, and Bernard Berelson. 1976. "The Record of Family Planning Programs." *Studies in Family Planning* 7: 1–40.

Hirschman, Charles. 1994. "Why Fertility Changes." *Annual Review of Sociology* 20: 203–233.

Knodel, John, and Etienne van de Walle. 1979. "Lessons from the Past: Policy Implications of Historical Population Studies." *Population and Development Review* 5: 217–246.

Lesthaeghe, Ron, and Chris Wilson. 1986. "Modes of Production, Secularization, and the Pace of Fertility Decline in Western Europe, 1870–1930." In *The Decline of Fertility in Europe,* ed. Ansley J. Coale and Susan Cotts Watkins. Princeton, NJ: Princeton University Press.

Lesthaeghe, Ron, and Johan Surkyn. 1988. "Cultural Dynamics and Economic Theories of Fertility Change." *Population and Development Review* 14: 1–45.

Mason, Karen Oppenheim. 1997. "Explaining Fertility Transitions." *Demography* 34: 443–454.

Notestein, Frank W. 1953. "Economic Problems of Population Change." In *Proceedings of the Eighth International Conference of Agricultural Economists.* New York: Oxford University Press.

Thompson, Warren S. 1929. "Population." *American Journal of Sociology* 34: 959–975.

United Nations. 2001. *World Population Prospects: The 2000 Revision.* 2 vols. New York: United Nations.

Wrigley, E. A. 1969. *Population and History.* New York: McGraw-Hill.

Charles Hirschman

FOOD SUPPLY AND POPULATION

The relationship between a population and its food supply is a matter of prime importance. Awareness of this is reflected, for example, in the Chinese characters corresponding to the English word *population*: 人口. In these characters, a human figure appears on the left; an open mouth—requiring food—is on the right. However, it was economist T. R. Malthus's so-called "First Essay" of 1798 that famously portrayed the relationship in its starkest form. If unchecked, wrote Malthus, a population could grow geometrically, but given a limited area of cropland its food supply could grow only arithmetically, at best. These arguments raised the specter of "gigantic inevitable famine," which by raising the death rate would be the ultimate factor in restoring a rough balance between the population's size and its food supply.

Population and Food Supply—Recent History

Concern that population growth might outstrip the capacity to raise food production has been expressed many times since Malthus—particularly during the period from 1950 to 2000, when the world's population increased from about 2.5 billion to 6 billion. Writers like Paul Ehrlich and Lester Brown doubt whether food output can be raised to match this demographic growth. They see a future of mounting food supply difficulties, increasing hunger, and famines. However, the global death toll from famines has fallen very considerably since the mid-twentieth century. And while acknowledging that the world food situation and outlook have many problems, most analysts, including Nikos Alexandratos in 1995; Tim Dyson in 1996; Donald Mitchell, Merlinda Ingco and Ronald Duncan in 1997; and Alex McCalla and Cesar Revoredo in 2001, take a significantly more positive view.

The relationship between food supply and population is complex. There is no doubt that *average* levels of per capita food availability for the world as a whole have increased appreciably during recent decades. Thus the United Nations Food and Agricultural Organization (FAO) estimates that between the period from 1969 to 1971 and the period from 1997 to 1999 the average daily global level of per capita calorie (i.e. food energy) supply rose from 2,413 to 2,802 calories, and the daily availability of protein increased from about 65 to 75 grams per person (calorie and protein figures cited are from FAO, 2002). However, most of the world's population growth during this period happened in poor regions, like South Asia and sub-Saharan Africa, where it is estimated that sizeable fractions of the populations are undernourished (i.e. having levels of food consumption below those required to maintain body weight and support light activity). Consequently, FAO estimates that the total number of undernourished people in the world declined only modestly in the same period: from around 941 million to about 826 million, according to Alexandratos in 1995 and FAO in 2000.

East Asia—Positive Developments

At a broad regional level progress has been very variable. The most positive developments have occurred in East Asia. In China the period since 1980 has seen major gains in average per capita calorie supplies and protein intake, and the diet has generally become better and more diverse. Per capita incomes have risen, and with increased incentives to invest and increase their production, farmers have sharply increased their output of most foodstuffs—notably rice, wheat, fruits, vegetables, and pork. However, because there is little new land that can be brought into cultivation, almost all of this increase in food production has come about through processes of agricultural intensification: the improvements in food supply that China's growing population have enjoyed have occurred mostly through increasing food crop *yields* (i.e. output per unit of harvested area). China has invested heavily in crop research—especially in developing higher yielding varieties of rice—and Chinese farmers have also sharply raised their use of chemical fertilizers.

Southeast Asia, the Middle East, and Latin America—Mixed Results

In Southeast Asia, the Middle East, and Latin America there have also been significant gains in average levels of per capita food availability during recent decades—despite the occurrence of considerable population growth. Diets have generally become more varied, and the populations of these regions have experienced marked rises in their average supplies of calories and protein—again, mainly due to increased food crop yields. The technological developments arising from the so-called *Green Revolution* starting in the late 1960s—especially the introduction of higher-yielding varieties of rice and wheat, combined with greater applications of nitrogenous fertilizers on irrigated land—have benefited most countries.

However, in the Middle East, where water for agriculture is often in short supply, many countries have also turned to purchasing sizeable quantities of cereals on the international market—much of which is then used as livestock feed in order to produce meat. Indeed, some Middle Eastern countries rely upon cereal imports for as much as half of all the grain they use. This is a notable case in which increased trade has augmented food supplies in the face of a significant environmental constraint (i.e. water scarcity) and substantial demographic growth.

Conditions for food production are generally favorable in Latin America, where some countries, notably Brazil and Argentina, are major exporters of products like fruits, vegetables, wheat, and meat. Of course, the positive food situation in these three regions should not obscure the fact of considerable inter-country variation. Cambodia, Peru, and Sudan, for example, have populations with very low per capita supplies of calories and protein. And, as in East Asia, there are significant numbers of poor, undernourished people in each of these regions.

South Asia—Significant Problems

The food situation in South Asia is significantly worse than in the regions discussed above. The FAO estimates that India alone contains about one quarter of all the world's undernourished people; in the years 1996 to 1998 its average calorie supply was estimated at only 2,434 per person per day. A particular problem of the South Asian diet is its lack of high quality protein due, in part, to widespread vegetarianism. It is uncertain whether the nutritional content of the Indian diet has improved much during recent decades, despite significant increases in average incomes and little change in the real price of food. What has happened is that people have diversified the foods they consume, purchasing more fruits, vegetables, and milk, but reducing their consumption of legumes, which are nutritionally rather valuable. Food production in South Asia has benefited from high-yielding varieties of wheat and rice, but there has been little change in the cultivation of traditional coarse cereals. Consequently, the per capita availability of these latter food crops, which tend to be more nutritious, has fallen.

The nutritional status of South Asia's population is generally dismal. In India, for example, nearly half of all children under age three are estimated to be underweight, and a similar proportion of adult women are anemic. However, such health and nutritional problems are often not seen as problematic by the people themselves: Virtually all Indian households report that they have "two square meals a day." With an increasing variety of non-food items available for purchase in local markets, increased per capita incomes have often not been spent on food.

South Asia's population could well increase by 600 million in the first half of the twenty-first century. Average levels of food consumption may well rise, but this demographic growth, and recent trends in food demand and production, do not augur well for a major decrease in the total number of undernourished people.

Sub-Saharan Africa—Widespread Undernourishment, Grim Prognosis

In major world regions the food situation is probably grimmest in sub-Saharan Africa, where FAO (2000) estimates that in the period from 1996 to 1998 about one-third of the total population was undernourished. The region's estimated per capita daily calorie supply for the years 1997 to 1999 suggests scant improvement compared to the 1969 to 1971 period. This is the world's poorest region and it has experienced the fastest demographic growth, with populations often doubling in less than 25 years.

African farmers have been unable to raise their food crop yields at similar rates. In fact, average cereal yields rose very little in the decades around the turn of the century. Consequently, total food output has been increased largely through processes of extensification—increasing the harvested area. Traditional fallow periods have been reduced (often leading to losses in soil fertility) and the area of cropland has been increased by converting tracts of bushland and forest to cultivation. These developments have sometimes occurred in conditions of sociopolitical instability, and where governments have neglected the agricultural sector. Moreover, until the early 1990s global agricultural research tended to be focused on crops like rice and wheat, which are not widely grown in sub-Saharan Africa. There is no doubt that given appropriate levels of investment this region's agricultural potential is considerable. But most analysts envisage that in the first decades of the twenty-first century average levels of per capita food production and consumption will not rise by much. With the likelihood of considerable future population growth the total number of undernourished people may well increase. Adding to this bleak outlook, the region may continue to experience food crises and famines—often with warfare acting as an important contributory cause.

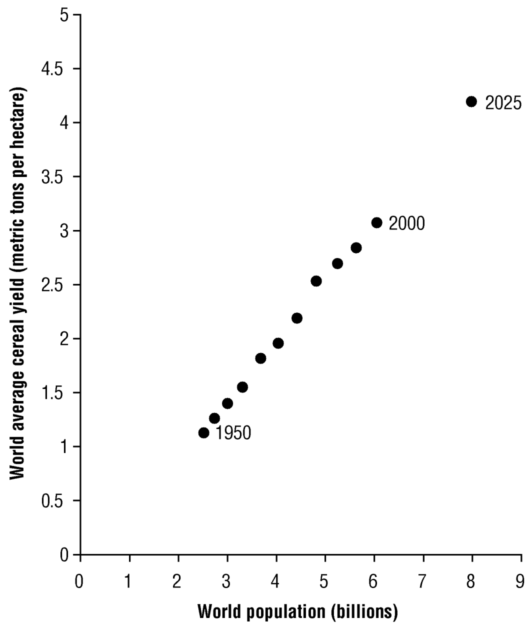
The Developed World—Obesity, Overproduction, Farm Subsidies

In considering the world's more developed regions, the situation is clearly very different. In most developed countries the number of people who are undernourished is tiny (although the economic disruption following the collapse of communism in Eastern Europe and the former Soviet Union in the 1990s caused real hunger at times). However, in the developed world obesity—linked to overeating and sedentary lifestyles—is often a serious and growing problem (one, it must be said, which is also increasing in many urban areas of the developing world).

Recent decades have seen considerable competition in the agricultural sector, particularly between the United States and the European Union. Both these major food-producing blocs have experienced difficulties in trying to reduce the subsidies they pay their farmers, yet at the same time agricultural yields have continued to rise, often at a brisk pace. Consequently, the overproduction of food in relation to the volume of *effective demand* (the ability of people or nations to pay for it) has been, and continues to be, a serious problem. A consequence is that the prices of many foods, including important cereal crops like wheat and maize (i.e. corn), on the international market remain low. This benefits the developing countries that import these crops—for example, those in the Middle East. But these same low prices are harmful to agricultural producers and exporters in other countries, including some of the poorest developing countries. These problems of international political economy are the subject of ne-

FIGURE 1

Relationship Between the Size of the World's Population and Average Global Cereal Yield, 1950–2000 and a Projected Estimate for 2025



Note: The cereal yields are 3 year averages; data for years 2000 and 2001 are provisional. The projected yield of 4.19 tons per hectare corresponding to a population of 8 billion derives from linear regression.

SOURCE: *FAO Production Yearbooks*, Rome: Food and Agricultural Organisation, various years, and United Nations *World Population Prospects*, New York: United Nations. See also Lloyd Evans (1998).

gotiations in the World Trade Organization, but they are unlikely to go away.

Summary—Progress and Problems

In summary, progress in feeding the growing world population has been mixed. For most regions the situation has improved; although even in China, where progress has been marked, there remain tens of millions of people who lack the purchasing power to buy sufficient quantities of food. The record of South Asia, however, is best described as patchy; and for sub-Saharan Africa it is bad. There is no doubt that the knowledge, crop varieties, and technologies to significantly raise per capita food supplies in these two regions exist. But the socioeconomic and political conditions for their successful utilization have often been lacking. Moreover, population growth in both regions has probably made the task of raising average levels of food availability per person harder than it would otherwise have been. This situation appears likely to continue into the early decades of the twenty-first century. There will be significant progress in raising average levels of food consumption in most regions, but with South Asia and, still more, sub-Saharan Africa lagging behind. In general, population growth in the developing world will continue to be the main factor contributing to the growth of world cereal demand; and some of this growth in demand will be met by increased production from farmers in more developed regions, especially in North America.

Cereals—Indicator of Diet Quality

This brief account of food and population can appropriately conclude with a comment on cereals, the most important component of the human diet. Cereals make up about half of all direct human caloric intake (as bread or cooked rice, for example), and perhaps two-thirds if account is taken of the large quantities of cereals that are fed to animals to produce meat, milk, and eggs. Cereal data can be used to exemplify the same basic element of identity between a population and its food supply that was illustrated by the Chinese characters for population described above. Figure 1 plots the relationship between the size of the world's population since the early 1950s and the average level of the world cereal yield. It reflects the fact that to a considerable extent the huge growth of the global population during recent decades has both contributed to, and been supported by, the rise in the average world cereal yield. Demographic growth has meant that yields have had to be increased, while at the same time the attainment of higher yields has supported the increasing population. Note that the relationship is fairly tight—sufficiently so to make a reasonably firm prediction that when the world's population reaches 8 billion, which it is projected to do around the year 2025, the world cereal yield will be slightly above four metric tons per hectare. Such a yield will be required to supply food for a world of 8 billion.

See also: *Land Use; Natural Resources and Population; Nitrogen Cycle.*

BIBLIOGRAPHY

Alexandratos, Nikos, ed. 1995.*World Agriculture Towards 2010, An FAO Study.* Chichester, Eng.: John Wiley.

Bansil, P. C. 1999. *Demand for Foodgrains by 2020 AD.* New Delhi: Observer Research Foundation.

Brown, Lester R., Gary Gardner, and Brian Halweil. 1999. *Beyond Malthus: Nineteen Dimensions of the Population Challenge.* New York: W. W. Norton.

Cohen, Joel E., and Nina V. Federoff, eds. 1999. *Colloquium on Plants and Population: Is There Time?* Washington, D.C.: National Academy of Sciences.

Devereux, Stephen. 2000. *Famine in the Twentieth Century.* Working Paper 105. Sussex, Eng.: Institute of Development Studies.

Dyson, Tim. 1996. *Population and Food: Global Trends and Future Prospects.* London and New York: Routledge.

———. 2001. "World Food Trends: A Neo-Malthusian Prospect?" *Proceedings of the American Philosophical Society,* 145(4): 438–455.

Ehrlich, Paul E. 1968. *The Population Bomb.* New York: Ballantine Books.

Evans, Lloyd T. 1998. "Greater Crop Production." In *Feeding a World Population of More Than Eight Billion: A Challenge to Science.* eds. J. C. Waterlow, D. G. Armstrong, Leslie Fowden, and Ralph Riley. New York and Oxford: Oxford University Press and the Rank Prize Funds.

Food and Agricultural Organization (FAO). 2000. *The State of Food Insecurity in the World 2000.* Rome: Food and Agricultural Organization.

IIPS and ORC Macro. 2001. *National Family Health Survey (NFHS-2), 1998–99: India.* Mumbai: International Institute for Population Sciences.

McCalla, Alex F., and Cesar L. Revoredo. 2001. *Prospects for Global Food Security: A Critical Appraisal of Past Projections and Predictions.* Washington, D.C.: International Food Policy Research Institute.

Mitchell, Donald O., Merlinda D. Ingco, and Ronald C. Duncan. 1997. *The World Food Outlook.* Cambridge, Eng.: Cambridge University Press.

INTERNET RESOURCE.

Food and Agricultural Organization (FAO). 2002. *FAOSTAT.* <http://www.apps.fao.org>.

TIM DYSON

FORCED MIGRATION

Prior to the 1920s, international migration was largely unrestricted, and little was done to legally categorize immigrants according to the reason for their movement. Previous centuries had seen large forced population displacements (the Huguenots from France in the seventeenth century being just one example). However, the twentieth century saw massive, forced population movements across international borders, and these gave rise to legal distinctions that have affected all those seeking refuge outside their country of origin.

It is essential to make a distinction between *forced migration* (the subject of this article), which involves the movement imposed on large populations (groups of persons counted in the thousands), on the one hand, and individual migrants, who may or may not be part of a larger group but are persecuted in their country and seek asylum and the legal status of refugee as individuals in another country. The need for distinguishing between the two categories became clear as a result of post-World War II developments when political, religious, or ethnic persecution forced large numbers of people to leave their home countries, making the established procedures for individual consideration of applications for refugee status unworkable. The terms *forced migration* and *forced displacement* are used interchangeably in this article. Deportations within states, such as those in the Soviet Union during the 1940s, in which more than 3 million people were deported within the state, are not dealt with here.

Six specific large forced population displacements are briefly referred to below. These are the displacements of Russians, Armenians, German and Austrian Jews, Hungarians, the Indo-Chinese, and the victims of ethnic cleansing in the former Yugoslavia in the 1990s. These cases are chronologically handled: the League of Nations period, the Cold War period, and the post-Cold War period provide a useful categorization. Worldwide, a great many more people have been forced to flee their homes and cross international borders, as they became the targets of group persecution. However, the six cases highlighted here paint a historical picture of forced migration in the twentieth century.

The League of Nations

The first two cases of forced migration, those of the Russians and the Armenians, can be described as being part of the aftershocks of World War I. The Russian Revolution and the civil war that followed it led to a Bolshevik regime, self-described as a dictatorship of the proletariat, which placed large population groups, declared to be class enemies, in physical jeopardy. Economic collapse, culminating in a massive famine, exacerbated the fears of persecution on political-ideological grounds. By 1921, it is estimated that some 800,000 to 1.5 million Russians fled the country to seek safety and a better future in other European countries. In February 1921, the League of Nations passed its first resolution on refugees and, later that year, held a conference on the question of Russian refugees and appointed a prominent Norwegian, Fritjof Nansen, as High Commissioner for Refugees. Special arrangements included the creation of the Nansen Passport, a travel document for those deprived of the protections normally granted by a state of citizenship to the bearer of a passport.

The disintegration of the Ottoman Empire had disastrous consequences for Armenians, a Christian minority with an ancient and distinct culture living within a Muslim population. Decades of repression in the dying phase of Ottoman rule generated substantial Armenian refugee movements, notably at the end of the Greco-Turkish War (1897). By World War I, the Armenians were essentially a stateless victim group, in the precarious position of being relatively prosperous, middle-class, and urban. In 1915, the Turks had begun what Claudena Skran describes as "a radical method of dealing with the unwanted Armenian minority: genocide" (Skran 1995, p. 44). In addition to massive loss of life, the fledgling Armenian state was besieged by its neighbors, with the Russians and Turkey carving up the territory of the new republic between them. By 1924, more than 200,000 Armenian refugees were spread through Europe, the Balkans, and the Middle East. Many of these eventually settled in the United States. The tragedy of the Armenians was not only that so many fled, but also that so many perished because they did not become refugees.

In Germany, the Nazis's rise to power in early 1933 raised the prospect that a similar situation would eventually develop as to that country's Jewish population: Under Nazi laws, Jews were officially discriminated against on the basis of racial criteria. By October of 1933, the League of Nations had decided that the persecution and exodus of German Jews posed such a problem to other states that a new High Commissioner was appointed specifically for refugees coming out of Germany. By 1938, 150,000 people, mostly Jews, had fled Germany, and 126,000 fled Austria following the Anschluss in that year. (As it later transpired, these numbers represented a small fraction of the persecuted population that eventually perished in concentration camps and forced labor camps during World War II.) To deal with this migrant flow, two new definitions were created—for those fleeing Germany and for those fleeing Austria, as a result of Nazi persecution. Both the new High Commissioner post, and the new definitions, highlighted a difficult international political problem. Creating specific measures for specific groups of refugees and naming the state from which they fled was tantamount to an explicit international legal and political accusation that a state was engaged in persecuting a minority. Such an accusation, it was argued, did not help in finding a diplomatic solution to the problem. The decision was therefore made to work toward a universal definition of a refugee—making asylum, the granting of refuge, a less overtly political act.

The Cold War

In the immediate aftermath of World War II, there were large numbers of displaced persons—persons outside of their country of origin seeking protection from the war's effects, or deportees or former prisoners of war unwilling to return home fearing persecution. An even larger group consisted of German refugees—citizens of Germany and persons of German ethnicity who formerly resided either in territories now outside the redrawn German borders or who formerly resided as members of the German minority in countries East of Germany. They either fled to the West in anticipation of expulsion or were forcibly expelled. The German refugees were given citizenship rights in either West or East Germany and were readily absorbed into the population within Germany's new borders. (Many residents of East Germany in subsequent years fled to West Germany and settled there.) The non-German displaced persons were eventually also resettled, either in various Western European countries (including Germany) or overseas, mostly in North America and Australia. The difficulties experienced in that process led to the adoption, in 1951, of the Convention Relating to the Status of Refugees. It defined an individual refugee as someone who is outside his or her country of origin and is unwilling or unable to avail himself or herself of the protection of that country due to a well-founded fear of persecution on the grounds of that person's religion, nationality, race, or social group. The definition was in principle universal, in that it did not mention any specific group or state(s), but the Convention did allow for reference to specific acts of persecution occurring in Europe.

The 1951 Convention was aimed both at dealing with the remaining numbers of displaced persons as a result of World War II, and with the new Cold War problem of targeted persecution. The first major challenge to the Convention, as a tool for determining the status of individuals, came in 1956. The anti-Soviet and anti-communist Hungarian uprising of 1956 led to some 200,000 persons fleeing to Austria and Yugoslavia. The Convention was not applied to all Hungarians: Most were protected temporarily in Austria and Yugoslavia, on an ad hoc basis, for up to a year, but virtually all of them were soon resettled throughout Western Europe, the United States, Canada, Australia, and New Zealand. Most of them were simply given legal immigration status in the receiving countries, with employment opportunities readily available in the reconstructing post-World War II economies.

While other forced displacements took place in most world regions in the Cold War years, the next major challenge to the universal system established by the signing of the 1951 Convention and the creation of the office of the United Nations High Commissioner for Refugees originated in Indo-China. As a result of the war in Vietnam and the related political-ideological conflict and severe economic hardship, large numbers of people fled or were, by their own estimation, forcibly expelled from Vietnam, Laos, and Cambodia. From 1975 to mid-1979, some 245,000 Vietnamese, Laotians and Cambodians arrived in Thailand alone. Large numbers of refugees also entered other states neighboring Indo-China, notably Malaysia and Hong Kong: Between 1979 and 1988, some 500,000 Vietnamese "boat people" landed in these countries of presumed first asylum. Thailand and Malaysia called for solidarity from more distant states, in particular for resettlement of the refugees. In these Asian states in which initial protection was sought, the refugees were routinely denied asylum, reflecting the expectation of the receiving states that permanent solutions for these displaced persons would be found in other countries. Large numbers were indeed permanently resettled in developed countries, notably in the United States. As the Vietnamese conflict was settled, the impetus to resettle diminished and the eventual fate of large remaining numbers of displaced persons was to return, often under duress, to their country of origin. No specific status definitions were made for Indo-Chinese refugees, although principles of first asylum followed by resettlement as a permanent solution, and of global solidarity, were developed as a result of two international conferences held in 1979 and 1989 that were devoted to the problem.

Post-Cold War

As the Cold War drew to an end, the states of Western Europe anticipated, and feared, a massive exodus from Eastern Europe: not a forced migration, but one of people who a short time before would indeed have been considered to be refugees. This exodus did not occur on anything like the anticipated scale. However, as war, sparked by long-standing ethnic and religious conflict, broke out in the Balkans, from 1992 to 1995 an estimated 3.5 to 5 million people fled Bosnia Herzegovina, Croatia, and Serbia. Forced migration of whole populations on this scale and within so short a time had not been seen in Europe since World War II. The exodus found the countries of Western Europe both unprepared and with a sharply diminished desire to grant protective status to persons from former communist states. Refusing to grant most of these people the status of refugee, on the ground that they fled generalized violence rather than individually-targeted persecution, European states began to develop a doctrine of temporary protection, based not on the principle of a durable solution ultimately being found in integration, or resettlement, but on voluntary return, or mandatory repatriation as the only acceptable final arrangement. Each state developed its own definition of temporary protection—notwithstanding that this situation arose during a time when the member states of the European Union were seeking harmonization of their asylum policies. In some definitions, the former Yugoslavia was mentioned specifically in new laws and policy documents. The world's management of massive forced displacements seemed to be coming full circle to nationality-based definitions of those who would receive, or be denied as the case might be, protection.

The Kosovo crisis of 1999 evoked a similar response. About half the population of Kosovo, almost a million persons, fled to neighboring Albania and Macedonia. Like Thailand and Malaysia in the 1970s, Macedonia reinforced its appeal to other states for assistance by temporarily closing its border with Kosovo, preventing people from becoming refugees. An evacuation program removed some 90,000 people from Macedonia to Western European states, Turkey, Australia, and the United States during a three-month period, and many more were transferred to Albania. In the summer of 1999, rapid repatriation occurred. As NATO forces and then a United Nations mission took control of the province, the vast majority of the 1 million people who had fled returned, initially from Macedonia and Albania, and over the following months from further afield.

Conclusion

By 2000, virtually all countries of the world had strict control over immigrant entries to their territories, and many were imposing high barriers to entry even for those persons forced to flee their country of origin, whether individually or en masse as described above. Though the moral duty to protect human rights was professed and the legal tools to enact refugee protection worldwide were in place, the actual willingness to grant refuge was clearly absent in most countries—perhaps most obviously in those parts of the world most capable of protecting significant numbers of forced migrants and those farthest away from the countries those migrants would be forced to leave.

See also: *Asylum, Right of; Communism, Population Aspects of; Ethnic Cleansing; Refugees, Demography of; Resettlement; War, Demographic Consequences of.*

BIBLIOGRAPHY

Cohen, Roberta, and Francis M. Deng. 1998. *Masses in Flight: The Global Crisis of Internal Displacement.* Washington, D.C.: Brookings Institution Press.

Indra, Doreen, ed. 1999. *Engendering Forced Migration: Theory and Practice.* New York: Berghahn Books.

Jackson, Ivor C. 1999. *The Refugee Concept in Group Situations.* Dordrecht, Netherlands: Martinus Nijhoff Publishers.

Loescher, Gil. 2001. *The UNHCR and World Politics: A Perilous Path.* Oxford: Oxford University Press.

Skran, Claudena. 1995. *Refugees in Inter-war Europe: The Emergence of a Regime.* Oxford: Oxford University Press.

United Nations High Commissioner for Refugees. 2000. *The State of the World's Refugees 2000.* Oxford: Oxford University Press.

van Selm-Thorburn, Joanne. 1998. *Refugee Protection in Europe: Lessons of the Yugoslav Crisis.* Dordrecht, Netherlands: Martinus Nijhoff Publishers.

Viviani, Nancy. 1996. *The Indochinese in Australia 1975–1995: From Burnt Boats to Barbecues.* Melbourne, Australia: Oxford University Press.

Zolberg, Aristide, Astri Suhrke, and Sergion Aguayo. 1989. *Escape from Violence: Conflict and the Refugee Crisis in the Developing World.* Oxford: Clarendon Press.

JOANNE VAN SELM

FORECASTS, POPULATION

See *Projections and Forecasts, Population*

FREEDMAN, RONALD

(1918–)

Ronald Freedman is a social demographer who has devoted most of his career to the study of fertility and was instrumental in the development of the sample survey as a means of investigating levels, trends, and determinants of fertility. Freedman completed his Ph.D. at the University of Chicago in 1947, writing a dissertation on population distribution in the United States, having already taken up a teaching position in the Department of Sociology at the University of Michigan in 1946. He quickly shifted his attention to fertility and, with a pioneering younger generation of social scientists at Michigan with whom he had formed the Institute of Social Research, began to explore how the sample survey might advance fertility research. Freedman recognized that the sample survey naturally lent itself to the measurement of knowledge and attitudes, an attractive feature given Freedman's deeply sociological approach to fertility that placed considerable emphasis on values and norms.

In 1955, Freedman directed the first national fertility survey in the United States, the Growth of American Families, with Pascal Whelpton. Many had questioned whether intimate matters such as contraceptive behavior could be measured in survey interviews. The results of the 1955 survey largely allayed those concerns, as can be seen in the 1959 book written by Whelpton, Freedman, and Arthur Campbell as a result of this work. The sample survey has subsequently become the primary source of data on reproductive attitudes and behaviors in all regions of the world.

Freedman turned his attention to fertility in developing countries, and, in the early 1960s, forged a relationship with researchers in Taiwan that has been remarkably productive for him and his associates at Michigan since that time. During the 1960s, many national governments (including Taiwan's) and private agencies were considering launching family planning programs in order to accelerate fertility decline, but the likely impact of such programs was the subject of much dispute. Freedman and his Taiwanese collaborators conducted an experiment in the city of Taichung, with new services randomly assigned to a sub-set of neighborhoods. The results, published in 1969 as *Family Planning in Taiwan: An Experiment in Social Change*, demonstrated convincingly that the new family planning services facilitated adoption of modern contraception and, interestingly, that the effects spilled over to adjacent neighborhoods. The Taichung study was a landmark in demographic research and remains one of the few rigorous applications in demography of classic experimental design. Through a succession of islandwide fertility surveys, Freedman and his collaborators charted the course of fertility transition in Taiwan; few transitions are better understood from the standpoint of both causes and consequences.

Freedman became a leading figure in research on fertility in developing countries, authoring many influential papers and serving in numerous advisory capacities. He steadfastly maintained a theoretical perspective strongly grounded in the social sciences, in which socioeconomic conditions, cultural systems, and targeted programs each have causal roles. Freedman was a gifted institution-builder, notably of the Population Studies Center at the University of Michigan, which he directed from its establishment in 1962 through 1971. He had a remarkable ability to spot talent and to bring out the best in those with whom he worked. Freedman was also a dedicated teacher, serving on the faculty of the University of Michigan for 41 years. Freedman was elected to the U.S. National Academy of Sciences in 1974, and was awarded the IUSSP (International Union for the Scientific Study of Population) Laureate in 2002.

See also: *Demographic Surveys, History and Methodology of; Demography, History of; Family Planning Programs; Fertility Transition, Socioeconomic Determinants of; Whelpton, P. K.*

BIBLIOGRAPHY

SELECTED WORKS BY RONALD FREEDMAN.

Freedman, Ronald. 1961–1962. "The Sociology of Human Fertility." *Current Sociology* 10/11: 35–121.

———. 1979. "Theories of Fertility Decline: A Reappraisal." *Social Forces* 58: 1–17.

———. 1987. "The Contribution of Social Science Research to Population Policy and Family Planning Program Effectiveness." *Studies in Family Planning* 18: 57–82.

Freedman, Ronald, and John Y. Takeshita. 1969. *Family Planning in Taiwan: An Experiment in Social Change.* Princeton: Princeton University Press.

Freedman, Ronald, Ming-Cheng Chang, and Te-Hsiung Sun. 1994. "Taiwan's Transition from High Fertility to Below-Replacement Levels." *Studies in Family Planning* 25: 317–331.

Whelpton, Pascal K., Ronald Freedman, and Arthur Campbell. 1959. *Family Planning, Sterility, and Population Growth.* New York: McGraw-Hill.

John B. Casterline

FUTURE GENERATIONS, OBLIGATIONS TO

Unless something goes drastically wrong in the next few centuries, future people will greatly outnumber those currently alive. The actions of present generations have potentially enormous impact on those who will live in the future. Perhaps the most significant impact is that society's decisions affect who those future people will be—and even if there will be any future people at all.

Despite its obvious importance, intergenerational ethics has not loomed large in traditional moral philosophy. Only since the 1960s have philosophers really begun to grapple with the complexities involved. Much of the discussion has been highly technical, focusing on logical puzzles regarding the value of existence and on the possibility of comparing the lives of different possible individuals. But underlying these difficult-to-understand technicalities are some of the deepest moral questions. What makes life worth living? What do we owe to our descendants? How do we balance their needs against our own?

The Non-Identity Problem

In his classic discussion of the present generation's obligations to future generations, Derek Parfit distinguished two kinds of moral choice. In a *Same People Choice,* society's actions affect what will happen to people in the future, but not which people will come to exist. If an individual's actions does affect who will exist in the future, then one is making a *Different People Choice.* Parfit claimed that Different People Choices are much more frequent than one might expect and that many traditional moral theories cope much better with Same People Choices than with Different People Choices. Taken together, these two claims constitute Parfit's *Non-Identity Problem,* so called because in a Different People Choice, those who would come to exist in one possible outcome are not (numerically) identical to those who would come to exist in an alternative possible outcome.

Suppose the cheapest way to meet the energy needs of the present generation is to build a power plant in a presently unoccupied desert. Experts know that the plant will be safe for several generations but will then leak radiation, harming those living nearby. The choice is made to build this plant, rather than to build a safer, more expensive one somewhere else. To many this behavior seems outrageous. Several common moral principles, however, imply that there is nothing wrong with the decision. Suppose one thinks that an act is wrong only if it wrongs some particular person, that people are wronged only if they are harmed, and people are harmed only if they end up worse off than they would otherwise have been. Now apply these principles to the choice of energy policy. Suppose the lives of those who suffer from radiation poisoning are worth living overall. If the safer plant was chosen, those future people would never have existed, because their great-grandparents, who moved to the desert to build the plant, would never have met. So the future people have no complaint, because the choice has not harmed them.

Philosophers have responded to the Non-Identity Problem in three distinct ways: (1) Some deny that present-day society has any obligations to future people. For instance, David Heyd is a defender of a "generocentric" position, where the behavior of the present generation is constrained only by obligations to contemporaries and to themselves. (2) "Person-affecting theorists" argue that society does have obligations to particular future people, even if our actions create those people and their lives are worth living. One common approach appeals to rights. If future people have a right to an unpolluted atmosphere, then our current practices might violate that right, even though the resulting people have lives worth living. (3) Utilitarians argue that society should make future humans as happy as possible, regardless of their identity.

The Repugnant Conclusion

Utilitarianism avoids the Non-Identity Problem by treating Different People Choices and Same People Choices analogously. In either case, individuals seek to maximize the happiness of whoever exists. Unfortunately, utilitarianism faces other problems, especially in *Different Number Choices,* where society decides how many people there will be.

In describing Different Number Choices, Parfit imagined a choice between two possible futures, A and Z. In A, there are 10 billion people, all of whom have wonderful lives. In Z, there is a much larger number of people, all of whom have lives that are "barely worth living." Parfit argued that if the second population is sufficiently large, then traditional utilitarianism must prefer Z, because it contains more happiness.

This "Repugnant Conclusion" is the organizing problem of contemporary utilitarian value theory. Some utilitarians reply that the value of a possible outcome should be a function of the average happiness, as well as total happiness. Others embrace the Repugnant Conclusion but argue that the Z future cannot be as bad as Parfit suggested. Debate often focuses on the precise specification of the "zero level"—the point below which a life ceases to be worth living. By definition, the people in Z live just above that zero level. If the zero level is set at a comparatively high level, then life in the Z world might be reasonably worthwhile. Some philosophers argue that, in this case, it would not be repugnant to prefer Z to A.

The Unequal Circumstances Problem

The quality of life of future generations is largely dependent on society's decisions. By contrast, the quality of life for present generations is not affected at all by decisions of future generations. Present generations can do a great deal to posterity, but posterity cannot do anything to them. Western political philosophy has often discussed justice in terms of mutually advantageous reciprocal interaction, either in the actual world or in some hypothetical choice situation. Traditional political theories thus find it hard to generate *any* obligations to future generations.

Some theorists expand the traditional social contract, imagining a contract between different generations, perhaps built on a series of contracts between overlapping generations. Others reject the individualism of much contemporary political philosophy, arguing that only a holistic approach can provide an adequate framework for thinking about our obligations to future generations. If members of the present generation view their own lives as bound together with those of their ancestors and descendants in an intertemporal community, then it is easier to see how they might have obligations to future people.

See also: *Environmental Ethics; Generational Accounting; Intergenerational Transfers.*

BIBLIOGRAPHY

Barry, Brian. 1977. "Justice between Generations." In *Law, Morality, and Society: Essays in Honour of H. L. A. Hart,* ed. P. M. S. Hacker and J. Raz. Oxford: Clarendon Press.

———. 1978. "Circumstances of Justice and Future Generations." In *Obligations to Future Generations,* ed. Richard Sikora and Brian Barry. Philadelphia: Temple University Press.

Heyd, David. 1992. *Genethics: Moral Issues in the Creation of People.* Berkeley: University of California Press.

Kim, Tae-Chang, and Ross Harrison, eds. 1999. *Self and Future Generations: An Intercultural Conversation.* Cambridge, Eng.: White Horse Press.

Mulgan, Tim. 1999. "Teaching Future Generations." *Teaching Philosophy* 22: 259–273.

Parfit, Derek. 1984. *Reasons and Persons.* Oxford: Oxford University Press.

Tim Mulgan

G

GALTON, FRANCIS

(1822–1911)

Sir Francis Galton, scientific polymath, eugenicist, hereditarian and pioneer of statistical methodology, was born in Birmingham, England, the third son of the wealthy banker Samuel Tertius Galton, and the grandson of doctor and poet Erasmus Darwin. Galton began his scientific career, at the age of 16, as a medical student at the Birmingham Free Hospital. From there he moved to King's College London to study medicine, and to Trinity College Cambridge in 1840 to read mathematics. Achieving only a pass degree at Cambridge, due to the first of several mental breakdowns, Galton reluctantly persisted with his medical training. But, coming into a fortune on his father's death in 1844, he abandoned medicine. In 1850, after several idle years, Galton financed and led an exploratory expedition to Southwest Africa, returning in 1852. Lionized by the scientific community, he gradually established himself as one of Victorian Britain's most respected scientists.

Galton's professional energies were mostly devoted to exploring human heredity and developing means by which to study it. And, as heredity could only systematically be investigated at the population level, he made many practical contributions to population studies. Having read, and been profoundly influenced by, English naturalist Charles Darwin's (his half-cousin) *The Origin of Species* (1859), a decade later Galton published *Hereditary Genius* (1869). In this unequivocally Darwinist work, Galton collated hundreds of eminent pedigrees in an attempt to prove that high intellectual ability is largely a function of hereditary endowment. On this basis, he proposed measures to ensure that the more intelligent members of society achieved the highest rates of fertility. (Galton's own marriage, however, was childless.) Galton coined the term *eugenics* in 1883, in his *Inquiries into Human Faculty,* derived from the Greek *eugenes* meaning "good in stock."

Galton was among the first scientists to apply mathematical tools to the study of the inheritance of human mental and bodily traits. He began with rather rudimentary methods. However, it was his consistent fascination with variation around the population mean that later enabled him to develop the fundamental statistical techniques of both correlation and regression—procedures later systematized and more fully explicated by Galton's admirer and first biographer, the statistician Karl Pearson (1857–1936). From 1904, Galton privately financed research fellowships in statistics and eugenics at University College London, and he left money for their continuation in his will.

Galton's interest in heredity was practical as well as numerical. Collaborating with Darwin, he tested the theory of the inheritance of acquired characteristics by transfusing blood among different breeds of rabbit. Galton then bred several generations of sweet-pea plants in an attempt to establish the mechanics of heredity; from his results he formulated the ancestral law of heredity, a model of inheritance later superceded by Mendelian genetics. The same fascination about heredity also stimulated his research on fingerprints (and their use in criminology), unconscious mental phenomena, variation in stature and strength, and the supposed physical indices of criminality. In addition, symptomatic of his polymathic interests, Galton made significant contributions to geography and meteorology; in 1862, he named and described the "anti-cyclone."

Galton was honored with numerous prestigious awards and was knighted in 1909. As a scientist he was idiosyncratic, utterly dedicated and, though frequently naive, often strikingly effective. His maxim was "Whenever you can, count," and his research suggests a man with an almost obsessive compulsion to do so. At the personal level, Galton suffered from an unusually low self-esteem and recurrent mental health problems. Yet, he also displayed a willingness to scandalize popular opinion, and he pushed the materialism of his fellow protagonists of Darwinism further than most would have dared.

Galton's eugenic ideas stimulated demographic research in both Europe and America. But it was his contributions to statistical methodology, made in the context of his hereditarian pursuits, that make Galton such an important figure in the history of population studies.

See also: *Darwin, Charles; Eugenics; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY FRANCIS GALTON.

Galton, Francis. 1869. *Hereditary Genius.* London: Macmillan.

———. 1883. *Inquiries into Human Faculty.* London: Macmillan.

———. 1889. *Natural Inheritance.* London: Macmillan.

SELECTED WORKS ABOUT FRANCIS GALTON.

Gillham, Nicholas W. 2001. *A Life of Sir Francis Galton: From African Exploration to the Birth of Eugenics.* New York: Oxford University Press.

Pearson, Karl. 1914–1930. *The Life, Letters and Labours of Francis Galton,* 3 vols. Cambridge, Eng.: Cambridge University Press.

John Waller

GENDER

Gender refers not just to differences between women and men but to the socially constructed norms, expectations, patterns of behavior, and ideology surrounding those differences. Gender is an organizing principle in all known societies, shaping individual lives and social institutions. The resulting social organizational patterns and dynamics are known as a gender system.

A distinction is often drawn between "sex" and "gender," with sex referring to the biological differences between women and men (such as in chromosomes, hormones, or secondary sex characteristics) and gender to the social differences between women and men. Gender, according to the scholar Joan Wallach Scott, is thus "a social category imposed on a sexed body" (1986, p. 1056). But this seemingly simple division—sex denoting biology, gender denoting social manifestation—is now understood to be more complicated, because definitions and understandings of sex and biology may themselves be socially constructed. Moreover, it is often difficult to separate biological and social aspects of human behavior, or to point to distinct biological and social influences on the differences between women and men. Real and perceived physical differences between women and men are often part of the meaning and organization of gender. Nonmaterial elements of society are also involved: images, symbols, and language are likewise gendered and underscore and contribute to gender differences.

The conceptualization of gender varies from society to society. Most societies recognize only two genders, male and female, but some societies recognize more than two. The *hijras* of India and the *berdache* in some North American Indian tribes are examples of recognized third genders, with their own expectations and norms.

Gender as a Social Institution

Besides the immediate differences between the societal positions of women and men—for example, that men are more likely than women to engage in warfare or that women are more likely than men to face discrimination in the labor market—gender plays a role as a social institution: it is a set of social and cultural practices that influences the lives of all women and men, and that interacts with other social institutions.

Schooling presents an example of this interaction. Because of differential access to schooling, women in most societies are more likely to be illiterate than men. For instance, women are less likely to be able to read newspapers or directions on medicine bottles. But the implications of differential access to schooling extend beyond the individual level: women are less likely to participate in higher education, less likely to be trained for high-level positions, and thus less likely to influence policy decisions that affect the society. In societies where girls are excluded from education, schools will be geared to boys who make up the majority of the students; employers will also expect to hire males since there will be fewer well-trained females applying for jobs. This pattern may have further ramifications in the economy: If men are not expected to participate equally in family life and make up most of the workers, then employers may structure the workforce using the standard of these male workers and expect workers to work longer hours or be away from home more regularly. Such actions make it even more difficult for women—with their family responsibilities—to break into the ranks of laborers. The gendered nature of illiteracy thus affects the shape of the workforce.

Gender interacts with many other features of society such as class, ethnicity, nationality, and sexuality. Historically in the United States, race interacted with gender in clear and pervasive ways: Evelyn Higginbotham noted in her 1992 work that the term "lady" was applied only to white women; African-American women were never considered "women" in the way that white women were. In contemporary Egypt, class position is an important influence on Muslim women's decisions about whether or not to wear the veil. Many upper-class women in Cairo reject the veil as confining and inappropriate to modern Egyptian life. But Arlene MacLeod pointed out in 1991 that some working class women have taken to wearing the veil because it provides them a freedom of movement outside of the house, and allows them to take jobs and to mix with males in ways that would not otherwise be socially acceptable.

Family and marriage practices are also central components of the gender system. In places where women marry early, where marriage is patrilocal (the bride moves to live with her husband's family), and where lineage is traced through the paternal line, women seem to fare less well than in other family systems. For example, in northern India, women usually marry outside their village, move to their husbands' house and village, and have fewer ties with their natal families after marriage; in southern India, in contrast, women are more likely to marry later, more likely to retain ties to their natal families, and less likely to spend as long living with their husbands' parents. These different patterns of marriage and family are related to the significant disadvantages faced by females in the north compared to those in the south—including lower food consumption, higher child death rates and maternal mortality, and shorter life expectancy.

Gender and Power

Power lies at the heart of any gender system. Gender orders social relationships in such a way that some individuals have greater power than others. "Power to" allows individuals access to material goods, opportunities, and events. Compared to men, women often have less power to go to school, get training, or move freely in public areas. Another kind of power might be described as "power over"—the ability to influence other people in particular ways. In most societies, men occupy positions of power and decision in the government, in religious organizations, and in the economic structure. That positioning gives men more power than women to direct courses of action, policies, and individual lives. Women have nevertheless found numerous ways to resist the gender system and their role in it. This resistance has taken many shapes, from strikes over wages and treatment of women workers in the *maquiladoras* on the U.S.–Mexican border to the way that "office ladies" in Tokyo companies refuse to do work for some bosses. However, such resistance has not overturned the gender system—indeed, in some instances resistance may reinforce underlying beliefs about women, men, and gender.

Persistence of Gender Inequality

Gender systems result from and contribute to "persistent inequalities" between women and men (Tinker, 1990). But like other social institutions, gender is not static. It is created and recreated with every social interaction. While one cannot point to a single cause of gender inequality or fully specify the conditions for change, there are indications that some conditions may lead to a more equitable system. The status of women in some societies seems to be higher where their traditional spheres of work are valued, even though those may be different from men's. Other research has suggested that women's access to the valued resources of the society is the key to greater gender equality. In societies where women enjoy equal access to formal education and education is the main pathway to visible roles in the public sphere, or where women have more control over the money they earn or the land that they farm, women are likely to have roles, voices, and rights that resemble or are equal to those of men. However, increased education and more prominent public and economic roles do not automatically translate into a leveling of gender inequality. With the shift from household to market economy, women may lose their earlier status as household workers but find that in the formal labor market their value is tied to their level of income. Their low wages relative to those of men may translate into decreased power and status.

For decades, scholars have debated the reasons for the existence of gender inequalities in most societies. Some argue that women's different biology and physiology, particularly their smaller size and reproductive capacity, are at the root of gender systems and inequalities. Social scientists, focusing on social and cultural explanations, have more often pointed to the ways that society organizes such activities as reproduction and warfare and attributes different meaning and values to these and other related activities. Early feminist anthropologists argued that women's lower social position is related to women being associated with nature and men with culture in most societies. Other theories have pointed to the ways that women's connection to the private sphere and men's to the public have been at the root of gender hierarchy. These and other theories have been crucial in the development of understandings of gender inequalities, even as they have also been subject to criticism and revision. The connections between gender systems and other social processes, structures, institutions, and ideologies are the focus of much attention from social scientists seeking to understand the continuing pervasiveness and influence of gender systems across the world.

See also: *Feminist Perspectives on Population Issues; Reproductive Rights; Women's Status and Demographic Behavior.*

BIBLIOGRAPHY

Collier, Jane, and Sylvia Yanagisako, eds. 1987. *Gender and Kinship: Essays Toward a Unified Analysis.* Stanford, CA: Stanford University Press.

di Leonardo, Micaela, ed. 1991. *Gender at the Crossroads of Knowledge: Feminist Anthropology in the Postmodern Era.* Berkeley: University of California Press.

Fausto-Sterling, Anne. 1992. *Myths of Gender: Biological Theories about Women and Men.* New York: Basic Books.

Ferree, Myra Marx, Judith Lorber, and Beth Hess. 1999. *Revisioning Gender.* Thousand Oaks, CA: Sage Publications.

Higginbotham, Evelyn. 1992. "African-American Women's History and the Metalanguage of Race." *Signs* 1: 137–69.

MacLeod, Arlene. 1991. *Accommodating Protest: Working Women, the New Veiling, and Change in Cairo.* New York: Columbia University Press.

Marshall, Barbara. 2000. *Configuring Gender: Explorations in Theory and Politics.* Toronto: Broadview Press.

Ogasawara, Yuko. 1998. *Office Ladies and Salaried Men: Power, Gender, and Work in Japanese Companies.* Berkeley: University of California Press.

Risman, Barbara. 1998. *Gender Vertigo.* New Haven, CT: Yale University Press.

Scott, Joan Wallach. 1986. "Gender: A Useful Category for Historical Analysis." *American Historical Review* 91: 1053–1075.

Tiano, Susan. 1994. *Patriarchy on the Line: Labor, Gender and Ideology in the Mexican Maquila Industry.* Philadelphia: Temple University Press.

Tinker, Irene, ed. 1990. *Persistent Inequalities: Women and World Development.* New York: Oxford University Press.

Vogel, Lise. 1993. *Mothers on the Job: Maternity Policy in the U.S. Workplace.* New Brunswick, NJ: Rutgers University Press.

Nancy E. Riley

GENDER PREFERENCES FOR CHILDREN

Parents and prospective parents, separately or as couples, often have preferences concerning the gender of their children. This article discusses patterns of gender preference in various countries and regions of the world, the different value of sons and daughters, the effect of gender preferences, and the differential treatment of girls and boys.

Patterns of Gender Preference

Gender preferences exhibit a variety of patterns. Most common are a preference for sons and a preference for a balance of daughters and sons (often expressed as a desire to have at least one child of each sex). Son preference is particularly strong in a band of countries from North Africa through the Middle East and South Asia to East Asia. The strongest preference for sons has been found in India, Nepal, Bangladesh, Egypt, South Korea, and China. The diversity of these countries indicates that son preference does not emerge from a single set of cultural or historical experiences. Even in countries with a strong son preference, many parents want to have one daughter among their children. An overall preference for daughters over sons is rare but has been found to exist to a small extent in a few countries in Latin America and the Caribbean.

Widespread preference either for sons or for daughters is not common in developed countries or in most countries in Latin America, sub-Saharan Africa, and Southeast Asia. In these areas, the most common survey responses to questions on the topic indicate a preference for an equal number of daughters and sons, at least one daughter and one son, or no preference at all. Where a preference for a gender balance is paramount, however, some parents prefer to have a son for their first child.

Value of Sons and Daughters

Gender preferences for children can be based on community norms or personal desires. Children of a particular sex are usually desired because they provide certain utilities (that is, satisfactions or tangible returns, primarily in the economic, social, psychological, or religious domains) or they entail smaller costs. Economic considerations often favor sons for their ability to help on the family farm or in the family business, to earn wages from work outside the home, and to provide support for parents when they get old. Sons may also be valued for their ability to help out the family in emergencies and help younger siblings through school. Daughters are more likely to be valued for providing assistance with household chores and caring for younger siblings. Daughters are sometimes seen as a more reliable source of emotional support and even economic assistance to elderly parents, although in many cultures their services are lost to their parents on marriage. Marriage patterns often provide a strong (even an overriding) incentive for preferring sons in countries where large dowry payments are the norm and for preferring daughters where a substantial bride-price is required as is the case in some countries in Africa.

In the social sphere, sons may be seen as useful for enhancing the power and prestige of the family and for carrying on the family line and the family name, and daughters may be wanted to "balance the family." Both daughters and sons may provide companionship and psychological satisfaction for parents, but women often express a particular desire for a daughter for companionship. Although both daughters and sons may be called on for the performance of religious rituals, many religions favor sons for performing religious functions at the time of a parent's death (e.g., burial rites or lighting of the funeral pyre).

Effect of Gender Preferences

One of the most contentious issues regarding gender preferences is the effect of gender preferences on demographic behavior and the extent to which preferences and their impact are likely to change over time. On the one hand, it is argued that couples who have reached their desired family size may nevertheless continue having children if they have not yet achieved their preferred sex composition of children, thereby delaying the transition to low fertility. On the other hand, there are several examples of countries (such as Korea and China) that have achieved very low levels of fertility in a short span of time despite a continuing strong preference for sons. In 1997 Monica Das Gupta and P. N. Mari Bhat posited that gender preference is likely to intensify over time as fertility falls, but the evidence for this effect is not consistent across countries.

There is no doubt that strong gender preferences may have an effect on such demographic outcomes as contraceptive use, fertility behavior, birth spacing, and the incidence of induced abortions, but the magnitude of these effects is uncertain. Fred Arnold has developed a measure to quantify the impact of gender preferences on demographic behavior. This measure is designed to assess what would happen if gender preferences were to suddenly disappear in a country. Application of the measure in a number of countries with a strong preference for sons demonstrates that gender preferences can reduce levels of contraceptive use and increase fertility, but that gender preferences are not likely to be a major obstacle to fertility decline.

One other consequence of gender preferences is the increasing use of sex-selective abortions (and, more recently, chromosome separation techniques applied to the sperm prior to artificial insemination) to achieve the desired number of daughters and sons. In China, Korea, and India, selective use of abortion for female fetuses has resulted in more masculine sex ratios at birth, leading to skewed sex ratios for children (particularly for younger children born into families that already have many children). Such a pattern may have various unfavorable social consequences in the future—not least, a "marriage squeeze" due to a shortage of marriageable women relative to men.

Differential Treatment of Girls and Boys

If parents prefer children of a particular sex (usually sons), they might give favored treatment to those children in health care, nutrition, educational opportunities, or other areas. In most countries, children receive approximately equal treatment regardless of their sex and the nature of gender preferences in the society. There is ample evidence, however, that in some countries with a strong son preference, boys are often given preferential treatment with respect to medical care, educational opportunities, and (less often) food allocation.

In serious cases, discrimination against girls may result in an increased risk of infant and child mortality. In most countries, male mortality is higher than female mortality at almost every age, but Dominique Tabutin and Michel Willems in 1995 showed that in high-mortality countries, females often have an appreciably reduced advantage or even a higher mortality than males during childhood. This pattern is particularly pronounced in South Asia and Egypt. The precise reason for higher than normal mortality among young girls relative to boys in these countries is not certain, but discrimination against girls, particularly in health care, must be considered the most likely cause.

See also: *Family Size Intentions; Sex Ratio; Sex Selection; Women's Status and Demographic Behavior.*

BIBLIOGRAPHY

Arnold, Fred. 1985. "Measuring the Effect of Sex Preference on Fertility: The Case of Korea." *Demography* 22: 280–288.

———. 1997. *Gender Preferences for Children.* Calverton, MD: Macro International.

Basu, Alaka Malwade. 1989. "Is Discrimination in Food Really Necessary for Explaining Sex Differentials in Childhood Mortality?" *Population Studies* 43: 193–210.

Das Gupta, Monica, and P. N. Mari Bhat. 1997. "Fertility Decline and Increased Manifestation of Sex Bias in India." *Population Studies* 51: 307–315.

Gu, Baochang, and Krishna Roy. 1995. "Sex Ratio at Birth in China, with Reference to Other Areas in East Asia: What We Know." *Asia-Pacific Population Journal* 10(3): 17–42.

Hill, Kenneth, and Dawn M. Upchurch. 1995. "Gender Differences in Child Health: Evidence from the Demographic and Health Surveys." *Population and Development Review* 21: 127–151.

Klasen, Stephan, and Claudia Wink. 2002. "A Turning Point in Gender Bias in Mortality? An Update on the Number of Missing Women." *Population and Development Review* 28: 285–312.

Marcoux, Alain. 2002. "Sex Differentials in Undernutrition: A Look at Survey Evidence." *Population and Development Review* 28: 275–284.

Sommerfelt, A. Elisabeth, and Fred Arnold. 1998. "Sex Differentials in the Nutritional Status of Young Children." In *Too Young to Die: Genes or Gender?* New York: United Nations.

Tabutin, Dominique, and Michel Willems. 1995. "Excess Female Mortality in the Developing World during the 1970s and 1980s." *Population Bulletin of the United Nations* 39: 45–78.

FRED ARNOLD

GENEALOGICAL RECORDS

A genealogy provides an account of the ancestors and descendants of a person or family. It describes the relationships among a group of individuals descended from common ancestors or a founding couple. The primary pieces of information contained within genealogies are individual-level demographic events, including the dates (and often places) of birth, marriage(s), and death. Each of these events links an individual to other persons: A birth ties an individual to parents and siblings; a marriage, to a spouse, in-laws, and children; and a death, to surviving family members. Other information may also be available in a genealogy, although the quality, coverage, and type of information vary.

The descendants of a founding couple are all related, and this web of kinship is generally referred to as a pedigree. The genetic connection between an ancestor and a descendant is often termed a lineage; tracing ancestors through the maternal side of the family is matrilineal, and similarly, through the paternal side, patrilineal. While genealogies contain information about the nature of the blood relationship between any two individuals, they may also contain information on persons and families living in the same place during the same historical period but who are unrelated.

Because the same data are recorded for each individual, genealogies can be used to answer questions related to entire kinship networks, including questions about demographic conditions and change. Topics examined using genealogical data include temporal patterns in fertility, widow and widower survival, longevity, consanguinity, and genetic variation.

Historical and Family Data

Some genealogies span many generations. This historical depth provides opportunities to examine how broader social changes affect family-level patterns in fertility, migration, and mortality. For some historical periods, genealogies are the principal source of data about the prevailing demographic conditions, although the information they provide is unlikely to be representative of the population at large. In other cases, genealogies provide an important supplement to official records of births, marriages, and deaths. Unlike those records, which are collected and maintained at the individual level, genealogical data are organized around nuclear families and extended pedigrees. Such data may allow analysts to estimate patterns of fertility (e.g., age at first birth, parity, birth intervals, age at last birth), marriage (e.g., number and outcome of marriages, polygamy, consanguineous marriages), and mortality (e.g., infant mortality, maternal mortality, widowhood and surviving spouse mortality, longevity). Genealogies also hold data on predictors of these outcomes, such as gender, age, and places and dates of important demographic transitions. In some genealogies, information on religion and social standing are also available. Standard demographic analysis can then be substantially improved and expanded to incorporate explanatory variables associated with characteristics of offspring, siblings and parents.

Kinship

Genealogies offer major opportunities for the study of kinship and its changes over time. Genealogies contain a record of the life course of an individual and the additions and losses to his or her kinship network. From a genealogy, it is possible to discern the family circumstances into which a person is born, the survival of siblings, the timing of the person's marriage and subsequent fertility patterns, the presence and location of in-laws, and the survival of his or her parents. Rather than relying on a static view of family life and structure at an arbitrary age or point in history, genealogical data allow the study of these transitions, their causes and consequences, and their patterning over large stretches of individual and historical time. Assembled as a linked set of life histories, the resulting data can be analyzed using statistical techniques that allow for changes both in outcomes and explanatory factors (e.g., time series analysis, survival models with time-dependent covariates).

Assessing Demographic Behavior within Families and Pedigrees

Genealogies do not generally contain the extensive number of covariates often found in large national demographic surveys. However, they do permit examination of the effects of observable predictors on key demographic outcomes while controlling for a wide range of family characteristics that are unobservable. For example, in a study of infant mortality, it might be of interest to know whether a child's birth order affects its chances of surviving the first year of life. Given that the mortality risks for one child are related to the mortality risks of its siblings (for reasons that are not observable to the demographer), one can exploit the fact that siblings share similar environmental and genetic characteristics. Analytical techniques that take this statistical dependency into account include the estimation of robust standard errors and fixed- and random-effects models.

Genealogies and Studies of Communities

Some genealogies are geographically based so that demographic events affecting a set of pedigrees occur in a defined place. This strategy has been used in places where parish registers and reconstructed family histories of entire villages make it possible to develop a genealogical database. Genealogies constrained by geography, while more limited in their scope, provide an opportunity to study a complete (and often relatively closed) social system. Focusing on a particular region or community during key historical periods can provide insights into the demography of families that would not otherwise be possible.

Non-Random Selection

Demographers are often faced with data that are subject to various forms of non-random selection and the biases that they engender. For example, a study of maternal mortality requires that a woman live to reproductive age, have a partner or be married, and bear children before maternal mortality can be examined. Because many genealogies are a record of extinct cohorts where a person's life and its events are depicted from birth to death, it is possible to observe and understand who has been selected out of the sub-population of interest and to make assessments of any selection biases that omissions may present.

Example: Utah Population Database

A summary account of the large number of genealogies that may be of interest to demographers was given by Natalia Gavrilova and Leonid Gavrilov (specialists in the biodemography of aging) in their 1997 study. What follows is a brief description of one of the world's largest and most comprehensive computerized genealogies: that contained within the Utah Population Database (UPDB). In the 1970s, approximately 170,000 Utah nuclear families were selected from the archives held in the Utah Family History Library, each with at least one member having had a vital event (birth, marriage, death) on the Mormon Pioneer Trail or in Utah. These families have been linked across generations; in some instances, the records span seven generations. The UPDB holds data on migrants to Utah and their Utah descendants (not only Mormons, that is, members of the Church of Jesus Christ of Latter-day Saints) that number more than 1.3 million individuals born from the early 1800s to the mid-1900s and that are linked into multi-generation pedigrees. The UPDB is an active genealogy: New families and their members are continually being added as the UPDB is linked to other sources of data, including birth and death certificates. Additional information on these families comes from sources such as drivers' license records and the Utah Cancer Registry. With these additions, the database represents over 6 million individuals. Studies using the UPDB can examine the availability of kin, intergenerational transmission of demographic outcomes (e.g., age at first birth, children born), and familial clustering of specific conditions (e.g., extreme longevity, cancer mortality). These latter lines of inquiry are also of interest to anthropologists, biologists, and geneticists.

See also: *Family Reconstitution; Historical Demography.*

BIBLIOGRAPHY

Adams, Julian. 1990. *Convergent Issues in Genetics and Demography.* New York: Oxford University Press.

Bean, Lee L., Geraldine P. Mineau, and Douglas Anderton. 1990. *Fertility Change on the American Frontier: Adaptation and Innovation.* Berkeley: University of California Press.

Bean, Lee L., Geraldine P. Mineau, and Ken R. Smith. 1999. "The Longevity of Married Couples." In *Nearly Everything Imaginable: The Everyday Life of Utah's Mormon Pioneers,* ed. Ronald W. Walker and Doris R. Dant. Provo, UT: Brigham Young University Press.

Dyke, Bennett, and Warren T. Morrill ed. 1980. *Genealogical Demography.* New York: Academic Press.

Jorde, Lynn B. 2001. "Consanguinity and Prereproductive Mortality in the Utah Mormon Population." *Human Heredity* 52: 61–5.

Kerber, Richard A., Elizabeth O'Brien, Ken R. Smith, and Richard M. Cawthon. 2001. "Familial Excess Longevity in Utah Genealogies." *Journal of Gerontology: Biological Sciences* 56: B130–9.

Knodel, John. 1970. "Two and a Half Centuries of Demographic History in a Bavarian Village." *Population Studies* 24: 353–376.

Mineau, Geraldine P., Ken R. Smith, and Lee L. Bean. 2002. "Historical Trends of Survival among Widows and Widowers." *Social Science and Medicine* 54: 245–254.

Willigan, Dennis J., and Katherine A Lynch. 1982. *Sources and Methods of Historical Demography.* New York: Academic Press.

INTERNET RESOURCES.

Gavrilova, Natalia, and Leonid Gavrilov. 1999. "Data Resources for Biodemographic Studies on Familial Clustering of Human Longevity." *Demographic Research.* <http://www.demographic-research.org/Volumes/Vol1/4>.

Utah Population Database. 2003. <http://www.hci.utah.edu/groups/ppr>.

Ken R. Smith
Geraldine P. Mineau

GENERATIONAL ACCOUNTING

Most fiscal analysts realize that official government debts do not include implicit liabilities. But most analysts do not realize that the division of government liabilities between implicit and explicit (official) is arbitrary. The same holds for assessing the share of any particular program that is financed by general revenue. Two observers of the same fiscal reality can use different, but equally valid, fiscal labels, report entirely different levels of implicit and explicit debts, and reach entirely different conclusions about the fiscal condition of particular programs. This is one of several lessons to be learned from examining fiscal policy by means of *generational accounting,* a relatively new method of long-term fiscal analysis that has found increasing application around the world.

Definition of Generational Accounts

Generational accounts represent the sum of the present values of the future net taxes (taxes paid minus transfer payments received) that members of a birth cohort can expect to pay over their remaining lifetimes if current policy is continued. The sum of the generational accounts of all members of all living generations indicates how much people who are now alive will pay toward the government's bills. The government's bills are the sum expressed as a present value of all the government's future purchases of goods and services plus its official net debt (its official financial liabilities minus its official financial assets, including the value of its public-sector enterprises). Bills not paid by current generations must be paid by future generations. This is the zero-sum nature of the *government's intertemporal budget constraint:* the basic building block of modern dynamic analyses of fiscal policy.

This budget constraint can be written as $A + B = C + D$, where D is the government's official net debt, C is the sum of future government purchases valued to the present, B is the sum of the generational accounts of those now alive, and A is the sum of the generational accounts of future generations valued to the present. Given $C + D$, the smaller B (the net payments of those now alive) is, the larger A (the net payments of those yet to be born) must be.

The Fiscal Burden of Future Generations

A critical feature of generational accounting is that the size of the fiscal burden confronting future generations (A) is invariant to the government's fiscal labeling, that is, how the government describes its receipts and payments. Unfortunately, this is not true of the government's reported size of its official debt. In terms of the equation $A + B = C + D$, different choices of fiscal labels alter B and D by equal absolute amounts, leaving C and A unchanged; that is, the values of B and D depend on language and are not economically well defined. However, the value of A and the difference $D - B$ are independent of language and are economically well defined. Since the terms A, B, and C are all present values, they all depend on assumed discount rates, productivity growth rates, and population growth rates. Higher population and productivity growth rates can be expected to raise all three terms. Higher discount rates lower all three terms.

The difference between the lifetime net tax rate of current newborns (the generational account of current newborns divided by their lifetime earnings) and the projected net tax rate on future newborns (the collective net tax burden on future newborns, the term A, divided by the projected present value of their future earnings) measures the imbalance in generational policy. The lifetime net tax rates of current and future newborns are directly comparable because both involve net taxes over entire lifetimes. If the lifetime net tax rate facing future generations is higher than the lifetime net tax rate facing current newborns, current policy not only is generationally imbalanced, it also is unsustainable. In other words, the government cannot continue over time to collect the same net taxes measured as a share of lifetime income from future generations that it would collect under current policy from current newborns without violating the intertemporal budget constraint.

Achieving Generational Balance

The calculation of generational imbalance is an informative counterfactual, not an indication of a likely policy scenario, because it imposes the entire fiscal adjustment needed to satisfy the government's intertemporal budget constraint on those born in the future. Although unrealistic, this counterfactual delivers a clear message about the need for policy adjustments. Once that need is established, interest turns to alternative means of achieving generational balance that do not involve foisting the entire adjustment on future generations.

As an example, one can determine the percentage reduction in C that would lower the size of A (i.e., the size of $C + D - B$) enough to achieve generational balance. Regardless of the size of that percentage reduction in the present value of government purchases, the policy could be implemented by means of an immediate and permanent cut in the annual flow of those purchases by that percentage. Another example is an immediate and permanent percentage increase in annual income tax revenues. This would raise B—the collective generational accounts of those now alive—and thus reduce A. The precise size of the percentage income tax hike needed to achieve generational balance is found when the growth-adjusted generational accounts of future generations equal those of newborns.

Applications of Generational Accounting

Although it was developed only recently, generational accounting has been applied to more than thirty countries around the world. The generational accounts for the United States that were prepared in June 2001 can be taken as an example. For newborns, who are assumed to pay taxes and receive benefits over their lifetimes in accordance with current (2001) U.S. policy, the lifetime net tax rate was 17.7 percent. For future generations the tax rate required to meet the intertemporal budget constraint was over twice as large: 35.8 percent. Stated differently, future generations, according to the policies in place in 2001, would have to be asked to pay 18.1 cents more per dollar earned than current newborns will pay.

To understand the gravity of the long-term U.S. generational imbalance, suppose the government tried to eliminate the generational imbalance by immediately and permanently raising the federal corporate and personal income tax by a given percentage. How large would the tax hike have to be? The answer as of 2001 was 68.2 percent. An alternative to raising federal income taxes alone is to raise all federal, state, and local taxes. In that case an across-the-board tax hike of 25.7 percent could achieve generational balance. Of course, cutting transfer payments and decreasing government purchases are alternatives to raising taxes. Cutting all Social Security, Medicare, Medicaid, food stamps, unemployment insurance benefits, welfare benefits, housing support, and other transfer payments by 43.5 percent would be another way to eliminate the generational imbalance. Two final options one can consider are immediately and permanently cutting all government purchases by 38.9 percent or totally cutting all federal purchases (the latter course would still not achieve a generational balance: to do so the cut that would be needed is calculated to be 116.9 percent). The U.S. generational imbalance is, as these numbers indicate, of grave national concern. Remarkably, this imbalance is smaller than those of many European countries and of Japan.

While economic growth would mitigate the generational imbalances in the United States and other countries, it represents no panacea. The reason is that in the U.S. and many other countries, government spending is fairly closely tied to the general level of a country's per capita income. Indeed, in the U.S. programs like Social Security are explicitly indexed to the level of real wages earned by workers. Hence, as the economy grows, so do the government's bills.

Immigration is also generally viewed as a cure for generational imbalances. In the United States, simply increasing the number of immigrants, while maintaining their composition, would do little to reduce the size of the intergenerational imbalance. In contrast, allowing only highly skilled and highly educated individuals to immigrate would provide some fiscal relief because these immigrants would pay more in taxes than they receive in benefits. Unfortunately, the source of such immigrants would be Japan and the European Union, which will seek, for the same reasons, to reduce out-migration of skilled workers to the extent possible.

See also: *Future Generations, Obligations to; Intergenerational Transfers.*

BIBLIOGRAPHY

Auerbach, Alan J., Laurence J. Kotlikoff, and Willi Leibfritz, eds. 1999. *Generational Accounting around the World.* Chicago: University of Chicago Press.

Kotlikoff, Lawrence J. 2002. "Generational Policy." In *Handbook of Public Economics,* 2nd edition, ed. Alan J. Auerbach and Martin S. Feldstein. Amsterdam: North Holland.

Laurence J. Kotlikoff

GENETIC TESTING

Genetic testing has been evolving for many years. The first genetic tests were offered clinically in the late 1950s and early 1960s when disorders associated with missing or extra chromosomes (e.g., Down's syndrome, Klinefelter's syndrome) were identified. During this same period, the first biochemical tests for genetic conditions referred to as inborn errors of metabolism were being identified. There are now thousands of genetic tests available. They are used in virtually all areas of medicine, from primary care to medical specialties.

Types of Genetic Tests

There are three main categories of genetic testing. *Cytogenetic* tests involve the analysis of human chromosomes to identify structural or numerical changes in the chromosomes of an individual's cells. The uniqueness of each chromosome's size and staining features allow them to be individually distinguished and organized into a karyotype. These tests allow a complete analysis of the human genome, though at low resolution—capable of identifying changes that are the size of about 5 million base pairs of DNA. *Biochemical* genetic tests are tests that identify the presence of a genetic condition by the analysis of metabolites, including amino acids, organic acids, and sugar compounds, present in body tissues or fluids or by the analysis of enzymatic activity that reflects an underlying genetic disorder. These tests commonly identify the biochemical abnormality that results from the genetic abnormality and are therefore highly focused. *Molecular* genetic tests involve the analysis of DNA and RNA but also may overlap with any of the other types of testing when protein analysis is part of a molecular test or when a molecular test uses the chromosome as the target for the test (molecular cytogenetics). Molecular genetic tests are usually highly focused and identify DNA changes ranging in size from one base pair to millions of base pairs. Molecular cytogenetic methods bridge the gap between the two technologies.

Uses of Genetic Tests

There are many uses for genetic tests. They can detect genetic changes that are acquired over the lifetime of an individual—for example, those that may reflect the development of cancer and leukemia. These tests can diagnose the condition, gauge the aggressiveness of the disease, guide therapy, and suggest prognoses. However, this group of tests is targeted at changes in specific tissues or organs. Genetic tests can also be directed at the germ line that is characteristic of all cells in an individual and that could be inherited. Such tests can be used to diagnose particular conditions in an individual and can identify other members of his or her family that may be carriers of the condition, and who are at risk of having similarly affected children. Genetic tests can be performed prenatally, at birth, or later in life and can be used to diagnose an individual with late-onset genetic conditions such as Huntington's disease even before the onset of symptoms (presymptomatic testing). Genetic testing can also determine whether someone is likely to respond to a particular drug treatment. When a genetic change is not one that will invariably lead to a particular disease, the identification of a change may indicate susceptibility to a disease. The disease could manifest itself if the appropriate environmental or other nongenetic factors were present. An example of this use of genetic testing is in the determination of predisposition to breast cancer.

The most frequently used genetic tests at the beginning of the twenty-first century are those performed to diagnose newborns with treatable conditions. In the United States, over 4 million newborns are tested each year in public health-mandated screening programs to identify those most likely to have a particular treatable genetic condition. The classic example of this is testing for phenylketonuria (PKU) in newborn infants. Infants with this condition are unable to metabolize a particular amino acid, resulting in the accumulation of a product that leads to mental retardation. Treatment entails removing that amino acid from the infant's diet. Most states currently screen for three to eight genetic conditions but new tests are being introduced that can identify as many as 20 to 30 conditions.

Ethical, Legal, and Social Considerations in Genetic Testing

The power of genetic tests to assess an individual's genetic predispositions raises many concerns. At present comparatively few people outside of the newborn period are being tested for heritable traits and only certain unfavorable genetic traits can be determined, although identification of these may expose the persons affected to unfair discrimination. However, it is estimated that each person has 8 to 20 such genetic changes that could increase risks to them, or to their children. Efforts to protect individual genetic privacy will be increasingly important. As more tests are developed, it will be critical that their scientific and clinical validity be well understood so that people can make informed decisions about testing in the light of the potential benefits and risks.

New Technologies and Applications

New technologies being introduced into genetic testing are distinguished by their ability to test many samples at once for multiple genetic markers at a low cost. Tandem mass spectrometry is capable of testing for many rare biochemical genetic diseases involving amino acids, organic acids, or fatty acids in a single assay. The development of molecular microarrays and DNA and RNA chips allows for a rapid determination of the presence, absence, or expression of many DNA sequences in a single test. Arrays may replace cytogenetic testing that identifys gains or losses of genetic material, although the test results may not provide the underlying reason for that gain or loss. Arrays are also capable of determining whether or not and to what extent a particular gene is being expressed. This capability has permitted the identification of important differences between cancer cells and normal cells, which in turn has led to the development of a new generation of diagnostic tests.

The mapping of the human genome and eventual identification of all genes, combined with powerful analytical and computer technologies, will have a significant impact on the types of genetic tests that are available. Most tests are currently done to detect very rare diseases affecting a small percentage of the population. In the years to come, genetic tests will be developed for more common conditions such as breast cancer or Alzheimer's disease and will identify genetic factors that increase the risk of developing the condition that may often be amenable to change.

See also: *Eugenics; Reproductive Rights; Reproductive Technologies.*

BIBLIOGRAPHY

Bartlett, Kim, Simon J. Eaton, and Morteza Pourfarzam. 1998. "New Developments in Neonatal Screening." *Archives of Diseases in Childhood* 79: 116–119.

Carpenter, Nancy J. 2001. "Molecular Cytogenetics." *Seminars in Pediatric Neurology* 8: 135–146.

Grody, Wayne W. 1999. "Cystic Fibrosis: Molecular Diagnosis, Population Screening and Public Policy." *Archives of Pathology and Laboratory Medicine* 123: 1041–1046.

Lee C., E. Lemyre, P. M. Miron, and C. C. Morton. 2001. "Multicolor Fluorescence In Situ Hybridization in Clinical Cytogenetics." *Current Opinion in Pediatrics* 13: 550–555.

McGlennen, Ronald C. 2001. "Miniaturization Technologies for Molecular Diagnostics." *Clinical Chemistry* 47: 393–402.

Michael S. Watson

GENETICS, POPULATION

See *Archeogenetics; Biology, Population; Evolutionary Demography*

GENOCIDE

One of the few things undisputed about the term genocide is its origin. It was introduced and discussed at some length in a 1944 book, *Axis Occupation of Europe,* by Raphael Lemkin, a Polish-Jewish jurist writing in the United States. Lemkin defined genocide broadly in terms of

> the destruction of a nation or of an ethnic group. . . . Genocide does not necessarily mean the immediate destruction of a nation, except when accomplished by mass killings. . . . It is intended rather to signify a coordinated plan of different actions aiming at the destruction of essential foundations of the life of a national group, with the aim of annihilating the groups themselves . . . . Genocide is directed against the national group as an entity, and the actions involved are directed against individuals, not in their individual capacity, but as members of the national group.

The attacks on nationhood could be political, social, cultural, economic, biological, religious, moral, or physical. Physical attacks were further subdivided into racial discrimination in feeding, endangering of health, and mass killings. Although he never used the term "cultural genocide," Lemkin seems to have included the cultural destruction of a people within the scope of genocide.

The term was referred to several times during the 1945–1946 Trial of the Major War Criminals at Nuremberg. The indictment, for example, alleged that the defendants "conducted deliberate and systematic genocide, viz., the extermination of racial and national groups, against the civilian populations of certain occupied territories in order to destroy particular races and classes of people and national, racial, or religious groups, particularly Jews, Poles, and Gypsies and others." Since genocide was not at that point recognized as separate crime under international law, at Nuremberg these allegations were included among the "war crimes." Shortly thereafter, the United Nations General Assembly adopted a resolution declaring genocide to be a crime under international law. This resolution both broadened Lemkin's concept of genocide, by adding "political and other groups" to the list of potential victims, and narrowed it, by giving only passing attention to the cultural aspect of Lemkin's concept.

By 1948, when the United Nations Convention on the Prevention and Punishment of the Crime of Genocide was adopted, both the cultural and the political components of the term were ignored, and genocide was defined as:

> any of the following acts committed with intent to destroy, in whole or in part, a national, ethnical, racial or religious group, as such: (a) killing members of the group; (b) causing serious bodily or mental harm to members of the group; (c) deliberately inflicting on the group conditions of life calculated to bring about its physical destruction in whole or in part; (d) imposing measures intended to prevent births within the group; (e) forcibly transferring children of the group to another group.

An important distinguishing feature of the new crime of genocide was that it was not necessarily linked to an overt war, unlike the related concepts of "crimes against humanity" and "war crimes" used at Nuremberg. The same definition of genocide was used, unchanged, in the statutes for the International Criminal Tribunal for the Former Yugoslavia and the International Criminal Tribunal for Rwanda, established in 1993 and 1994, respectively, and in those for the International Criminal Court created in 1998.

Subsequent scholars have varied the definition, particularly to overcome perceived short-comings in the concept of genocide under international criminal law. For example, Irving Lewis Horowitz defined genocide as "a structural and systematic destruction of innocent people by a state bureaucratic apparatus" (1997). Frank Chalk and Kurt Jonassohn defined the term as "a form of one-sided mass killing in which a state or other authority intends to destroy a group, as that group and membership in it are defined by the perpetrator" (1990). And Helen Fein defined it as the "sustained purposeful action by the perpetrator to physically destroy a collectivity directly or indirectly, [the latter] through interdiction of the biological and social reproduction of group members, sustained regardless of the surrender or lack of threat offered by the victim" (1990).

Related terms sometimes associated with or distinguished from genocide include *politicide,* where the victims are defined primarily in political terms; *democide,* encompassing genocide, politicide, massacres, extrajudicial executions, and other forms of mass murder; and *ethnocide,* the destruction of the culture of a population, particularly an indigenous population.

Data and Estimation Issues

Even with agreement on definition, quantifying a genocide is difficult. Limits on geographical scope and time period must be set. But how can the destruction of a people's culture, language, or socioeconomic accomplishments be measured? By default, the focus is usually on the number of deaths, occasionally supplemented with the number of forced migrants or with the monetary value of confiscated property and personal injuries.

Even considering deaths alone, estimates can rarely be made with any degree of precision. For example, there is the question of which deaths to count: (1) only those deaths directly attributable to genocidal killing operations (i.e., mass executions and the like), (2) such direct deaths plus those attributable to malnutrition and ill-health associated with populations confined or dislocated due to other genocidal operations, or (3) any elevated mortality in a target population during a defined period. Genocide mortality, as with mortality generally, may be measured directly as an estimated number of deaths over a period of time or indirectly as the difference in population size before and after, adjusted for fertility, non-genocidal mortality, and net migration. The two approaches are often used together. In countries with reasonably well-developed statistical systems, data from population censuses or population registration systems are often available for the initial population. Indeed, in some of these countries, the perpetrators have used such information to identify and target genocidal victims or as a baseline against which to assess the outcome of a genocide.

Other approaches to estimating genocide mortality do not depend on a preexisting statistical infrastructure. The bureaucratic organization of many large genocides may offer various direct or proxy indicators of scale. Mortality counts can also be derived from mass graves or from retrospective surveys. This last approach, like any survey-based retrospective reporting of deaths, is often subject to substantial response errors. In the 1990s dual and multiple system estimation techniques began to be used to control for these response errors so as to obtain improved estimates of genocide mortality from such retrospective reporting.

The interpretation and analysis of mortality estimates also pose challenges. Estimates presented simply as the number of persons killed, while an excellent indicator of the scale of genocidal operations, often obscure the impact of genocide on the victim population. A better measure of this impact is the proportion of the population killed. For example, in Cambodia from the 1975 to 1979, the Pol Pot regime is estimated to have killed over 1.3 million Khmers (the majority group) and less than 350,000 persons belonging to various ethnic minorities. However, while the Khmer victims made up an estimated 11 percent of the 1975 Khmer population, the minorities taken as a group lost 44 percent of their 1975 population.

An Inventory of Selected Modern Genocides and Genocide-like Events

Table 1, adapted primarily from information in the sources cited in the bibliography, is a tentative and incomplete listing of major genocides in modern times. It indicates the widespread incidence of genocide and its complex and varied character. Many of the assessments and estimates given are disputable: It is the nature of the field that no such inventory would be universally accepted. The table's omissions may be its greatest shortcoming. For example, no mention is made of the African slave trade or the suppression of minorities in the USSR and China. Information about these and many other genocides and similar human rights tragedies can be found in the works cited in the bibliography.

Population Issues

From the perspective of population studies, three aspects of modern genocides are particularly relevant. First, the crime of genocide under international law is defined largely in demographic terms. Three of the five elements of the crime—killings, coercive birth prevention, and the forcible transfer of children—are demographic in nature. On the other hand, forced migration, a frequent precursor to the mass killings of genocide and a major source of "conditions of life calculated to bring about . . . physical destruction" of a group, is not included in the legal definition. Second, the measurement of genocide mortality and survivorship will continue to present major challenges. As with any human rights tragedy, the emotional and political after-effects make objective assessment difficult for both scholars and advocates. In these circumstances, estimates of losses gain credibility by the qualifications that accompany them rather than by the number of significant digits in which they are expressed. Third, from a strictly long-term demographic viewpoint, genocide and re-

TABLE 1

Selected List of Genocides and Genocide-like Events: Perpetrators, Victims, Definitional Issues, and Estimated Mortality

Perpetrator and Time Period	Victims	Covered by UN Genocide Convention	Indigenous Population Involved	Role of Forced Migration	Estimated Mortality (thousands)
Cambodia, 1975-1979	Ethnic minorities	Yes (1)	Some	Varied	about 350
	Khmers	Not clear	No	Major	about 1,300
Europe under Nazis, 1933–1945	Jews	Yes (2)	No	Varied	about 6,000
	Roma/Sinti (Gypsies)	Yes (2)	No	Major	230–680
	Others	Varied	No	Varied	7,700 (4)
Guatemala, 1960–1996	Indians and others	Not clear	Yes	Minor	134
Rwanda, April–July 1994	Tutsis	Yes (3)	No	Minor	} over 500
	moderate Hutus	Not clear	No	Minor	
Ottoman Empire, 1915–1922	Armenians	Yes (1)	No	Major	600–2,000
Yugoslavia 1991–1992	Croats and non-Serbs	Yes (3)	No	Important	over 0.2
Bosnia-Herzegovina, 1992–1995	Muslims and Croats	Yes (3)	No	Major	over 9
Kosovo, 1999	ethnic Albanians	Not clear	No	Major	7–14
USSR, 1932–1933	Ukranian population	Not clear	No	Major	3,000–5,000
United States, 1800–1900	Native Americans	Not clear	Yes	Major	200–800

(1) Presumably yes, using the standards now applied in International Criminal Tribunal proceedings.
(2) Reference to term during an International Criminal proceeding.
(3) Indictment or conviction at an UN Tribunal.
(4) Includes an estimated 150,000 handicapped, 3,000,000 Soviet prisoners of war, 4,500,000 Soviet civilians, and a comparatively small number of others.

SOURCE: Adapted by author mainly from material presented in the sources included in the bibliography.

lated state efforts directed toward the destruction of specific populations often fail. For example, those who identify themselves as Armenian, Jewish, or Native American are more numerous or nearly as numerous now than most creditable estimates of their size when genocidal or related activities began. This is not to minimize the terrible short-run impact of genocides in the lives lost, pain to individuals, families, and societies, and the damage to culture. Rather it is a simple testament to the transitory impact of a period of even greatly elevated mortality in the face of the recuperative powers of human populations.

See also: *Forced Migration; Holocaust; Indigenous Peoples; War, Demographic Consequences of.*

BIBLIOGRAPHY

Alvarez, Alex. 2001. *Governments, Citizens, and Genocide: A Comparative and Interdisciplinary Approach.* Bloomington: Indiana University Press.

Andreopoulos, George J., ed. 1994. *Genocide: Conceptual and Historical Dimensions.* Philadelphia: University of Pennsylvania Press.

Ball, Patrick, Wendy Betts, Fritz Scheuren, Jan Dudukovich, and Jana Asher. 2002. *Killings and Refugee Flow in Kosovo, March–June 1999: A Report to the International Criminal Tribunal for the Former Yugoslavia.* Washington, D.C.: American Association for the Advancement of Science and American Bar Association Central and Eastern European Law Initiative.

Chalk, Frank, and Kurt Jonassohn. 1990. *The History and Sociology of Genocide: Analyses and Case Studies.* New Haven, CT: Yale University Press.

Fein, Helen. 1990. "Genocide: A Sociological Perspective." *Current Sociology* 38 (1): 1–126.

———, ed. 1992. *Genocide Watch.* New Haven, CT: Yale University Press.

Horowitz, Irving Lewis. 1997. *Taking Lives: Genocide and State Power,* 4th edition. New Brunswick, NJ: Transaction Publishers.

Jonassohn, Kurt, and Karin Solveig Björnson. 1998. *Genocide and Gross Human Rights Violations in Comparative Perspective.* New Brunswick, NJ: Transaction Publishers.

Kuper, Leo. 1982. *Genocide: Its Political Use in the Twentieth Century.* New Haven, CT: Yale University Press.

Lemkin, Raphael. 1944. *Axis Rule in Occupied Europe: Laws of Occupation, Analysis of Government, Proposals for Redress.* Washington, D.C.: Carnegie Endowment.

United Nations General Assembly. 1946. *Resoultion 96* (I), 11 December 1946. Reprinted in Kuper, 1982.

United Nations. 1948. "Convention on the Prevention and Punishment of the Crime of Genocide." Paris, 9 December 1948. Reprinted in Andreopoulous, 1994 and in Chalk and Jonassohn, 1990.

United States Office of Chief Counsel for the Prosecution of Axis Criminality. 1946. "Nazi Conspiracy and Aggression, Volume I." Chapter III, *International Military Tribunal Indictment No.1, Count 3—War Crimes.* Washington, D.C.: U.S. Government Printing Office.

William Seltzer

GEOGRAPHIC INFORMATION SYSTEMS

Geographical Information Systems (GIS) are a rapidly developing branch of information technology that promises to greatly improve the treatment of locational and other spatial variables in population research, policy making, and program development and execution.

GIS Hardware and Software

A GIS comprises sets of computer hardware and software that facilitate the storage, interrogation, manipulation, analysis, modeling, visualization, and interpretation of multiple sets of spatially referenced information. "Spatially referenced" (or "georeferenced") means that each data element in the system has associated with it a specific location on the earth's surface, identified within a common coordinate system—usually latitude and longitude. This additional information about the unit under study (such as person, family, household, farm, factory, health service, or store) allows the analyst to consider (1) the specific characteristics of the unit's location and the immediate vicinity; (2) its location in relation to other units, such as distance of a household from the nearest medical facility; and (3) information about the unit from other data sources.

Geographical Information Systems

A Geographical Information System can be conceptualized as a series of layers of information with each observation in each layer tied to specific points and areas on the earth's surface via a specific latitude and longitude. The layers refer to different characteristics at that place, such as population numbers, educational characteristics, fertility levels, mortality levels, accessibility to health services, and income levels. The data in the layers may be quantitative or qualitative in nature and presented in point, linear, or area format. GIS software allows us to cut vertically through the layers of data and analyze the relationship between the various layers. Provided the data are georeferenced or relate to a specific areal unit, they can be included in the analysis.

A Simplified Model of a Geographical Information System

Georeferencing can be achieved by use of a global positioning system (GPS) to compile the latitude and longitude of each location in question—such as the locations of respondents, sample clusters of villages, buildings, and neighborhoods. Increasingly, countries have developed national systems, which not only provide georeferencing for standard spatial units like census districts, local government areas, electoral districts, and postal codes, but also allow individual addresses to be electronically assigned georeferences. This means that analysis of individual and household data does not have to be constrained by the need to use standard divisions like census blocks or counties; they can be readily assigned to spatial units more relevant to the particular investigation, whether labor market areas, cultural zones, health care catchment areas, or river basins.

For population studies, GIS allows population-related information to be combined with other information on the basis of common geographical locations. Thus, information on fertility or mortality can be linked to data on climate and other dimensions of the physical environment, service provision records, road and transport routes, or cultural variables. At the simplest level, GIS enhances our ability to visualize population information, not only as traditional maps but also in new ways: using animation to depict processes of change, or through use of three-dimensional and virtual-reality type representations. Such visualization can be a powerful way of presenting population information to policy makers and planners.

The 2000-round of global censuses collected a wealth of small-area population data that would be amenable to GIS analysis. Indeed, several countries are geocoding their census results. Most of the surveys conducted under the Demographic and Health Surveys (DHS) program are now georeferenced and allow detailed spatial analysis.

Uses of GIS and SIS

Wider use of GIS could potentially increase the power of many population analyses. The incorporation of GIS into multi-regional modeling, for example, opens new analytical directions in what is already an important and well-developed area of population geography. GIS makes possible the use of larger and more complex data sets and allows ready incorporation of important geographical variables such as accessibility, proximity, and relative location. It also assists in the development of spatially referenced composite variables such as socioeconomic status, locational disadvantage, well-being, and social capital.

What are the major ways in which GIS can be useful in population related analysis? Firstly, demographers have tended to neglect context and place as a causal variable in examining fertility, mortality, migration and other demographic processes. Use of GIS allows the characteristics of where people live and their location relative to large cities, services or other things, which can exert an important influence on people's lives. Demographers have simply differentiated urban and rural areas but the dimension of place is more complex and GIS allows this to be captured and operationalized in analysis. GIS also greatly facilitates the detection of spatial variation in demographic characteristics over space and time. This can be helpful in the identification of causal processes.

The United Nations (1997, pp. 16–17) has identified the following as being important uses of GIS for population related statistics:

- Data management: GIS aids in inventory and database management for censuses and large scale surveys.
- Health issues: GIS allows spatial patterning of the distribution and spread of disease and relates it to environmental, community, accessibility, socioeconomic and demographic characteristics.
- Service provision: GIS allows services to be optimally located where they are most accessible to the largest number of people in need.
- Family planning: Adoption of family planning can be readily related to a range of accessibility, socioeconomic, cultural, community, and service provision characteristics.
- Demographic-environmental relationships: This remains one of demography's most underdeveloped areas and GIS provides a methodology that allows demographic and environmental information (e.g. satellite imagery on forest covers, salinity, soil erosion, deforestation etc.) to be analyzed together.
- Disaster relief planning: GIS allows resources to be deployed in the most cost-effective, timely, and equitable way.

For all its potential advantages for population studies, GIS is not a "silver bullet." Problems still need to be identified, clarified, and articulated. Appropriate information relating to these problems needs to be collected. Appropriate techniques have to be selected and applied to particular problems and the results of SIS analysis need to be carefully interpreted. The technology and methodology is more sophisticated and powerful than anything available in the past, allowing larger, more varied, and more complex data sets to be analyzed, and in a much shorter time. But GIS does not replace the expertise, experience, and judgement of the individual analyst.

See also: *Geography, Population; Remote Sensing.*

BIBLIOGRAPHY

Demographic and Health Surveys. 2000. "New Directions: DHS Surveys Incorporate Geographic Data." *DHS Dimensions* 2(1): 1–2.

Entwisle, B., R. R. Rindfuss, S. J. Walsh, and T. P. Evans. 1998. "Satellite Data and Social Demographic Research." Paper presented at annual meeting of the Population Association of America, March 23rd.

Hugo, G. J. 2001. "Addressing Social and Community Planning Issues with Spatial Information." *Australian Geographer* 32(3) November: 269–293.

Liverman, D., E. Moran, R. Rindfus, and P. Stern, eds. 1998. *People and Pixels: Linking Remote Sensing and Social Science.* Washington D.C.: National Academy Press.

Longley, P., and G. Clarke, eds. 1995. *GIS for Business and Service Planning.* Cambridge: Geoinformation International.

Martin, D. 1996. *Geographic Information Systems and Their Socioeconomic Applications.* London: Routledge.

Rosero-Bixby, L. 1997. "Spatial Dimensions of Family Planning in Costa Rica: The Value of Geocoding Demographic Surveys." In *Demographic Diversity and Change in the Central American Isthmus,* ed. A. Pebley and L. Rosero-Bixby. Santa Monica, CA: Rand.

United Nations. 1997. *Geographical Information Systems for Population Statistics.* Department of Economic and Social Information Statistics Division Studies in Methods. New York: United Nations.

Graeme Hugo

GEOGRAPHY, POPULATION

Population geography, with intellectual roots that go back to the mid-nineteenth century, studies the way in which spatial variations in the distribution, composition, migration, and growth of population are related to the nature of places. A concern with spatial variation has been the geographer's distinctive contribution to population studies, in comparison to the demographer, who is much more interested in patterns of birth, marriage, and death, and less interested in the influence of migration and spatial variations in general.

Within the discipline of geography, population study has long been important, and increasingly the boundaries between geography and other disciplines interested in population matters—economics, sociology, history, psychology, and biology, as well as demography—are blurred. Population geography is not concerned exclusively with spatial distribution, or with description over theory: it can encompass, for example, the explanation of regional and national levels of fertility, detailed patterns of disease diffusion, and advanced modeling of interregional population growth. Population variables also form a key component in Geographical Information Systems, which allow the processing of large amounts of data for discrete geographical units. Nevertheless, population geographers are more concerned with migration and spatial variation than with other matters. The *International Journal of Population Geography,* founded in 1995, is a useful indicator of the scope of the field.

Development of Population Geography

Lesek Kosinskî traces the origins of population geography back to the German and French schools of human geography of the second half of the nineteenth century and early twentieth century. These schools had a particular concern with population mapping and with the relationship between population and the environment. It was only after World War II, however, that the sub-discipline began to take its modern shape, following the publications of Pierre George (1951) in France (reflecting that country's particular interest in demographic issues), and Glenn T. Trewartha (1953) in the United States. Germany, where demography had been discredited by its association with Nazi policy, and some other countries were slower to follow, although there was significant progress in the Soviet Union, Japan, and India. For Trewartha, "population is the point of reference from which all other elements are observed and from which they all, singly and collectively, derive significance and meaning. It is population which furnishes the focus" (1953, pp. 6 and 14). His "tentative system of content and organisation" for population geography defined the field broadly, including historical population geography, the dynamics of population growth, distribution, migration, population structure, and socioeconomic characteristics. At the core of population geography was a fascination with the global pattern of population distribution and the way it reflected both demographic processes and the wider human and physical environment.

The postwar growth in the field was facilitated by the increased availability of demographic data and impelled by the very obvious relevance of population issues in both the developed and developing countries. Publication of a number of influential textbooks—such as those by John Clarke (1965) and George Demko, Harold Rose, and George Schnell (1970)—gave population geography a firm place in the geography curriculum in many countries. The field was strengthened by an improved institutional environment, marked by the activities sponsored by the Commission on Population Geography of the International Geographical Union (especially from the late 1950s), the Population Specialty Group of the Association of American Geographers (from 1980), and the Population Geography Study Group of the Institute of British Geographers (from 1963). Population geographers have had some, though more limited, involvement with multidisciplinary groups such as the International Union for the Scientific Study of Population.

These early foundations of population geography were quite different from (and indeed had relatively little effect on) demography, but from the 1970s it was increasingly argued that geographers needed to focus more clearly on demographic methods. Thus, texts such as Robert Woods (1979) gave greater emphasis to the central demographic phenomena of fertility and mortality and rather less to migration. The idea was to merge population geography and spatial demography around a core of theory derived from demography. This coincided with the greater use of quantitative methods in geography generally, with texts such as Philip Rees and Alan Wilson's (1977) focusing on the use of population accounts and models for spatial demographic analysis, and Peter Congdon and Peter Batey's (1989) bringing an interdisciplinary view of "regional demography."

Contemporary Population Geography

Although standard texts such as Huw Jones (1981) still took a broadly based view, for some geographers this attachment to the methods of demography signaled an unwelcome narrowing of population geography, distancing it from the rest of geography just at the time when debates about critical social theory in geography were intense. Some population geographers called for a greater awareness of social theory in population geography, for a more critical view of established data sources and theories, and for a move to qualitative as well as quantitative methods. Interestingly, though their impetus came largely from the discipline of geography, their concerns mirrored ones expressed within demography. These critical geographers would agree with the demographer-anthropologist Susan Greenhalgh's view that "reflexivity about the politics of demographic praxis is notably lacking in the field. . . . Neither the global political economies of the 1970s, nor the postmodernisms and postcolonialities of the 1980s and 1990s, nor the feminisms of any decade have had much perceptible impact" (1996, p. 27).

However geographers choose to define their field at a particular moment, their abiding interest is in spatial variations at different scales. Patterns of population growth through time and space, and particularly the demographic transition, have been considered fundamental to the understanding of wider geographical processes of urbanization, industrialization, and the use of resources. There has been a continuing interest in the links between the physical and human environments, for example in the impact of natural disasters.

Attention to fertility and mortality has been directed in particular to highlighting the spatial dimension of patterns and their links with environmental or social conditions—for example the spatial incidence of mortality and disease or fertility. Others have combined demography and geography to produce persuasive portraits of countries or continents. Demographers such as Ansley J. Coale and Susan Cotts Watkins have themselves taken an interest in international and national patterns of demographic change that have clear geographical dimensions. Geographers have also shared with historians an interest in historical geographies of population, reconstructing patterns of fertility and mortality as well as household and family formation through techniques such as family reconstitution and the detailed manipulation of past census, registration, and ecclesiastical records.

Yet population geographers have given most attention to migration, estimating gross and net flows at various scales; building models of interregional flows; and analyzing economic and social causes and consequences. Studies of migration have included international movements, rural-urban, urban-

urban, and intra-urban flows, as well as seasonal and diurnal movements. Geographers like Russell King, Paul White, and John Connell have also looked at the subjective experience of migration, drawing on in-depth surveys and creative literature.

Population geography, through its content and approaches, serves to remind both demographers and practitioners with population interests in other disciplines that demographic changes have spatial as well as temporal dimensions. At the same time it reminds geographers that population characteristics are a key ingredient in the character of places.

See also: *Central Place Theory; Density and Distribution of Population; Geographic Information Systems; Geopolitics.*

BIBLIOGRAPHY

Clarke, John I. 1972. *Population Geography,* 2nd edition. Oxford: Pergamon.

Clarke, John I., ed. 1984. *Geography and Population: Approaches and Applications.* Oxford: Pergamon.

Cliff, Andrew, and Peter Haggett. 1992. *Atlas of Disease Distributions.* Oxford: Blackwell.

Coale, Ansley J., and Susan Cotts Watkins, eds. 1986. *The Decline of Fertility in Europe.* Princeton, NJ: Princeton University Press.

Coleman, David, and John Salt. 1992. *The British Population: Patterns, Trends and Processes.* Oxford: Oxford University Press.

Congdon, Peter, and Peter Batey. 1989. *Advances in Regional Demography: Information, Forecasts, Models.* London: Belhaven.

Demko, George J., Harold M. Rose, and George A. Schnell, 1970. *Population Geography: A Reader.* New York: McGraw-Hill.

George, Pierre. 1951. *Introduction à l'Etude Géographique de la Population du Monde.* Paris: Institut National d'Etudes Démographiques.

Gould, William T. S., and M. Brown. 1996. "Research Review 2: Fertility in Sub-Saharan Africa." *International Journal of Population Geography* 2: 1–22.

Greenhalgh, Susan. 1996. "The Social Construction of Population Science: An Intellectual, Institutional and Political History of Twentieth-Century Demography." *Comparative Studies in Society and History* 38: 26–66.

Jones, Huw. 1990. *Population Geography,* 2nd edition. London: Paul Chapman.

King, Russell, Paul White, and John Connell, eds. 1995. *Writing Across Worlds: Literature and Migration.* London: Routledge.

Kosinskî, Lesek. 1984. "The Roots of Population Geography." In *Geography and Population: Approaches and Applications,* ed. John I. Clarke. Oxford: Pergamon.

Noin, Daniel, and Robert Woods, eds. 1993. *The Changing Population of Europe.* Oxford: Blackwell.

Ogden, Philip E. 2000. "Population Geography." In *The Dictionary of Human Geography,* 4th edition, ed. R. J. Johnston, Derek Gregory, Geraldine Pratt, and Michael Watts. Oxford: Blackwell.

Rees, Philip, and Alan Wilson. 1977. *Spatial Population Analysis.* London: Edward Arnold.

Trewartha, Glenn T. 1970. "A Case for Population Geography" (1953). In *Population Geography: A Reader,* ed. George Demko, Harold Rose, and George Schnell. New York: McGraw-Hill.

Woods, Robert I. 1979. *Population Analysis in Geography.* London: Longman.

Philip E. Ogden

GEOPOLITICS

At one time the term *geopolitics* referred almost exclusively to the determining effects of global location and environmental characteristics (climate, soils, topography, etc.) on conflict between powerful states and empires. In popular usage this remains the dominant definition. Since the 1970s the meaning has shifted among scholars toward a more critical appreciation of how interpretations of geographical divisions, conditions, and designations enter into the foreign policies and military strategies of the great powers and their adversaries.

As a result, for example, in the twenty-first century it is how the Middle East is constructed as a region in American foreign policy (including the role of the Israel–Palestine conflict, the rise of militant Islam, and the region's oil in world trade) rather than the environmental characteristics of the region (deserts, relative location between Europe and South Asia, limited resource base beyond oil, etc.) that constitutes the dominant understanding of how geography affects the making of world politics.

Population and Geopolitics

Population characteristics and processes are among the most important elements that enter into geopolitical interpretations. In the classical deterministic geopolitics that prevailed from the 1890s until 1945 population was introduced in terms of a series of differences between dominant states with respect to their need for territorial expansion (known in German as *Lebensraum*): racial hierarchies, comparative fecundity, population vitality (a euphemism linking population growth with the need for territorial expansion), and population degeneration (associated with population decline and/or miscegenation). Writers such as the German Friedrich Ratzel and the Englishman Halford Mackinder preached an organic conservatism in which human history was seen in terms of a struggle between geographically concentrated groups (typically the state or empire of the writer in question) and threatening outsiders, such as other states with burgeoning populations or nomadic invaders sweeping across the land to transform history. In an attenuated form this type of thinking maintains a hold on those who see states as the sole containers of economic activity and as being the exclusive source of political identity. Population size and growth thus are seen as significant indicators of political strength and actual or potential great-power status.

Whether this way of thinking continues to make sense in a world in which national economies are subject to global competitive pressures rather than existing as isolated entities building purely on their internal assets is open to question. Tremendous increases in the mobility of capital, technology, and people suggest that the relationship between population and geopolitics is quite different from the relationship problematically mapped by classical geopolitics. Avant-garde thinking about geopolitics tends to see states as historically contingent actors with powers within their territories and beyond them that wax and wane in capacity and scope rather than as transcendental entities with permanent drives and needs.

How Population Enters into Contemporary Geopolitics

Eschewing the determinism that afflicted and, after the Nazi period, discredited classical geopolitics does not mean abandoning attention to material factors (such as population characteristics and processes) that potentially impinge on the geographical conditioning of world politics. However, it does require seeing those factors as they are refracted through the discourse and practice of politics. In the end it is whether population issues are seen as important by political leaders and mass publics and enter into the calculus of public decision making that matters, not whether there really is a specific population problem per se.

Debates in the most widely circulated foreign policy magazines (such as *Foreign Affairs* and *Foreign Policy*) and in the professional literature on international relations and world politics suggest that a number of population-related issues are of vital importance to contemporary geopolitics. Of course, this assumes that these debates reflect the sensibilities and concerns of many contemporary "intellectuals of statecraft," a term coined by Gearoid Ó Tuathail and John Agnew (1992) to cover the array of policy professionals, military strategists, and politicians involved in shaping foreign policies in the United States and other countries.

European states and states established by European settlers (such as the United States) have long dominated world politics. Japan's status as the sole representative of the rest of the world in the ranks of the great powers is the exception that proves the rule. Though never numerically as prevalent as their global power status would suggest if there was a one-to-one relationship between population size and global political significance, Europeans today constitute a shrinking portion of the world's total population. As the first part of the world to experience the demographic transition, Europe has since been joined by much of the rest. Its loss of demographic singularity can be seen in prophetic terms. In many recent commentaries, the rise of India and China to global political prominence is predicated on the potential linkage between their massive populations and economic growth. As a result, the Eurocentric world of the past four centuries is seen as facing eclipse with the emergence of a world in which the distribution of global power finally catches up with the relative distribution of population.

This logic is based in part on historical analogy with cases such as France in the mid-twentieth century, when population decline seems to have been correlated highly with political immobilism and defeat. However, it also reflects the sense of threat that countries with large and growing populations pose to countries that have passed their demographic peak. In this understanding population growth is taken as a surrogate for a vast array of national characteristics, particularly the idea of national vitality as indicated by population growth and the association of population decrease with national decline (and fewer bodies to throw into battle).

These "classic" ideas persist despite all manner of counterfactual information. For example, countries with smaller populations tend to have higher standards of living and lower levels of inequality in incomes and wealth than do larger countries, and, not unlike smaller families everywhere, countries with smaller populations invest more per capita in their children. At the same time countries with relatively small populations at the time of their initial territorial expansion and relatively few resources, such as Britain and Japan, have been major world powers. There is also tremendous inertia in world politics, giving established powers numerous advantages over rising ones, not the least of which is access to financial and military information that others do not have the resources to acquire. Whether Europe and its overseas offshoots are ripe for eclipse, therefore, is open to doubt.

Less problematic is the view that the global dominance of the rich few over the poor many is politically and environmentally unsustainable over the long term. If anything, the absolute gap between global haves and have-nots has grown since 1980. In this perspective the development gradients between rich countries such as the United States and poorer ones such as Mexico could produce increasing conflict.

The logic here is that of relative deprivation combined with rising expectations. On the one hand, high average affluence exists alongside high average penury. On the other hand, there is increased information about what is possible on the other side of the border and resentment that prospects are so poor on this side. What seems more likely than open conflict—and is already under way—is that people who are able to will try to move from the poor area to the rich one in the hope of bettering their and their children's life chances. This accounts for one of the major intersections between population and geopolitics in the late twentieth century: the massive increase in migration from poor countries to rich ones. This is stimulated in part by the large economic differentials (employment, income, welfare, etc.) between countries but also by the so-called gray dawn in many industrialized countries as the population ages and many economic sectors can continue to function and prosper only if they are staffed by immigrants. Some of these immigrants carry out low-paid labor, but a considerable proportion is involved in highly skilled activities (medicine, software engineering, etc.), thus draining their home countries of many of their most talented and ambitious people.

The vast heterogeneity of the underdeveloped world makes the employment of terms such as the "Third World" and "global South" potentially misleading, however. Such terminology characterizes the world in geopolitical abstractions that disguise the fact that some countries and regions, such as Southeast Asia and coastal China, have made major strides in economic development, whereas others, such as much of Africa, have become less rather then more important to world economics and politics. Of course, growth in incomes and exports is not always synonymous with development, particularly in regard to improvement in the living prospects for the very poor. However, those prospects are definitely not the same everywhere within the erstwhile Third World (a term that is the fruit of the cold war opposition between an American-allied First World and a Soviet-organized Second World), suggesting the limits of the global-rich-versus-global-poor geopolitical scenario.

A more apocalyptic scenario, named "the coming anarchy" by the journalist Robert Kaplan (2000), sees the global development gap as increasingly likely to impose costs on the rich and powerful because of the spread of diseases and famine and the subsequent spilling over of pestilence and political instability into the world at large. This logic is one of contagion from threatening places that cannot be contained by conventional military or economic means.

In this perspective the world is headed for a Malthusian crisis based on a world divided into two halves. According to Kaplan, the danger lies in the spread of diseases (beginning with AIDS) for which there are no cures; the collapse of states whose territories then provide refuge for terrorists, criminals, and drug traffickers; and the specter of perpetual low-intensity conflict involving ethnic cleansing and local warlordism. A world divided between an affluent global North and a penurious global South therefore threatens the long-term prospects of the North as much as those of the South.

This portrayal of geopolitics after the cold war, however, obscures the more specific causes of environmental degradation and disease propagation. In particular, it ignores the dispossession of people to permit resource extraction, the immense increase in the number of refugees because of civil wars, the global debt crisis, the decline of traditional social mores that govern sexual behavior, and the corrupt behavior of local political elites, often supported by foreign sponsors. More generally, it colors a more complex geography in black and white terms, with countries allocated neatly into North and South. Not only are countries internally differentiated in complex ways with respect to the incidence of disease, famine, and instability, the North–South division obscures the degree to which each geopolitical division contains islands and archipelagoes of the other (Garrett 2001). The threat is at home as much as abroad, suggesting that home is where solutions are to be sought, wherever home might be. The geopolitical framing misconstrues more than clarifies the nature of the problems that must be addressed.

The Threat of Terrorism

One population issue relating to the North–South tension that does seem to have had an impact on American geopolitical thinking has taken on special importance since 2001. In the aftermath of the terrorist attacks on New York's World Trade Center and the Pentagon near Washington, DC, on September 11, 2001, much attention has been given to the fact that the Arab world in particular and the Islamic world more generally have a huge number of alienated young men with poor job prospects who are possible recruits into terror networks, such as Osama bin Laden's al-Qaeda, for suicidal terrorist missions. The mismatch between population growth and economic development, the identification of repressive governments with developmental failure, the attraction of a religious utopia based on a return to the caliphate of early Islam, and the role of the United States in backing repressive and non-Islamist governments are connected by Islamic militants to create a geopolitical worldview counter to the discourses of positive globalization and modernization emanating from Washington and other Western capitals. More specific concerns about the failure of local states to address inequalities and the festering conflict between Israel and Palestine probably have as much to do with recruitment into terror networks as do perceptions of the role of the United States. However, the relative youthfulness of the population in Middle Eastern cities and the well-known disposition of young men to risk life and limb for a cause probably play a contributory role in creating the terrorist threat that has become the main leitmotif of post–cold war global geopolitics.

Conclusion

Contemporary geopolitics therefore is marked by a number of important population-related themes. From the aging of populations and mass immigration to the increasing global divide between haves and have-nots, the possible spread of disease and instability from South to North, and the availability of youthful zealots for terror networks, politicians and commentators are not short of population-related threats against which to organize their countries.

See also: *Geography, Population; Lebensraum; States System, Demographic History of; War, Demographic Consequences of.*

BIBLIOGRAPHY

Agnew, John A. 2001. "Disputing the Nature of the International in Political Geography." *Geographische Zeitschrift* 89: 1–16.

———. 2002. *Making Political Geography.* London: Edward Arnold.

Corbridge, Stuart. 1988. "The Debt Crisis and the Crisis of Global Regulation." *Geoforum* 19: 109–130.

Dalby, Simon. 2001. "Geopolitics and Ecology: Rethinking the Contexts of Environmental Security." In *Environment and Security: Discourses and Practices,* ed. Miriam R. Lowi and Brian R. Shaw. London: Macmillan.

Flinn, Michael W. 1981. *The European Demographic System, 1500–1820.* Baltimore: Johns Hopkins University Press.

Garrett, Laurie. 2001. *Betrayal of Trust: The Collapse of Global Public Health.* New York: Hyperion.

Grigg, David. 1993. *The World Food Problem,* 2nd edition. Oxford: Blackwell.

Harding, Jeremy. 2000. "The Uninvited." *London Review of Books* February 3, pp. 3–25.

Hewitt, Paul. 2002. "Managing the Global Aging Transition." *Brown Journal of World Affairs* 8: 241–249.

Kaplan, Robert. 2000. *The Coming Anarchy: Shattering the Dreams of the Post Cold War World.* New York: Random House.

Kennedy, Paul. 1986. *The Rise and Fall of the Great Powers: Economic Change and Military Conflict from 1500 to 2000.* New York: Random House.

Knox, Paul, and John Agnew. 1998. *The Geography of the World Economy,* 3rd edition. London: Edward Arnold.

Loup, Jacques. 1983. *Can the Third World Survive?* Baltimore: Johns Hopkins University Press.

ÓTuathail, Gearoid, and John A. Agnew. 1992. "Geopolitics and Discourse: Practical Geopolitical Reasoning in American Foreign Policy." *Political Geography* 11: 190–204.

Peterson, Peter G. 1999. *Gray Dawn: How the Coming Age Wave Will Transform America and the World.* New York: Times Books.

Posth, Martin. 2001. "China's Economic Powerhouse." *Internationale Politik,* transatlantic edition 3: 47–54.

Scott, Bruce R. 2001. "The Great Divide in the Global Village." *Foreign Affairs* 80(1): 160–177.

World Bank. 2000/2001. *World Development Report: Attacking Poverty.* New York: Oxford University Press.

John A. Agnew

GINI, CORRADO

(1884–1965)

Italian statistician Corrado Gini wrote widely on statistical methodology and applied statistics, although he is perhaps best known as the originator of Gini coefficients, characterizing levels of inequality in a distribution. His bibliography includes 87 books and more than 800 papers. Some 200 titles among these are concerned with demographic topics; the areas most frequently discussed by Gini are the sex-ratio at birth, fertility and its measurement, and migratory movements.

Gini's multidisciplinary approach to the study of populations was the starting point for several important scientific initiatives. In 1931 he established the Italian Commission for the Study of Populations (CISP). Made up of eight sections from the natural sciences to the human sciences, CISP was open to those intending to work "without racial prejudice." CISP activities included publication of numerous monographs on anthropological and demographic expeditions and the journals *Metron* and *Genus,* founded by Gini in 1920 and in 1934, respectively. Gini also established the Faculty of Demographic, Statistical, and Actuarial Sciences within the University of Rome in 1936.

French demographer Alfred Sauvy (1898–1990) recognized Gini as one of the few scholars who had contributed to the development of a "general theory" of population (in his article "Démographie" in *Histoire de la Science,* 1957). Gini's contribution was the "cyclical theory," in which the growth of populations is based on a model of the biological cycle of human beings. Gini assumed that the reproductive capacity of populations follows a cyclical trend, and that human societies are renewed by the effect of an intrinsic differential biodemographic factor imparted by the inequality in reproduction rates among social classes (the less-fertile upper classes are replaced in the course of time by elements of the more-fertile lower classes). In the book *Esquémas téoricos y problémas concretos de la poblacion* (1963), published when he was Chairman of the International Institute of Sociology, Gini devoted more than 100 pages in the chapter on demographic theories dealing with the evolution of societies.

Frank W. Notestein (1902–1983), demographer at Princeton University, characterized Gini's theory as "biological" and considered it, together with that of Raymond Pearl (1879–1940), among the outdated concepts in the population field. A broader characterization of Gini's work is given in the biographical entry by Camilo Dagum, statistician and economist, in *The New Palgrave Dictionary of Economics* (1987), where he is described as "An extraordinary prolific writer and thinker, endowed with powerful new ideas . . . a true Renaissance man."

See also: *Population Thought, Contemporary*

BIBLIOGRAPHY

SELECTED WORKS BY CORRADO GINI.

Gini, Corrado. 1908. *Il sesso dal punto di vista statistico.* Milano-Palermo-Napoli: Remo Sandron.

———. 1912. *I fattori demografici dell'evoluzione delle nazioni.* Torino-Roma-Milano: Fratelli Bocca.

———. 1930. "The Cyclical Rise and Fall of Populations." *Population:* 3–139.

———. 1934. *Research on Population.* Cleveland, OH: University of Cleveland.

———. 1934. *Saggi di demografia.* Roma: Cisp, V, Istituto Poligrafico dello Stato.

———. 1945. *Teorie della popolazione.* Roma: Casa Editrice Castellani.

———. 1957. "The Physical Assimilation of the Descendents of Immigrants." *Proceedings of the First International Congress of Human Genetics.* Copenhagen; S. Karger, Basel & New York.

———. 1961. "Some Statistical Research Connected with Sex-ratio." *Bulletin of the International Statistical Institute* 38 (Part III).

Italo Scardovi

GLASS, DAVID

(1911–1978)

David Victor Glass was an English demographer, a sociologist, and the founding editor of *Population Studies.* From 1928, when he became an undergraduate, most of Glass's intellectual life was spent at the London School of Economics (LSE). In 1936, he became Research Secretary of the newly formed Population Investigation Committee (PIC), a full-time research post. In 1946, Glass was appointed Reader in Demography at the LSE; he was appointed Professor of Sociology in 1948.

In 1936 Glass published *The Struggle for Population,* presenting research undertaken for the Eugenics Society. The Society was concerned about Britain's low birth rate and wanted evidence on the pronatalist measures taken in some European countries. A revised and enlarged version appeared in 1940 as *Population Policies and Movements in Europe.*

In 1946, in work for the Royal Commission on Population, Glass (assisted by Eugene Grebenik) conducted a Family Census, based on a ten percent sample of ever-married women in Great Britain. Dates of birth of the respondents' live-born children were recorded, enabling a detailed examination of family building. In their report, Glass and Grebenik presented what may well be the earliest attempt to model fertility. Comparing childbearing in contemporary Britain with the (presumed uncontrolled) childbearing of late-nineteenth-century rural Irish women, and making assumptions about contraceptive effectiveness, they estimated proportions of women attempting to limit their family and desired family sizes.

Glass was influential in bringing about Britain's first national survey of birth control practice (1946–1947), a study sponsored by the Royal Commission. He was a major voice in determining the approach adopted (as he was with later such surveys carried out by the PIC in 1959–1960 and 1967–1968).

In 1947, the PIC established the journal *Population Studies* with Glass as editor. He continued in that position for the rest of his life (from 1954 with Grebenik as co-editor), and made the journal one of the most important in the field.

In 1949, the LSE and Ministry of Labour conducted a large-scale survey focusing on social mobility, exploring the difference between the social class of parents and that of their children. Glass was editor of, and a major contributor to, the project report, published as *Social Mobility in Britain* in 1954.

Glass was a prolific writer on a wide range of demographic topics. An obituary bibliography listed 104 items, published between 1934 and 1976. His interests included both demographic history and the history of demographic ideas and methods. In 1953, Glass edited *Introduction to Malthus: Population in History,* with David Eversley, which appeared in 1965.

See also: *Demography, History of; Population Policy; Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY DAVID GLASS.

Glass, David V. 1936. *The Struggle for Population.* Oxford: Clarendon Press.

———. 1940. *Population Policies and Movements in Europe.* Oxford: Clarendon Press. Reprint: 1967. New York: A. M. Kelley.

———. 1973. *Numbering the People: The Eighteenth-Century Population Controversy and the Development of Census and Vital Statistics in Britain.* London: Gordon & Cremonesi.

Glass, David, ed. 1953. *Introduction to Malthus.* New York: Wiley.

———, ed. 1954. *Social Mobility in Britain.* London: Routledge & Paul.

———, ed. 1957. *The University Teaching of Social Sciences: Demography: A Survey Prepared under the Auspices of the International Union for the Scientific Study of Population.* Paris: UNESCO.

Glass, David V., and David E. C. Eversley, eds. 1965. *Population in History; Essays in Historical Demography.* London: Edward E. Arnold.

Glass, David V., and Eugene Grebenik. 1954. *Great Britain Royal Commission on Population Papers,* Vol. 6: *The Trend and Pattern of Fertility in Great Britain; A Report on the Family Census of 1946.* 2 vols. London: H. M. Stationery Office.

SELECTED WORKS ABOUT DAVID GLASS.

Grebenik, Eugene. 1979. "David Victor Glass (1911–1978)." *Population Studies* 33: 5–17.

Langford, Christopher M. 1988. *The Population Investigation Committee: A Concise History to Mark Its Fiftieth Anniversary.* London: Population Investigation Committee.

C. M. Langford

GODWIN, WILLIAM

(1756–1836)

William Godwin was an English Dissenting preacher, a utopian philosopher, a novelist, a man of letters, the founder of philosophical anarchism. He married Mary Wollstonecraft, famous as the author of *Vindication of the Rights of Women* (1792), who died after the birth of their daughter, Mary. Later, Mary married Percy Bysshe Shelley. As the father-in-law of so famous a poet, Godwin was an influential member of a literary circle that included also William Wordsworth, Samuel Taylor Coleridge, and Lord George Gordon Byron. Among Godwin's works of fiction, *Adventures of Caleb Williams* (1794) is an extraordinary combination of a mystery story and an epic of conflict between social classes.

The work for which Godwin is best remembered is *An Enquiry Concerning the Principles of Political Justice* (1793), which denounced all political and social regimes as obstacles to human development. The good life is based entirely on reason, Godwin argued, which is a quality only of discrete individuals; government, law, wealth, marriage, and all other man-made institutions should be abolished. "Everything that is usually understood by the term cooperation is, in some degree, an evil." Since every principle incorporated in a person's mind affects his conduct, "the perfection of man [is] impossible [only because] the idea of absolute perfection is scarcely within the grasp of human understanding." Godwin held that a cultivated person is less eager to gratify his senses, and when sustenance is no longer available, humans will "probably cease to propagate. The whole will be a people of men and not of children." Concurrently, "the term of human life may be prolonged by the immediate operation of the intellect beyond any limits which we are able to assign."

Godwin's prolonged interaction with T. R. Malthus began with the first edition of *Essay on the Principle of Population* (1798), which judged Godwin's portrait of the future as no more than "a beautiful phantom of the imagination." Within days Godwin wrote Malthus, and they met to discuss their differences. Godwin agreed to drop the word "perfectibility," and Malthus conceded that, unlike other species, humans can apply their reason and avoid the dire effects of a limited food supply; the second and subsequent editions of Malthus's book in effect acknowledged that Godwin's criticism was well based. Following this amicable exchange, Godwin wrote a small book, *Parr's Spital Sermon* (1801), in which he expressed his "unfeigned approbation and respect" for Malthus, who had made "as unquestionable an addition to the theory of political economy as any writer for a century past."

This favorable judgment was reversed in a subsequent work, *Of Population* (1820). It is a prolix book and difficult to summarize, with four principal points: Malthus had changed his position from the first edition of the *Essay* (indeed, partly at Godwin's instigation); the world is not full (repeated a dozen times); the two ratios, arithmetic and geometric, misrepresent the potential increase of mankind and its subsistence; the population data cited in the *Essay* did not support its argument. He upbraided Malthus for failing to mention the Bible, not even Adam and Eve as the progenitors of all humanity. China and India, he asserted, "carry back their chronology through millions of years." The enumerated populations of England and Wales in 1801 and 1811 showed a growth of 1.3 million; Godwin announced a possibility that "there was not one human creature more." In an anonymous review of the book in *Edinburgh Review* (June 1821), probably written by Malthus himself, *Of Population* was characterized as "the poorest and most old-womanish performance that had fallen from the pen of any writer" over the past several decades, the product of an "enfeebled judgment." The principal modern edition of *Political Justice,* published by the University of Toronto Press, omits the section on population, ostensibly because its substance is available in *Of Population.*

See also: *Malthus, Thomas Robert; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY WILLIAM GODWIN.

Godwin, William. 1793 (1946). 1946. *Enquiry Concerning Political Justice and Its Influence on General Virtue and Happiness.* Dublin (Toronto: University of Toronto Press).

———. 1797. *The Enquirer: Reflections on Education, Manners, and Literature.* London: G. G. and J. Robinson.

———. 1801 (1968). *Thoughts Occasioned by the Perusal of Dr. Parr's Spital Sermon* (1801). In *Uncollected Writings . . . by William Godwin* (in facsimile), ed. Jack W. Marken and Burton Pollin. Gainesville, FL: Scholars' Facsimiles & Reprints.

———. 1820. *Of Population: An Enquiry Concerning the Power of Increase in the Numbers of Mankind, Being an Answer to Mr. Malthus's Essay on That Subject.* London: Longman, Hurst, Rees, Orme, and Brown.

———. 1831. *Thoughts on Man, His Nature, Productions and Discoveries, Interspersed with Some Particulars Respecting the Author.* London: Effingham Wilson.

SELECTED WORKS ABOUT WILLIAM GODWIN.

Albrecht, William P. 1955. "Godwin and Malthus." *Proceedings of the Modern Language Association* 70: 552–555.

Everett, Alexander H. 1826. *New Ideas on Population: With Remarks on the Theories of Malthus and Godwin,* 2nd edition. Boston: Cummings, Hilliard.

Paul, C. Kegan. 1876. *William Godwin: His Friends and Contemporaries.* 2 vols. London: King.

Petersen, William. 1971. "The Malthus-Godwin Debate, Then and Now." *Demography* 8: 13–26.

Stephen, Leslie. 1963. "Godwin, William." *Dictionary of National Biography*: 64–68.

William Petersen

GOMPERTZ, BENJAMIN

(1779–1865)

Benjamin Gompertz lived his entire life in London. He came from a prominent Jewish family: His father and grandfather were diamond merchants in London; his youngest brother, Lewis, founded the Society for the Prevention of Cruelty to Animals. In 1810, he married Abigail Montefiore, whose brother, Sir Moses Montefiore, helped found the Alliance Assurance Company in 1824. Gompertz served the company as actuary and chief officer from 1824 until his retirement in 1847. In 1819, he was elected a Fellow of the Royal Society of London. He published four major papers in the *Philosophical Transactions of the Society,* in 1806, 1820, 1825, and 1862. He also wrote 18 other pieces, including nine on astronomical instruments.

On June 10, 1825, Gompertz's most enduring and influential research contribution was read before the Royal Society. The 72-page work, "On the nature of the function expressive of the law of human mortality, and on a new mode of determining the value of Life Contingencies," was largely devoted to calculations and detailed tables. He considered and emphatically rejected the notion of a maximum lifespan. The centerpiece of his work, however, is the formula later known as Gompertz's Law, which Gompertz presented as follows: "the number of persons living at the age of x = $d{\cdot}g^{q^x}$," where d, g, and q are parameters with g, as Gompertz emphasizes, raised to the power q^x. Many demographers in the twenty-first century are more familiar with this formula in a different guise, namely that the force of mortality is an exponential function of age: $\mu(x) = ae^{bx}$, where Gompertz's q equals e^b, a is the force of mortality at the initial age of 10, 30, or 50 and x is the number of years since the initial age.

Gompertz argued that "death may be the consequence of two generally co-existing causes; the one, chance . . . ; the other, a deterioration, or an increased inability to withstand destruction." He seems to have associated *chance* with the parameter *a* and *deterioration* with the parameter *b*. He stressed that his formula "is deserving of attention because it appears corroborated during a long portion of life by . . . various published tables of mortality." Although in articles published in 1860 and 1862 he applied his formula to ages as young as 10 and as old as 100, he recognized that his law was an approximation and that different values of *a* and *b* were required for different age ranges. In 1860, the British actuary William M. Makeham suggested a simple modification of Gompertz's law, $\mu(x) = ae^{bx} + c$, that provided a much better fit to nineteenth-century European mortality. In developed countries of the twenty-first century, Gompertz's law captures the general pattern of the rise of mortality from about age 30 to about age 95.

See also: *Aging and Longevity, Biology of; Demography, History of; Mortality, Age Patterns of.*

BIBLIOGRAPHY

SELECTED WORKS BY BENJAMIN GOMPERTZ.

Gompertz, Benjamin. 1825. "On the Nature of the Function Expressive of the Law of Human Mortality, and on a New Mode of Determining the Value of Life Contingencies." *Philosophical Transactions of the Royal Society* 115: 513–585.

SELECTED WORKS ABOUT BENJAMIN GOMPERTZ.

Heligman, Larry, and J. H. Pollard. 1980. "The Age Pattern of Mortality." *Journal of the Institute of Actuaries* 107: 49–75.

Makeham, William M. 1860 "On the Law of Mortality, and the Construction of Annuity Tables." *The Assurance Magazine and Journal of the Institute of Actuaries* 8: 301–310.

Thatcher, A. R., V. Kannisto, and James W. Vaupel. 1998. *The Force of Mortality at Ages 80 to 120.* Denmark: Odense University Press.

James W. Vaupel

GRANDPARENTHOOD

Shifts to low or very low fertility in many developed countries have had, and will continue to have, the effect of making lateral kinship links—such as those with siblings, cousins, aunts and uncles, and nieces and nephews—less available than in the past. However, falls in mortality have increased the "vertical" extension of kinship networks, including grandparent–grandchild. A 1999 British survey, designed by Emily Grundy and Mike Murphy, found that over 75 percent of adults were members of families including at least three living generations. Half of all adults were a grandparent by the age of 50, and 80 percent of 20-year-olds had at least one grandparent alive. This implies that most children in low mortality populations now have the grandparent relationship potentially available to them throughout childhood. In countries with higher mortality and fertility, grandparenthood is also important. Even though higher mortality implies a lower probability of an individual of a given age having a grandparent available, this may be partly offset by earlier childbearing and shorter intergenerational age gaps. The scholars Albert Hermalin, Carol Roan, and Aurora Perez, for example, found that in Thailand in 1995, over 70 percent of people aged 50 to 54 were grandparents, higher than the equivalent proportion in Britain. Moreover, the high prevalence of intergenerational coresidence in many less developed countries implies high levels of interaction between grandparents and at least some of their grandchildren.

From a biological perspective, grandparenthood can be defined as the relationship with the children of one's children. Family dissolution and re-formation may also produce social or "step-" grandparent relationships. Older people may become step-grandparents through their own repartnering with a person who has grandchildren or through a child's partnership with someone who has children from a previous relationship.

Family Change and the Role of Grandparents

The increasing complexity of family relationships in many societies has prompted greater policy interest in the role of grandparents as potential "stress-buffers" in times of crisis and as a back-up for grandchildren faced with family disruption. Policy attention has also focused on the rights of grandparents in cases where their relationship with grandchildren is threatened by divorce. In the United States, a recent increase in custodial grandparenthood has led to the development of policies designed to support such families. The role of grandparents is also recognized to have become more important in populations seriously affected by the HIV/AIDS epidemic. One survey conducted in Zaire in the early 1990s found that 34 percent of HIV/AIDS orphans were being cared for by a grandparent.

Even in less extreme circumstances, grandparents may make substantial contributions to the welfare of their children's families. Many grandparents babysit or provide childcare while parents work. Surveys in Thailand, Taiwan, and the Philippines have shown that some 40 percent of people aged 50 and over live in households including minor grandchildren, and about half of those with a coresident grandchild under ten provide child care. In the United States in the mid 1990s, over a quarter of young children with working parents were looked after by a grandparent; studies in European countries have found similarly high, or higher, levels of grandparent involvement in child care. Such support can be particularly important for single parents.

In addition to the practical help that grandparents provide, they may also perform a number of important symbolic functions and undertake the role of "family watchdogs," as well as provide emotional support and advice to their children and grandchildren.

Contact between Grandparents and Grandchildren

Studies in both Western and other populations have found high levels of contact between grandparents and grandchildren. In Britain around half of grandparents see their eldest grandchild at least weekly. Research on variations in the strength of grandparent/grandchild relationships, the extent of contact, and the provision of help by grandparents has identified several consistent themes. There is a strong gender dimension to such relationships, with grandmothers seeing grandchildren more frequently than grandfathers do and providing more help. In the 1999 British survey, for example, two-thirds of grandmothers aged 50 to 59 saw their eldest grandchild at least once a week compared with only 52 percent of grandfathers of the same age. As might be expected, physical proximity has been identified as one of the most important factors affecting intergenerational contact. Grandparents see more of grandchildren when they live close to each other, and of course most of all when they are coresident. In the 1999 British survey referred to above, over half of grandparents aged 50 to 59 lived within 30 minutes journey time of their eldest grandchild, but among grandmothers in their seventies this proportion was only 30 percent, presumably because the older grandparents' eldest grandchild is more likely to have moved away from the childhood home. Level of education (itself associated with proximity) has been found to be negatively associated with the provision of grandchild care, at least in Britain and the United States.

In the early twenty-first century, grandparenthood is attracting growing attention in both popular culture and research. Possibly this reflects a perceived greater need for grandparent involvement because of the increase in family disruption in some societies, including disruption due to parental death in populations with a high HIV/AIDS prevalence. More positive images of older people, or at least of the so-called "young old," and increases in the disposable incomes and health status of significant segments of the older population may also be important. As has been pointed out in several commentaries, though, these changes and the associated greater opportunities for travel and leisure, and in some societies opportunities or pressures to postpone retirement, may mean that at least some grandparents will be less available to maintain intensive contacts with and to help take care of grandchildren.

However, the changing ratio of grandchildren to grandparents implied by population aging suggests that younger generations will increasingly benefit from the wisdom, stability, and resources provided by their grandparents.

See also: *Family Life Cycle; Parenthood.*

BIBLIOGRAPHY

Cherlin, Andrew J., and Frank F. Furstenberg. 1986. *The New American Grandparent: A Place in the Family, A Place Apart.* New York: Basic Books.

Clarke, Lynda, and Helen Cairns. 2001. "Grandparents and the Care of Grandchildren: The Research Evidence." In *Kinship Care,* ed. B. Broad. Dorset, Eng.: Russell House Publishing.

Grundy, Emily, Mike Murphy, and Nicola Shelton. 1999. "Looking Beyond the Household: Intergenerational Perspectives on Living Kin and Contacts with Kin in Great Britain." *Population Trends* 97: 33–41.

Hermalin, Albert, Carol Roan, and Aurora Perez. 1998. "The Emerging Role of Grandparents in Asia." *Research Report No. 98–52.* Ann Arbor: Population Studies Center, University of Michigan.

Kornhaber, Arthur. 1996. *Contemporary Grandparenting.* Beverly Hills, CA: Sage Publications.

Uhlenberg, Peter. 1996. "Mortality Decline in the Twentieth Century and Supply of Kin over the Life Course." *The Gerontologist* 36: 681–685.

Lynda Clarke
Emily Grundy

GRAUNT, JOHN

(1620–1674)

John Graunt was the author of the first quantitative analysis of human populations, *Natural and Political Observations* (1662). Widely acclaimed in Graunt's time, the *Observations* charted the course of vital and social measurement for the next century and a half, laying the basis for the emergence of demography and statistics in the nineteenth century.

Graunt cut an unusual figure among the scientific *literati* of his time. A London merchant who lacked higher education and was not versed in the natural sciences and algebra, he became a charter member of the Royal Society. His analyses relied on simple ratios, proportions, and odds and adhered closely to religious and political conventions in which a population's size and strength were considered to reflect a king's ability to govern in accordance with natural and God-given symmetries. However, Graunt's work also showed a keen awareness and originality with respect to contemporary scientific and rhetorical method and made implicit use of probabilistic concepts that were familiar at that time only to a small mathematical elite.

Graunt interpreted the old symmetries of the macrocosm and the microcosm in a new way: If human society has an inherent order of the kind that is supposed to characterize all natural or God-given phenomena, it should be possible to observe quantitative regularities in society that are similar to those a natural historian measures. The bills of mortality kept by London parish clerks provided Graunt with an extensive enumeration with which to explore this idea.

His search for quantitative regularities in a body of social data was without precedent and, as David Glass (1963) remarked, is characteristically statistical. Graunt, of course, knew nothing about those later developments. His method was a synthesis of three sources. The first was the philosopher Francis Bacon's (1561–1626) procedure for compiling natural histories: Graunt first ascertained that the bills were reasonably accurate compilations based on direct observation; he then compiled tables, grouping his observations to allow readers to check his logic and make their own observations. In cases where the bills appeared irregular, he examined and if necessary reclassified them to ensure consistency.

Graunt went beyond Bacon in employing his second methodological source—the arithmetic checks and balances of merchant bookkeeping—as a system to specify inherent natural regularities. Many of the measures he devised on this basis became fundamental to demography (e.g., rates of infant and child mortality, the imbalance of sex ratios at birth, crude vital rates presented as time series). The conception of population Graunt employed, however, remained basically a merchant's pragmatic notion of an *accompt*: Flows of births, deaths, and migrations are dealt with in an *ad hoc* manner rather than being related to a total population in a mathematically consistent way.

Graunt's third methodological source reflects the dual purpose of his observations as both natural *and* political: Each problem he addresses is treated as an exercise in political language as well as in what his contemporary, the economic writer William Petty (1623–1687), called "political arithmetic." A succession of proportions is built up persuasively in his text that demonstrate the capacities of the body politic; Graunt's book is a veritable compendium of *exempla* that show how to construct arithmetic arguments according to the methods used in influential rhetoric textbooks of the early seventeenth century.

Graunt's impressive arguments gave his work two enduring paths of influence. His ratios became the subject of political arithmetic as it was pursued by Petty and other economic writers like Gregory King (1648–1712) as well as many political, medical, and religious writers of the eighteenth century. This tradition, although unable to introduce major technical advances beyond Graunt's arithmetic and much less attentive to or effective in its powers of persuasion, increased awareness of the usefulness of enumerations in an era when such methods were subjects of popular suspicion.

Analytic development followed from one of Graunt's inventions that proved to be of deeper significance than he realized. Graunt's estimate of the number of "fighting men" (i.e., for London's defense) relied on a hypothetical table of mortality by age. Mathematicians interested in the nascent calculus of probabilities, such as mathematician Christian Huygens, astronomer Edmund Halley, and philosopher and mathematician Gottfried Leibnitz (1646–1716), quickly recognized in his reasoning a more general logic for calculating life expectancy. Although Graunt had not employed his table for that purpose, their analyses gave rise to the first abstract model of population: the life table.

The approach to longevity that Graunt inspired remained the only data-based social phenomenon that mathematicians could use to explore probability for over a century. By the early nineteenth century life tables had become the first formal models guiding state finance and corporate practice (in life insurance); this success shaped the data requirements of the newly established national statistical offices, enabling the ratios Graunt pioneered to be developed systematically.

See also: *Demography, History of; King, Gregory; Petty, William; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY JOHN GRAUNT.

Graunt, John. 1662. *Natural and Political Observations Made upon the Bills of Mortality.* London. Reprinted 1973 in *The Earliest Classics: Pioneers of Demography,* ed. P. Laslett. Farnborough, Hants, Eng.: Gregg International.

SELECTED WORKS ABOUT JOHN GRAUNT.

Glass, David V. 1963. "John Graunt and His Natural and Political Observations." *Proceedings of the Royal Society,* Series B, 159: 2–37.

Kreager, Philip. 1988. "New Light on Graunt." *Population Studies* 42: 129–140.

———. 1993. "Histories of Demography." *Population Studies* 47: 519–539.

———. 2002. "Death and Method: The Rhetorical Space of 17th-Century Vital Measurement." In *The Road to Medical Statistics,* ed. Eileen Magnello and Anne Hardy. Amsterdam: Rodopi.

Sutherland, Ian. 1963. "John Graunt: A Tercentenary Tribute." *Journal of the Royal Statistical Society,* Series A, 126: 537–556.

PHILIP KREAGER

H

HARDIN, GARRETT

(1915–)

American biologist and writer on ecology and human population, Garrett Hardin has degrees from the University of Chicago and Stanford, with a specialization in genetics. Hardin's writings about demographic topics reflect broader interests in public policy, both with respect to domestic U.S. issues, such as abortion and immigration, and concerning international affairs, such as foreign assistance. A lucid and engaging writer, he has published widely on these issues, reaching a broad and devoted popular audience and generating controversy with messages that have often been in conflict with prevailing opinions.

In reviewing one of his collections of articles (*Naked Emperors: Essays of a Taboo-Stalker*), the economist Kenneth Boulding commented: "In a day of endangered species, it is good to be able to report that a fine old literary species, the essay, is still alive and flourishing in the habitat of a remarkable mind, that of Garrett Hardin." Some of the felicitous flair of Hardin's prose no doubt derived from an asset thinly possessed by most demographers: extensive reading in and familiarity with the history of ideas about population matters. His book *Population, Evolution, and Birth Control: A Collage of Controversial Readings* appeared in several editions and perhaps helped many readers understand and draw illumination from past intellectual engagements with population issues.

Hardin also lectured extensively about population topics. One of his lectures, eventually cast in the form of a lean and elegantly crafted article, was published in 1968 in *Science* under the arresting title "The Tragedy of the Commons." This article became one of the most cited papers in the social sciences. It was reprinted in more than a hundred collections of readings in many fields: including biology, sociology, public health, demography, political science, ecology, philosophy, ethics, and economics. Hardin followed it with an equally provocative essay, "Living on a Lifeboat" (1974). Metaphorically, the essay portrayed the world and nations, each separately, as lifeboats of limited capacity that cannot take new passengers without endangering the occupants. "For the foreseeable future," Hardin concluded his article, "survival demands that we govern our actions by the ethics of a lifeboat. Posterity will be ill served if we do not."

The "Commons" article owed something to Hardin's antiquarian interest in long-forgotten writings. Its core proposition drew on the work of a little-known English mathematician W. F. Lloyd, who showed in 1833 that the "freedom of the seas" had to be abandoned now that the supply of oceanic fish was dwarfed by the demands of an expanding human population. The oceanic fish stock was an "unmanaged commons." Applying this proposition to the contemporary world scene, Hardin argued that freedom requires population control, and called for a policy of "mutual coercion, mutually agreed upon."

See also: *Common Property Resources; Ecological Perspectives on Population; Population Policy.*

BIBILIOGRAPHY

SELECTED WORKS BY GARRETT HARDIN.

Hardin, Garrett. 1966. *Biology: Its Principles and Implications.* San Francisco: W. H. Freeman.

———. 1968. "The Tragedy of the Commons." *Science* 162: 1,243–1,248.

———. 1969. *Population, Evolution, and Birth Control: A Collage of Controversial Readings.* San Francisco: W. H. Freeman.

———. 1972. *Exploring New Ethics for Survival: The Voyage of the Spaceship Beagle.* New York: Viking Press.

———. 1973. *Stalking the Wild Taboo.* Los Altos, CA: W. H. Kaufmann.

———. 1974. "Living on a Lifeboat." *BioScience* 24 (10).

———. 1982. *Naked Emperors: Essays of a Taboo-Stalker.* Los Altos, CA: W. H. Kaufmann.

———. 1985. *Filters Against Folly: How to Survive Despite Economists, Ecologists, and the Merely Eloquent.* New York: Viking.

———. 1999. *The Ostrich Factor: Our Population Myopia.* New York: Oxford University Press.

Paul Demeny

HAYAMI, AKIRA

(1929–)

Born in Tokyo, historical demographer, economic historian, and Fellow of the Japan Academy, Akira Hayami was educated at Keio University. Subsequently, apart from a brief period at an ethnological institute, he lectured in economic history at that university until 1989—from 1967 as a professor. He has also held appointments at the International Research Center for Japanese Studies (1989) and at Reitaku University (1995). He was president of the Socio-economic History Society, Japan (1991–1994) and vice-president of the International Economic History Association (1994–1998).

His first publications were on the economic history of Tokugawa Japan from 1603 to 1868. Since then, however, his major contribution has been to historical demography. Hayami first applied the methods of historical demography developed in France and the United Kingdom to Japanese data known as *shumon aratame-cho* (census-type annual listings of households and population). He drew attention to the wealth of information contained in those micro-data that could be used in the study of mortality, fertility, nuptiality, and the size and structure of households over several generations. He directed the collection and analysis of local population registers all over the country, but his own work focused mainly on two regions in central Japan. His investigations revealed that even allowing for the serious underenumeration of births and infant deaths in the registers, mortality in Tokugawa Japan was not high while marital fertility was moderate to low. He also found significant changes over time: a secular rise in the mean age at first marriage and a trend toward smaller households, which he associated with the growth of a market economy and intensive farming.

In 1995, he launched an international project on historical population registers in five European and Asian countries: Belgium, China, Italy, Japan, and Sweden. The purpose of the EurAsian project on Population and Family History (EAP) is to explore the ways in which pre-modern demography responded to resource constraints by looking at individual events in relation to the family life-cycle as well as regional circumstances. The EAP is planning to publish its research results in five volumes dealing with, respectively, mortality, reproductive culture, marriage, migration, and demographic systems.

See also: *Family Reconstitution; Henry, Louis; Historical Demography; Laslett, Peter.*

BIBLIOGRAPHY

SELECTED WORKS BY AKIRA HAYAMI.

Cornell, Laurel L., and Akira Hayami. 1986. "The *shumon aratame-cho:* Japan's Population Registers." *Journal of Family History* 11: 311–328.

Hayami, Akira. 2001. *The Historical Demography of Pre-modern Japan.* Tokyo, Japan: University of Tokyo Press.

van der Woude, Ad, Akira Hayami, and Jan de Vries, eds. 1990. *Urbanization in History: A Process of Dynamic Interactions.* Oxford: Clarendon Press.

SELECTED WORKS ABOUT AKIRA HAYAMI.

Saito, Osamu. 1995. "Historical Demography: Methodology and Interpretations." In *Historical Studies in Japan (VIII): 1988–1992,* ed. National Committee of Japanese Historians. Tokyo, Japan: Yamakawa Shuppansha.

OSAMU SAITO

HEALTH SYSTEMS

Health services, public and private, are a major sector of any national economy, and their organization and financing warrant close attention. Equally, the outputs of health systems need continual appraisal—especially in the light of new demands from aging populations and the burden of emerging diseases (notably AIDS) and also in view of widespread concern with persistent inequality in health status and access to health services in national populations.

In its *World Health Report 2000,* the World Health Organization (WHO) defined a health system as "all the activities whose primary purpose is to promote, restore or maintain health." Provision of health services, including traditional healers and medications, whether prescribed by a provider or not, are included in this definition, as are traditional public health activities such as health promotion and disease prevention. Road and environmental safety improvements (seatbelts, water management, and sanitation) are also included. Activities whose primary purpose is something other than health—for example general education—are excluded even though they often have important positive effects on health outcomes. The organizational responsibilities for health in government and donor agencies do not always align with health-system boundaries thus defined. Water and sanitation, for example, are usually managed by agencies responsible for public infrastructure rather than by health ministries, and investments in them are not usually counted as health expenditure.

Health systems vary significantly from country to country. The shape of a national health system often reflects societal values and views about the responsibilities of government for the health of citizens, but may also be the result of countries's responses to their changing demographic, epidemiological, and economic conditions. Health systems can differ in:

- How health care is financed—through taxes, payments to social or private insurance funds, or out-of-pocket payments or co-payments by consumers.
- How resources for health are managed and paid to providers—by governments through general or line-item budgets for providers, or by specialized payment schemes and contractual arrangements based on the number of patients and/or types of service provided.
- How health services are provided—through publicly owned and managed facilities, by private providers, or by some combination of these.
- The roles and responsibilities of different actors—including the public sector (as a financier, provider, or regulator), the private sector (including both for-profit and non-profit providers, insurance funds, professional associations and unions), and consumers.

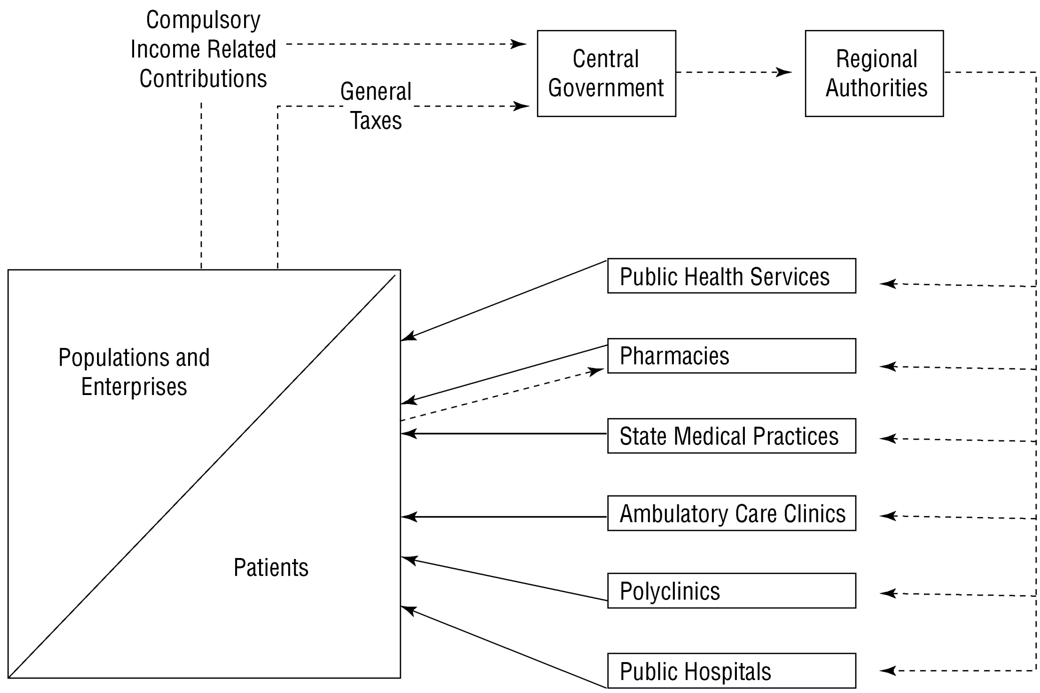
Figure 1 illustrates the flow of resources in a health system (that of the former German Democratic Republic) in which health was financed mainly through taxes from individuals and enterprises (the flow along the upper left hand corner of the figure) to government, which distributed funds from general revenues to local health authorities, who then supported provision of services through a variety of government-run services (the right-hand side of the figure). Out-of-pocket expenditures by consumers were very limited (mainly for non-prescription medications), although in similar systems informal ("under the table") payments from patients to health care providers are often substantial. In contrast, the private sector plays a much larger role in the U.S. health system. In most countries, health systems combine a mix of public and private involvement in financing, fund management, provision, and regulation.

Assessments of health systems performance can employ a range of criteria, including:

- Health status of the population—conventional measures of mortality and morbidity, including life expectancy and the incidence

FIGURE 1

Example of Resource Flows in a Tax-Funded Health System



SOURCE: OECD, 1994. (Based on the health system of the former German Democratic Republic.)

and prevalence of diseases and disabilities. More complex measures may also be applied, such as the burden of disease, as expressed in terms of disability-adjusted life years (DALYs) or similar indexes that attempt to express a population's health using a single, comparable metric.

- Economics—the cost and cost-effectiveness of different health interventions, including the cost of gaining an additional year of healthy life as measured in DALYs, as well as the financial sustainability of particularly models of health financing and delivery, as affected, inter alia, by the changing demographic structure of the population, especially aging.
- Equity—the extent to which persons of differing income levels, including the poor, have access to needed health services or are protected from falling into poverty as the result of a personal or family medical crisis, or that all of those afflicted by a particular malady have a chance to obtain treatment.
- Consumer satisfaction with the quality and affordability of services, as measured through public-opinion surveys, exit interviews, etc.

Health reforms have been introduced in order to improve health system performance. The principal reform measures include:

- Changes in the way health care is financed: shifting from tax-based financing to cost recovery (user fees) and risk pooling (social and private insurance).
- Changes in the way services are organized, including changed roles for the public and private sectors (shifting from public financing and provision to public purchasing of privately provided services) and decentralization (shifting control over resources and personnel from central to local governments).
- Changes in the ways providers are paid (from government budgets for public provision to various modes of contracting with private

providers—capitation, reimbursement schemes for specific types of treatments, performance-based contracting).

- Quality improvements (reorganization and redeployment of health personnel, changing the way in which medicines and other health-system inputs are purchased and distributed).
- Stewardship and accountability: introducing norms and reporting mechanisms for private providers, creating channels through which consumers and civil-society institutions can exercise oversight over health care.

Reforms are potentially beneficial but also contain risks. The effects of reform measures on reproductive health services, in particular, warrant close attention. Measures such as cost recovery may help to mobilize more resources for health care, but may also reduce access to needed reproductive health services by poor and vulnerable groups. Insurance schemes may lower the risks of being impoverished by most kinds of health emergency, but may not cover a life-threatening obstetric emergency. Integration into broader health programs of family planning and other priority services that previously had been funded as categorical programs may result in erosion of their priority status. Reproductive health advocates are active participants in the design and oversight of the reform process.

See also: *Disease, Burden of; Health Transition; Mortality Decline.*

BIBLIOGRAPHY

Hurst, Jeremy. 1992. *The Reform of Health Care: a Comparative Analysis of Seven OECD Countries.* Paris: Organization for Economic Cooperation and Development.

Murray, Christopher, and Alan Lopez, eds. 1996. *The Global Burden of Disease: a Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020.* Cambridge, MA: Harvard University Press for World Health Organization and World Bank.

The World Development Report 1993: Investing in Health. New York: Oxford University Press for World Bank.

The World Health Report 2000, Health Systems: Improving Performance. Geneva: World Health Organization.

Thomas W. Merrick

HEALTH TRANSITION

The health transition is the latest in a series of secular transitions that demographers and other social scientists are expected to describe and explain. Its relative conceptual novelty means that its implications for demographic research, both historical and contemporary, remain unclear. John Caldwell, who introduced the concept of a "health transition" in 1990, hoped that that concept would encourage demographers to pay more attention to how people stay healthy while alive instead of focusing narrowly on how long they live. Of particular importance to him was how ordinary individuals in developing countries use knowledge to preserve or restore health and extend life at the household level. In this case data on education are central to tracking the health transition.

The Importance of the Health Transition

The idea of a health transition became very popular very quickly, partly because so many different fields of research are concerned with health trends and their implications for health policy. From an epidemiological perspective the idea of a global transition to better health involves tracking the courses of specific diseases. As long as infectious diseases (new and resurgent) are out of control, no global transition to better health will be possible. When health and general human welfare are equated, the growing number of refugees produced by wars and famines can make the idea of a global transition to better health seem premature. Different frameworks for conducting research invariably produce inconsistent and even contradictory perspectives on change and thus on the implications of a health transition for health policy.

Explicitly or implicitly, demographers generally assume that healthier individuals live longer than do sick ones, and thus populations with high life expectancy are healthier than those with low life expectancy. To the extent that mortality data track the health status of a population, the mortality transition effectively proxies any separate health transition. Caldwell's earliest demographic critics argued in this vein. At most, all that was needed was more specialized measures of mortality, such as infant mortality or maternal mortality, to highlight the importance of knowledge in the production of health during development.

However, demographers specializing in developed countries with high life expectancy were more receptive to the idea that there is more to health than death, especially at older ages. For several decades they have worked with epidemiologists and public health planners to develop measures that can be used to track the health status of a population without relying on mortality data but can be linked to those data (Manton and Land 2000). Measures such as active life expectancy (ALE) estimate the length of the average life lived free from disabilities and diseases that interfere with the activities of daily living (ADL). Disability-free life expectancy (DFLE) deals with the same problem. Other related measures include disability-adjusted life years (DALY) and quality-adjusted life years (QALY). Among the many implications of this research is that the health of the elderly can deteriorate even if life expectancy is stable or rising at older ages.

Criticisms of the New Approaches

Despite the potential utility of these new approaches to the measurement of a population's health status, they all have been criticized for being subjective and value-laden. For example, the way in which disabilities are perceived and measured differs from context to context, and in every context judgments must be made about various degrees of disability (mild, moderate, severe) before policy can become relevant. All these judgments reflect the interests of those who make them, especially when substantial monetary or other entitlements are involved. In contrast to disability, death is a relatively simple biological state. Its measurement is virtually free of economic and political influences, assuming that deaths are reported accurately.

The relationship between health and death, or morbidity and mortality, is not a new problem in demography. Leading Victorian statisticians debated fundamental theoretical issues and their policy implications before national death rates began to fall in the 1870s. In 1837 Dr. William Farr argued that individuals born with less health (innate vitality) died earlier because they fell sick at earlier ages. Using this assumption, he surmised that the fall of infant and child mortality in England in the period 1755–1775 to 1813–1830, which he observed by using parish register data, meant that weaker infants were surviving to become relatively unhealthy, low-vitality adults. That is why England had higher adult death rates than Belgium or Sweden in the l830s. As Farr matured, his theories of mortality began to emphasize the role harsh environments could play in artificially accelerating the loss of health, thus causing premature (preventable) deaths that public health reforms could prevent without increasing the national burden of ill health.

Darwinian Interpretations

Unfortunately, Charles Darwin's theories gave a new scientific legitimacy to the idea that individuals were differentially frail or robust from birth and that nothing much could be done about it. The influential statistician Karl Pearson assumed that the process of culling, in which the frail die young, kept surviving adults relatively healthy. The fact that child mortality (persons age one to five) had been falling in England for several decades before 1900 explained why so many young men were rejected for military service in the first decade of the twentieth century. Females also were surviving to adulthood in poorer heath and thus were less able to bear children. This explained why birth rates were falling. To Pearson the well-intentioned campaigns to reduce infant death rates in England that began after 1900 would only result in the production of more and more physiologically frail, unhealthy adults who would be a burden to the country.

Inherent in this line of reasoning is the idea of an inverse health transition: As national life expectancy rises, the health status of the population decreases. Alternatively, as mortality falls, morbidity increases. Although this assumption has never dominated mainstream demography, its core ideas continue to reappear in different guises. In the same year that Caldwell introduced the concept of the health transition James Riley pointed out that as life expectancy continued to rise in the developed countries, so did most measures of morbidity. Indeed, as populations aged and chronic diseases replaced acute quickly killing diseases as the leading causes of death, the time spent by the living in states of ill health was bound to increase.

It is true that populations with low (or lower) life expectancy report less morbidity than do those with high (or higher) life expectancy levels. For example, in India people who live in Kerala State, which has the highest level of life expectancy, report more sickness than do people who live in states with low life expectancy levels such as Bihar. The United States has a higher level of life expectancy than does Kerala, but Americans report even higher levels of morbidity (see Figure 1).

Evaluations of Health

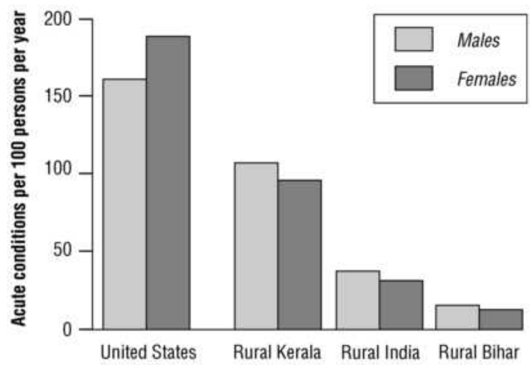
Fortunately, almost everyone who uses morbidity data from developed or developing countries recognizes that when people are asked to evaluate their own health, they draw on their knowledge of what good health means in the context in which they live. In some countries severe disabilities and certain diseases are consistent with reports of good health. In other countries any disease or disability, however mild, is equated with poor health.

Similar considerations affect comparisons of time off from work caused by sickness. In low-income countries the poor will work till they drop partly because taking time off from work is not subsidized in any way except by hard-pressed families that must pick up the slack or suffer the consequences. In high-income countries benefits are provided, and as they become more generous, workers take more time off from work. In general the inflation of morbidity as life expectancy rises is a form of cultural inflation, not a reflection of increasing frailty. In this case the term *cultural* includes how people have been taught to identify and respond to less than perfect states of health in conjunction with the amount of institutionalized support they receive for being sick.

Stressing the cultural inflation of morbidity (through its effects on reporting) does not mean denying the reality of adverse health trends. If people with diabetes are considered to live in a perpetually diseased state and diabetic persons live longer because insulin is available, saving their lives has increased the burden of illness. However, it can be argued that because of insulin they are not diseased, at least for many years. If Down's syndrome children are considered disabled, modern forms of care have greatly extended the life span of this disabled group.

FIGURE 1

Incidence of Reported Morbidity: Rural India (1973–1974) and United States (1985)



SOURCE: Murray and Chen (1992) p. 486.

In the early twentieth century most Down's syndrome children died before the age of 20; a century later most live to old age. However, whether those surviving to old age should be considered intrinsically disabled or unhealthy during their extended lives, and thus a burden to society, is highly controversial.

Obesity continues to increase in the developed countries, and the individuals affected are at risk of developing various chronic diseases and/or disabilities in old age without dying earlier (above a certain threshold obese individuals do have an higher than average age-specific risk of dying). Even if national life expectancy is rising, it makes sense to argue that an increasingly overweight population is becoming a less healthy population.

However, weight is only one dimension of health, and the idea of a heath transition implicitly averages the many dimensions of health, some of which may be improving while others deteriorate. In the face of irreducible complexity, there are three strategies that can be adopted with respect to measuring health and thus reaching conclusions about the course of the health transition, including its relationship to mortality trends both in the past and in the present.

Three Strategies for Measuring Health

The first strategy is to continue assuming that for most research purposes health trends are adequately proxied by mortality data. In this case as long as life expectancy keeps rising, health is improving. This solution keeps demographic data at the center of health research but suggests that rising life expectancy is all that matters. Currently this strategy dominates the growing body of research on "health inequality" during economic development, in which measuring health inequalities between countries becomes little more than a matter of comparing life expectancy levels.

The second strategy is to observe health by measuring its loss in the form of sickness and disability by using data that are relatively culture-free. In this case the health transition becomes a doctor's transition; it is based on tracking forms of biological suboptimality that ordinary people may not perceive directly. Blood pressure is an obvious example. From this medicalized perspective on health, tracking the health transition would be done by doctors who were trained in the same medical tradition (Western scientific, or biomedicine) and examined otherwise comparable age cohorts at different points in time during the rise of life expectancy.

One study that approximates this ideal is Dora Costa's comparison of medical measures provided by doctors for the first generation of American men to reach age 65 in the twentieth century, with data for later cohorts over 65 at the end of the century. Based on some standard indicators relating to respiratory problems, valvular heart disease, arteriosclerosis, and joint and back problems, the prevalence of unhealthy chronic conditions seemed to decline by 66 percent (averaged over the selected indicators) over the course of the twentieth century. These data are reassuring in that they suggest that when cultural influences can be minimized, it is possible to observe health improving despite the fact that reported morbidity may be increasing as well.

The third strategy is to embrace the health transition in all its implicit complexity. This involves accepting the idea that data on both perceived change and physiological change are equally real and equally relevant to health policy. It also accords equality to micro-level and macro-level research. Micro-level, localized research is best for understanding how ordinary people acquire the knowledge necessary to produce health on a daily basis at any level of income (given that their knowledge is applied in contexts that support or discourage certain attitudes and practices). Macro-level research involves all the impersonal forms of change that influence sickness and disease in all contexts. For example, public health can save lives without changing the knowledge and health-related behavior of ordinary people. Similarly, wars and famines can take lives that no amount of personal knowledge can save.

Conclusion

Doing justice to the health transition in its full complexity requires interdisciplinary research, but attempts at cooperation often are frustrated by the inability of experts from different fields to agree on conceptualization, research strategies, and measurement issues. Since demographers are not comfortable when research moves too far away from quantitative data and analysis, in all probability most will continue to use mortality data as a proxy for health trends and to treat the health transition as just another name for the mortality transition.

See also: *Caldwell, John C.; Disease, Burden of; Epidemiological Transition; Farr, William; Mortality Decline.*

BIBLIOGRAPHY

Caldwell, John. 1990. "Introductory Thoughts on Health Transition." In *What We Know about Health Transition: The Cultural, Social and Behavioral Determinants of Health,* ed. John Caldwall, Sally Findley, Pat Caldwell, Gigi Santow, Wendy Crawford, Jennifer Brand, and Daphne Broers-Freeman. Canberra: Australian National University Printing Service.

Cleland, John. 1990. "The Idea of the Health Transition." In *What We Know about Health Transition: The Cultural, Social and Behavioral Determinants of Health,* ed. John Caldwell, Sally Findley, Pat Caldwell, Gigi Santow, Wendy Crawford, Jennifer Brand, and Daphne Broers-Freeman. Canberra: Australian National University Printing Service.

Costa, Dora. 2000. "Understanding the Twentieth-Century Decline in Chronic Conditions among Older Men." *Demography* 37(2): 53–72.

Crimmons, E., Y. Saito, and D. Ingegneri. 1989. "Changes in Life Expectancy and Disability-Free Life Expectancy in the United States." *Population and Development Review* 15: 235–267.

Himes, Christine. 2000. "Obesity, Disease and Functional Limitation in Later Life." *Demography* 37: 73–82.

Horton, Richard. 1995. "Infection: The Global Threat." *New York Review of Books* April 6.

Johansson, Sheila R. 1991. "The Health Transition: The Cultural Inflation of Morbidity during the Decline of Mortality." *Health Transition Review* l: 39–68.

———. 1991. "Measuring the Cultural Inflation of Morbidity during the Decline in Mortality." *Health Transition Review* 2: 78–89.

———. 1996. "Doing 'Health' Research in an Unhealthy Research Environment." *Health Transition Review,* Supplement, 6: 371–384.

———. 2000. "Before the Health Transition: 'Health' and Health Policy in Victorian England and After." *Annales de Demographie Historique* 2: 109–132.

Manton, Kenneth, and Kenneth Land. 2000. "Active Life Expectancy Estimates for the U.S. Elderly Population: A Multidimensional Continuous-Mixture Model of Functional Change Applied to Completed Cohorts, 1982–1996." *Demography* 37(3): 253–265.

Murray, C., and L. Chen. 1992. "Understanding Morbidity Change." *Population and Development Review* 18: 481–503.

Murray, J. 2001. "Incentives and Absenteeism in Early Government Sickness Insurance Programs." Working Paper, Department of Economics, University of Toledo, Ohio.

Palloni, Alberto. 1989. *Sickness, Recovery and Death: A History and Forecast of Ill Heath.* Iowa City: University of Iowa Press.

———. 1990. "The Meaning of the Health Transition." In *What We Know about Health Transition: The Cultural, Social and Behavioral Determinants of Health,* ed. John Caldwall, Sally Findley, Pat Caldwell, Gigi Santow, Wendy Crawford, Jennifer Brand, and Daphne Broers-Freeman. Canberra: Australian National University Printing Service.

Riley, James. 1990. "Long Term Morbidity and Mortality Trends: Inverse Health Transitions." In *What We Know about Health Transition: The Cultural, Social and Behavioral Determinants of Health,* ed. John Caldwall, Sally Findley, Pat Caldwell, Gigi Santow, Wendy Crawford, Jennifer Brand, and Daphne Broers-Freeman. Canberra: Australian National University Printing Service.

Van de Walle, Etienne. 1990. "How do We Define Health Transition?" In *What We Know about Health Transition: The Cultural, Social and Behavioral Determinants of Health,* ed. John Caldwall, Sally Findley, Pat Caldwell, Gigi Santow, Wendy Crawford, Jennifer Brand, and Daphne Broers-Freeman. Canberra: Australian National University Printing Service.

Wilkinson, Richard. 1996. *Unhealthy Societies: The Affliction of Inequality.* London: Routledge.

S. Ryan Johansson

HENRY, LOUIS

(1911–1991)

Louis Henry was a French demographer who is considered the father of historical demography. Henry graduated from the Ecole Polytechnique in Paris in 1934 and served in the French army until 1945. In 1946 he joined the Institut National d'Études Démographiques (INED), which had been founded not long before that time by Alfred Sauvy (1898–1990), where he worked until his retirement in 1975. He also taught in many universities in France and abroad and was awarded a number of honorary doctorates.

Henry analyzed population trends in France and other European countries in the early postwar years for INED's journal *Population,* devising for that purpose improved tools of demographic analysis. That work led to an important treatment of interacting demographic phenomena ("D'un Problème Fondamental de l'Analyse Démographique," 1953) and to a book on marital fertility, *Fécondité des Marriages* (1953), in which he developed, in parallel with Norman Ryder in the United States, the concept of parity progression ratios, now a major tool of fertility analysis. Later his methodological innovations were brought together in *Démographie: Analyse et Modèles* (1972).

Henry also became interested in the level of fertility in populations in which birth control had not yet spread. He called such a regime "natural fertility." To find reliable evidence of such situations, he used data from the parish registers of pre-Revolutionary France (sixteenth through eighteenth centuries). The resulting analytical techniques, entailing "family reconstitution," were set out in a well-known manual, written with Michel Fleury, that was published in 1956. A pilot study of the village of Crulai in Normandy, a classic in historical demography, was published in 1958. In addition to analyses based on registration data, Henry made use of genealogical data.

The technique of family reconstitution from parish register data has been applied by countless historians in France and elsewhere. It took on even greater importance when it was used to reconstruct the total French population over the years 1670 to 1830. That project started in 1953, and the first aggregated results were published in a special issue of *Population* in 1975.

Those historical data also were used in the construction of models. Henry identified the key components of fertility (what later were termed the proximate determinants of fertility) and combined them in mathematical models to show how they result in age-specific or duration-specific marital fertility rates; he paid special attention to the analysis of birth intervals. His major papers on these issues have been translated into English (Henry 1972b).

Henry also developed models for nuptiality and various other analytical techniques.

See also: *Cohort Analysis; Demography, History of; Family Reconstitution; Historical Demography; Laslett, Peter; Ryder, Norman B.*

BIBLIOGRAPHY

SELECTED WORKS BY LOUIS HENRY.

Henry, Louis. 1953. *Fécondité des Mariages: Nouvelle Méthode de Mesure.* Paris: Institut National d'Études Démographiques.

———. 1967. *Manuel de Démographie Historique.* Paris: Librairie Droz, 1967.

———. 1972a. *Démographie: Analyse et Modèles.* Paris: Larousse. English translation: Edward Arnold, 1976; Spanish translation: University of Barcelona, 1976.

———. 1972b. *Selected Writings,* ed. Mindel Sheps and Evelyne Lapierre-Adamczyck. Amsterdam, New York: Elsevier.

SELECTED WORKS ABOUT LOUIS HENRY.

Fleury, Michel, and Louis Henry. 1956. *Manuel de Dépouillement et d'Exploitation de l'État Civil Ancien.* Paris: INED. Revised in 1965 and 1976.

Gautier, E., and Louis Henry. 1958. *La Population de Crulai: Paroisse Normande.* Paris: Institut National d'Etudes Démographiques.

Henri Leridon

HISTORICAL DEMOGRAPHY

It is conventional to draw a distinction between historical demography and demographic or population history. Historical demography, strictly defined, is the application of the array of conventional demographic methods to data sets from the past that are sufficiently accurate for analysis. Such data sets may take the form of vital records and censuses, but most frequently, particularly if produced before the nineteenth century (i.e., in *la période préstatistique*), would not have been created for the purposes of demographic enquiry. Parish registers, militia or tax lists, testamentary records, and genealogies have been the most prominent among the great variety of documentary sources used by historical demographers. Demographic history may subsume historical demography as a field of enquiry, but is more wide-ranging in its subject matter, being just as concerned with charting the impact of demographic processes on society and economy as on measuring and accounting for demographic change per se. For instance, demographic historians would be more interested in investigating the effects of massive demographic losses, such as the effects of the plague outbreaks in mid- fourteenth century Europe on the later medieval economy and values, or the consequences for New World civilizations of the introduction of Old World diseases into the Americas. Historical demographers would be more interested in tackling the technical problems of measuring and assessing the accuracy of estimates of the resulting mortalities associated with such catastrophic episodes or phases.

While the above definitional distinctions may seem clear cut, in practice the contrasts between the approaches and their practitioners can be quite muted. However, this discussion will not undertake a review of the history of demographic thought or techniques that form another set of considerations of demographic practice in the past. Most of the pioneering demographers who have been influential since the seventeenth century such as John Graunt, William Petty, Richard Cantillon, Johann Süssmilch, Adolphe Quételet, William Farr, Jacques Bertillon, Wilhelm Lexis, and Alfred Lotka were engaged in the development of technical means through which they could better understand the demography of their own times rather than developing a set of procedures for the study of specific demographic pasts. It will nonetheless be necessary to see how historical demography became integrated into the social sciences more generally and why a self conscious historical demography emerged in the quarter century after World War II.

Historical Development and the Role of Family Reconstitution

Historical demography secured a formal status first in France at the Institut National d'Études Démographiques (INED) where Louis Henry had begun research after World War II on contemporary fertility and fecundity. He was handicapped in his investigations of these matters since by the mid-twentieth century those states that collected the most reliable vital statistics possessed populations that were controlling their fertility and those that had what he termed "natural fertility" did not for the most part have well organized and accurate systems of vital registration. He was therefore drawn to records from the deeper European past.

First, Henry exploited genealogical sources of the Genevan bourgeoisie from the sixteenth to the seventeenth centuries and among other findings revealed that these families were already controlling their fertility using some form of birth control by the late seventeenth century. Subsequently in 1958, he made a truly path-breaking move when he used the events recorded in the parish register of the Normandy parish of Crulai to reconstruct the lives of the individual families resident in that community in the eighteenth century. The technique that he developed came to be known as family reconstitution and established a means of using data sets that had accumulated in the parochial registers of the Christian Church to calculate for the first time detailed and accurate measures of fertility, mortality, and nuptiality for the centuries that preceded state-based systems of census taking and vital registration.

Prior to Henry's innovation historical demography in the era that lacked censuses and vital registration had no obvious means of measuring demographic stocks and flows so essential for the calculation of crude and age-specific rates. Henry's method of reconstitution made it possible to devise a set of rules to determine the period of time during which a particular family might be regarded as under observation. The technique was quickly adopted and modified for work on English parish registers, which exist in large numbers from the late 1530s. E. A. Wrigley, an economic historian and geographer at Cambridge University, completed the first of these English studies on the Devon parish of Colyton in 1966. The findings from this study attracted much attention because it seemed that the parishioners of Colyton were limiting their fertility within marriage in the late seventeenth century and were also suppressing overall fertility by raising female marriage ages significantly.

In the subsequent three decades a large number of reconstitution studies from various European countries were completed using parish registers. The largest national samples still derive from France and England, but there are significant totals from Germany and a growing number from Spain and Scandinavia. One pervasive theme in these studies concerns the analysis of marital fertility. Levels of marital fertility proved to vary substantially even though the communities in question all displayed the characteristics of "natural fertility" (i.e., they showed no tendency toward parity dependent control or "stopping" behavior). For instance, marital fertility in Belgian Flanders was 40 percent higher than that of England in the eighteenth century, although the two regions are separated by only a few miles across the English Channel. Likewise marital fertility was almost 50 percent higher in Bavaria than it was in East Friesland in the eighteenth and nineteenth centuries. By enabling a comparison of the intervals between marriage and first birth with those between first and second birth, and comparison of inter-birth intervals following the birth of infants that died within the first year of life with those following births that survived at least through the first year of life, family reconstitution made it possible to conclude that the principal determinant of such fertility variations was the incidence and duration of breast feeding.

Family reconstitution also made it possible to scrutinize the findings of a seminal paper by John Hajnal on the distinctiveness of European marriage patterns. In the early phase of historical demography's emergence as a recognizable sub-discipline, the 1965 paper drew attention—principally on the basis of evidence in nineteenth century northern and western European censuses—to a marriage pattern characterized by late female marriage and a high proportion of women remaining permanently single. Such a pattern was apparently absent from all other major world regions. Family reconstitution allowed marriage ages to be calculated by linking individuals from their baptism to first marriage and showed that the geography of marriage sketched out by Hajnal had a deeper chronological presence and was detectable at least from the early seventeenth century and had not emerged as a result of social and economic changes downstream from or associated with rapid urbanization and industrialization after 1750.

Beyond Family Reconstitution and The Testing of Malthusian and Demographic Transition Theory

Family reconstitution provided remarkably detailed information about European populations in the *période préstatistique.* However, it was a technique that was not without certain shortcomings. It was extremely time-consuming to perform and required very well maintained parish registers to yield reliable results. Consequently even in relatively thoroughly researched settings such as England there are still fewer than 40 parishes out of some 10,000 that have been investigated demographically using this method; in France, a major project using family reconstitution overseen by Henry was based upon a sample of just one percent of 40,000 French rural parishes. The rules of family reconstitution result in the bulk of the demographic data accumulating around individuals who do not migrate and hence there is always the suspicion that the results might be biased toward the immobile, particularly in societies such as England with high rates of movement among parishes. This flaw also means that the demographic characteristics of highly mobile urban populations are far less well researched than those of rural and small town settings. But perhaps the most serious difficulty arises from the fact that family reconstitution does not make it possible to compute aggregate measures such as crude birth and death rates or indices of reproduction or natural increase. Searching for a solution to this problem loomed large in the research of the Cambridge Group for the History of Population and Social Structure in the 1970s and 1980s.

The Cambridge Group was the first center exclusively devoted to historical demographic research, notwithstanding the resources devoted to this field in Paris at INED and later in the École des Hautes Études en Sciences Sociales. In Cambridge the intellectual enquiry was principally energized by the desire to understand why the population in England had grown so much more rapidly over the eighteenth century than anywhere else in Europe. Family reconstitution, which had promised so much, could not provide a clear-cut answer to this highly significant question. Fundamentally a means was needed to provide information about population stocks that could be used to complement the data on flows that were provided by the events recorded in parish registers. A technique to accomplish this was devised in the late 1970s, initially termed "back projection" by James Oeppen, building upon pioneering work by Ronald D. Lee. The technique has been developed further and is known in the early twenty-first century as generalised inverse projection (GIP). The data requirements for the technique are not particularly demanding since only annual totals of births and deaths are needed, stretching backwards from a census of proven reliability—especially in accurately recording the death of persons at the very oldest ages. A valuable attribute of GIP is that all the estimates of demographic variables are constrained to be mutually consistent. GIP generates estimates of population totals and age structures at any earlier date, of fertility in the form of gross reproduction rates, estimates of expectation of life at birth and related sets of age-specific rates, and net migration rates. The technique has made it possible to generate long-run fertility and mortality series for England, Denmark, Scania, and Tuscany.

European countries vary considerably in the extent to which birth and death series may be assembled. For instance, in many Catholic countries the burials of children who died before they were of the age to receive communion were often not entered in the registers in the early decades of registration, making death series problematic. Such series have made it possible to test in specific contexts the applicability of the Malthusian model concerning the relationship between fertility and mortality and measures of per capita income. The English case has received most attention and as a result of the outputs from GIP it is possible to trace the size of the English population between the sixteenth and the nineteenth century and to compare it with a measure of real wages over the same period. Periods of rapid population growth were associated with significant declines in real wages. In fact, between 1541 and 1801 population growth rates up to 0.5 percent per annum did not reduce living standards, but once that rate was exceeded living standards fell. It is noteworthy that in the English case this economic-demographic relationship was disappearing just at the moment that T. R. Malthus published his famous *Essay* in 1798.

Not all of Malthus's predictions stand up to empirical testing. Real wages in England rose significantly between 1650 and 1750, but expectation of life at birth fell quite markedly. Fertility, driven by nuptiality changes, appeared to move much more consistently with real wages in the manner postulated by Malthus, particularly in his more optimistic second edition of the *Essay* published in 1803. In 1700 the English intrinsic population growth rate was very close to zero, but by the early decades of the nineteenth century the rate had risen to approximately 1.5 per cent, and over three-quarters of that growth could be attributed to a fall in the age of female marriage and a rising proportion ever married. Changes in marital and extra-marital fertility had little influence on the rate of population growth.

As a result of investigations of the kind carried out on the English demographic past historical demography moved to center stage in the debate over why the Industrial Revolution occurred and what its impact on demographic behavior had been. While this was a matter much discussed previously, it was not until historical demography had begun to generate reliable demographic data sets that economists acknowledged that the issues could be more clearly specified and historical economic-demographic relationships modeled formally.

Parish-register based demographic enquiry was only one strand in the demographic investigations of the Cambridge Group in the period from 1965 to 1985. Peter Laslett, the group's co-founder with Wrigley, pursued a linked enquiry into household and family demography and was concerned to construct patterns of household formation and population turnover. He came to realize that an essential correlate of late marriage in north-west European settings was the propensity of young adults to leave their natal hearths in their early- to mid-teens and to circulate as servants in the households of persons to whom they were generally unrelated, before marriage. At marriage they would for the most part establish nuclear households in communities where neither bride nor groom had been born. This feature was used by Hajnal to draw out a major contrast in the marital and household formation dynamics of historic and near contemporary societies distinguished by what he termed "north-west European household formation" rules and those in which "joint household formation" rules prevailed. The latter were distinguished frequently by early marriage of women who moved directly from their household of birth to that of marriage and in which sons tended to marry and co-reside patrivirilocally until household fission took place at a later point in time. Such research helped to justify a mode of enquiry in which demographic research was undertaken in conjunction with simultaneous investigation of family and social structure, ensuring strong disciplinary connections with historical sociology and anthropology.

As the quantity of research accumulated it became apparent by the 1980s that eighteenth and nineteenth century European demographic patterns were also noteworthy for their geographical variability. England and some other parts of Britain had rapid demographic expansion after 1750, but population growth in France was much more constrained, with fertility drifting down as life expectancy moved upward to sustain near zero-growth conditions. In contrast in Sweden, where mortality was far more volatile from year to year, fertility changed little, but demographic growth in the early nineteenth century resulted from a significant rise in life expectancy. The Swedish case is of particular interest since it appears to meet far more effectively the image of the pattern of long-term demographic change associated with classic demographic transition theory. Furthermore, because Swedish demographic data from the mid-eighteenth century had long been available, Sweden was erroneously used as a paradigm case. The innovations in the use of early data sets have, however, changed researchers' sense of the demographic landscape of what was for long deemed stage I of classic transition theory. This stage is assumed in pre-modern societies to be distinguished by high mortality and high natural fertility. The latter was viewed as varying little both regionally and through time.

Classic transition theory also emphasized the role played by industrialization and associated urbanization and its resulting improvements in well-being and medical science. These socioeconomic changes were seen as instrumental in shifting mortality away from a high plateau to lower and more stable levels and leaving fertility at pre-modern levels so that rapid demographic growth ensued, before fertility was adjusted downwards. The European Fertility Project, set up by Ansley Coale at Princeton University in 1963, investigated the fall in marital fertility in Europe from the late nineteenth century. Using evidence from early national census and civil registration offices, it confirmed that overall fertility was highly variable, reflecting major regional contrasts in nuptiality and marital fertility. Parish-register based research has subsequently shown that this feature extended back into the sixteenth and seventeenth centuries. Furthermore, the European Fertility Project also showed that there was a very limited correlation between the levels of economic development and living standards in European countries on the one hand and the resort to fertility control by their populations on the other. Such evidence from historical demographers working on the pre-transition and transition periods suggested that there was little to be gained by treating these epochs as distinct demographic systems and constituted a realization which drew historical demography more firmly within the larger fold of demographic practice.

Recent Developments and Future Preoccupations

The 1970s and 1980s marked a "golden age" of historical demographic research. While major issues that concern the characteristics of pre-transitional fertility and nuptiality and Malthusian theory still have pride of place in the sub-discipline, the subsequent years have seen a broadening of research interests and, particularly, research contexts. The West European center of gravity of early demographic research with its concentration upon nuptiality and Malthusian notions as a framework for understanding demographic dynamics has been challenged by a growth in research on non-European, particularly Asian, demographic regimes in the past and exploitation of household registers and genealogies as key demographic sources in such settings which, unless Christianized, lack parish registers. One theme, above all, has emerged suggesting that notwithstanding the prevalence in these areas of very early female marriage, population growth rates were generally no more rapid than those found in areas dominated by the European marriage regime. Extended breastfeeding, delayed starts to reproduction in marriage through spousal separation, abstinence, and abortion have been identified as means by which births were spaced out in China and Japan to produce total marital fertility rates that frequently fell below those found in Western Europe. Infanticide and child neglect often further constrained population growth. Researchers in these matters are now inclined to challenge a notion, prominent in the 1980s, that West European demographic growth rates were lower and more likely to have facilitated high savings levels, thereby facilitating longer term economic growth than would have been possible in areas of "joint household formation." A continued interest in further researching this theme is likely to dominate much future enquiry linking historical demography and the history of economic growth.

Use of population registers, both in East Asia and in some parts of Western Europe (in Sweden from 1750, in Netherlands, Belgium, and parts of Italy from the early- or mid-nineteenth century), is enabling a more sophisticated type of demographic research using event histories that make it possible to investigate demographic behavior both at the household and the individual level in a highly robust statistical fashion. However, the restricted geographical and chronological contexts within which this research method is feasible will likely limit the value of such research unless more effective means of creating longitudinal data sets can be achieved. Creation of such data sets would require linking censuses to the vital registration data that exist in large quantities for many societies both within and outside Europe from the beginning of the nineteenth century.

Research on mortality by historical demographers historically received far less attention than did investigations of nuptiality and fertility. Two highly distinctive positions dominated thinking on this topic: From the 1970s many argued that mortality was largely autonomous, being determined by the waxing and waning of epidemic disease and by climatic change, and was in no sense determined by human agency. Another argument claimed that mortality was largely determined by nutritional factors and only with the improvements in food supplies contingent upon rising agricultural productivity after 1750 did mortality decline as a result of growing resistance to infectious disease. British physician Thomas McKeown succeeded in promoting this latter view, particularly in medical circles.

Both positions regarding mortality in the past have been increasingly challenged as a result of growing realization that the inter- and intracontinental movements of population and the emergence of large metropolitan centers within emerging international trading systems had a major influence on levels of exposure and acquired resistance to infections—which in turn could lead to major changes in mortality levels, particularly among infants, children, and their mothers. Such influences were most likely responsible for the failure of model life tables based upon late-nineteenth and twentieth century population data to capture age-specific mortality patterns in historical populations. Those processes may also have been responsible for the existence of extended periods in the past when infant and child mortality could be seen to have worsened while the life chances of adults were static or improving.

Furthermore, McKeown's dismissal of the role of human intervention has been challenged by historians of public health who would argue that substantial declines in mortality arose from political interventions within urbanised societies in the late-nineteenth century that brought benefits to the poor as well as to the well nourished. New research on high and low status sections of European societies from the late Middle Ages has revealed very small differences in mortality levels and trends, especially after 1700 when adult life expectancies appear to have moved upward for all social status groups. There is growing evidence that adult female life expectancy in a substantial number of European countries has been moving upward in an unbroken fashion since about 1700 for all income groups.

Profitable research linking demographic patterns with anthropometric and paleodemographic investigation of skeletal remains and with data on human heights has been undertaken and there is considerable potential for more work of this kind over longer sweeps of time and in a variety of geographical contexts. The rising interest in adult mortality, particularly in declining mortality at the oldest ages, which is now regarded as the most dynamic demographic variable in many societies, has indirectly impinged on historical demography. Historical demographers are searching for more accurate measurements of change in that component as well as seeking to better understand the factors that may have influenced adult longevity. They are making use of the techniques of event-history analysis. This growth area of historical investigation is undoubtedly a refection of interest in contemporary demographic developments and once again reveals how greatly the orientation of research on the demographic past is determined by contemporary demographic concerns.

See also: *Ancient World, Demography of; Cities, Demographic History of; Demography, History of; Family Reconstitution; Hayami, Akira; Health Transition; Henry, Louis; Household Composition; Laslett, Peter; Malthus, Thomas Robert; Paleodemography; Peopling of the Continents; Population Thought, History of; World Population Growth.*

BIBLIOGRAPHY

Bengtsson, Tommy, and M. Lindstrom. 2000. "Childhood Misery and Disease in Later Life: The Effects on Mortality in Old Age of Hazards Experienced in Early Life, Southern Sweden, 1760–1894." *Population Studies* 54: 263–277.

Fleury, Michel, and Louis Henry. 1965. *Nouveau manuel de dépouillement et d'exploitation de l'état civil ancien.* Paris: Institut National d'Études Démographiques.

Fogel, Robert W. 1994. "The Relevance of Malthus for the Study of Mortality Today: Long-run Influences on Health, Mortality, Labour-force Participation and Population Growth." In *Population, Economic Development and the Environment*, ed. Kerstin Lindahl-Kiessling and Hans Landberg. pp. 231–284. Oxford and New York: Oxford University Press.

Gautier, Étienne, and Louis Henry. 1958. *La population de Crulai, paroisse normande: Étude historique.* Institut National d'Études Démographiques, Travaux et Documents, Cahier No. 33. Paris: Presses Universitaires de France.

Gutmann, M. P., and G. Alter. 1993. "Family Reconstitution and Event-History Analysis." In *Old and New Methods in Historical Demography,* ed. David Reher and R. Schofield. pp. 159–181. Oxford and New York: Oxford University Press.

Hajnal, John. 1965. "European Marriage Patterns in Perspective." In *Population in History: Essays in Historical Demography,* ed. David V. Glass and D. E. C. Eversley. pp. 101–145. London: Arnold, and Chicago: Aldine.

———. 1982. "Two Kinds of Pre-industrial Household Formation System." *Population and Development Review* 8: 449–484.

Haines, Michael R., and Richard H. Steckel, eds. 2000. *A Population History of North America.* Cambridge and New York: Cambridge University Press.

Henry, Louis. 1956. *Anciennes familles genevoises: Etude démographique XVIe-XXe siècle. Travaux et Documents,* Cahier No 26. Paris: Institut National d'Etudes Démographiques.

Johansen, H. C. 2002. *Danish Population History 1600–1939.* Odense: University Press of Southern Denmark.

Knodel, John E. 1988. *Demographic Behaviour in the Past: A Study of Fourteen German Villages in the Eighteenth and Nineteenth Centuries.* Cambridge, Eng., and New York: Cambridge University Press.

Landers, John. 1993. "From Colyton to Waterloo: Mortality, Politics and Economics in Historical Demography." In *Rethinking Social History: English Society, 1570–1920, and Its Interpretation,* ed. Adrian Wilson. pp. 97–127. Manchester and New York: Manchester University Press.

Laslett, Peter, and Richard Wall, eds. 1972. *Household and Family in Past Time: Comparative Studies in the Size and Structure of the Domestic Group over the Last Three Decades in England, France, Serbia, Japan, and Colonial North America, with Further Materials from Western Europe.* London and New York: Cambridge University Press.

Lee, James Z., and Wang Feng. 1999. *One Quarter of Humanity: Malthusian Mythology and Chinese Realities.* Cambridge, MA, and London: Harvard University Press.

Lee, Ronald D. 1974. "Estimating Series of Vital Rates and Age Structure from Baptisms and Burials: A New Technique with Application to Pre-industrial England." *Population Studies* 28: 495–512.

Lee, Ronald D., and M. Anderson. 2002. "Malthus in State Space: Macro Economic-demographic Relations in English History, 1540 to 1870." *Journal of Population Economics* 15: 195–220.

Livi-Bacci, Massimo. 1991. *Population and Nutrition: An Essay on European Demographic History.* Cambridge, Eng., and New York: Cambridge University Press.

McKeown, Thomas. 1976. *The Modern Rise of Population.* London: Arnold.

Oeppen, James. 1993. "Back Projection and Inverse Projection: Members of a Wider Class of Constrained Projection Models." *Population Studies* 47: 245–267.

Saito, Osamu. 1996. "Historical Demography: Achievements and Prospects." *Population Studies* 50: 537–53.

Wrigley, E. A. 1966. "Family Reconstitution." In *An Introduction to English Historical Demography from the Sixteenth to the Nineteenth Century,* ed. E. A. Wrigley. pp. 96–159. London: Weidenfeld and Nicholson; New York: Basic Books.

Wrigley, E. A., R. Davies, J. Oeppen, and R. S. Schofield. 1997. *English Population History for Family Reconstitution 1580–1837.* Cambridge, Eng., and New York: Cambridge University Press.

Wrigley, E. A., and R. S. Schofield. 1981. *The Population History of England 1541–1871: A Reconstruction.* Cambridge, MA: Harvard University Press.

———. 1989. *The Population History of England 1541–1871: A Reconstruction.* 1st paperback edition with new introduction. Cambridge, Eng., and New York: Cambridge University Press.

Richard M. Smith

HIV-AIDS

See *AIDS*

HOLOCAUST

The word holocaust, derived from a term used in an early Greek translation of the Old Testament meaning a religious offering completely consumed by fire, has had several distinct usages in English. Since the seventeenth century or earlier it had been used to refer to any mass slaughter or disaster. In the late 1940s the term "The Holocaust" started to be used to refer collectively to the calamity that befell all those targeted and victimized by Nazi oppression from 1933 to 1945, particularly Jews, Gypsies (more properly known as Roma), various Slavic population groups, and the victims of eugenic killing programs. In time, the term was increasingly used to refer to the policies and programs aimed at the extermination of particular population groups individually, notably European Jewry and the Roma.

Subsequently, the word has also been used to refer to genocides or other major human rights abuses directed against other population groups in other parts of the world and in various epochs. Finally, the term came to be used by some to refer to any kind of disturbance seen as significant to the user. In effect, this is a return to the word's general meaning prior to World War II.

This varied usage of the term "The Holocaust," no doubt fueled by the various personal and collective tragedies associated with such events, has given rise to a series of debates about the uniqueness of the events themselves (see, for example, Rosenbaum, 2001). Is "The Holocaust," referring to the experience of European Jewry or the Roma, unique? Does it differ in kind from what happened to others in World War II or from mass killings at other times? The answers to these questions are complex and often contentious. In an important sense every genocide is unique and warrants its own terminology. Thus the Hebrew word *Shoah* is often used to refer to the Jewish Holocaust and the Roma word *Porrajmos* to refer to the Roma Holocaust. (One of the first modern uses of the term "Holocaust" was in Israel in 1947 as an English translation of the word *shoah.*) On the other hand, the experiences of European Jews and Roma between 1933 and 1945 are classic examples of genocide under international law.

According to Raul Hilberg's authoritative 1985 account of the Jewish Holocaust, the Holocaust was an extended "destruction process" that consisted of several steps: "definition, expropriation, concentration, and annihilation." The same phased process was roughly followed in the persecution of European Roma, the other group targeted for destruction solely on "racial" grounds.

Direct Holocaust mortality—in the sense of deaths resulting from explicit state policies and programs—had four major components:

1. Those killed as a result of various euthanasia programs beginning in late 1939;
2. Those killed by the *Schutzstaffel* (S.S.)—directed mobile killing teams (called *Einsatzgruppen*) that operated just behind the front lines as the German army advanced into the USSR, Soviet-occupied Poland, and the Baltic countries beginning in June 1941;
3. Those killed as a result of planned starvation or overwork in ghettos and concentration camps or other forced labor situations; and
4. Those killed in extermination camps (i.e., facilities designed explicitly for mass killings, the first of which began operations in December 1941) and during mass transports to such camps.

Some writers, including Yahuda Bauer, do not consider the euthanasia program to be part of the Holocaust. In any case, in terms of magnitude, most Holocaust deaths can be directly attributed to the extermination camps and the *Einsatzgruppen.*

The Role of Population Science and Population-Related Programs in the Holocaust

Population science intersected with the Holocaust in several ways. These include: the contributions of population-related "science" in shaping concerns about Jews and other target populations, and in providing legal and technical support for conducting various facets of the Holocaust; the direct incorporation of population data systems in Holocaust operations; and the use of demographic data and analysis by the perpetrators and those acting on behalf of the victims to document Holocaust losses.

Population data and analyses, discussions of population policies, and eugenic principles (then considered a well-established element of population science) all contributed in important ways to the intellectual and ideological milieu from which the Holocaust sprang. Perceived population problems and policies focused both on declining fertility in Europe within the context of nationalism, and on the threats posed by other countries or by groups, such as the Jews and the Roma, who were seen as racially alien. Indeed, in Europe in the 1920s and

1930s, and particularly in Germany, the "Jewish problem"—for which the Holocaust became "the final solution"—was frequently defined as a population problem. Solutions to the Jewish problem were also expressed in large part in terms of population-related governmental actions: marriage and fertility restrictions, forced migration, and ultimately programs of mass killing.

The eugenics movement not only provided an intellectual rationale for considering certain population groups to be inferior, even less than human, but also provided examples of how "sound eugenic principles" could be implemented through governmental action. For example, the Nazis established a forced sterilization program in Germany within months of taking power, explicitly citing the eugenics-based forced sterilization laws of the United States as a model. By the late 1930s the Nazi government took up the call of two German scholars for the "destruction of life unworthy of life" by instituting eugenically-justified forced euthanasia.

In 1940 and 1941 the forced euthanasia program expanded in scope from child euthanasia to include adults, and its coverage successively widened from the most severely medically disabled to eventually include all those institutionalized people who were unable to do productive work or who were members of "unworthy" races. Stimulated by the logistical challenges of such an expanded program, its managers developed the technology of mass killing (gas and cremation) subsequently used in the extermination camps. Moreover, beginning in 1941 the Nazis directly transferred equipment and staff from the euthanasia program to assist the *Einsatzgruppen* killing teams and in the establishment of the extermination camps.

Even seemingly-benign sectors of the population field became involved in the effort. For example, individual institutions often initiated euthanasia operations under the guise of statistical investigations. Similarly, a range of population data systems, including population registration systems and regular population censuses, were used to assist in the general planning of the Holocaust in several countries, as well as in the identification and targeting of individuals and families for deportation and of neighborhoods for mob violence.

Estimating the Toll

Two sets of demographers were attempting to document the progress of the Holocaust even while it was underway. Richard Korherr, a German demographer on the staff of Heinrich Himmler—head of the German secret police and the S.S.—was secretly commissioned in late 1942 to assess the decline in the European Jewish population on behalf of the perpetrators. Quite independently, between 1942 and 1945 several Jewish demographers were producing independent estimates of Holocaust-related Jewish losses, which were largely ignored. Estimates of Holocaust losses also were part of the pleadings and judgments during the course of the International War Crimes trials beginning in 1945.

Subsequently, many Holocaust scholars, including some with demographic expertise, have attempted to refine estimates of overall losses. Efforts at mortality estimation continued in the 1990s, in connection with a new series of reparation claims. Given the substantial uncertainties of definition and measurement involved, however, none of them offers persuasive grounds to abandon the estimate of about six million Holocaust deaths—the number cited by the perpetrators at Nuremberg, independently developed by victim advocates at the time, and accepted by the Nuremberg Tribunal itself.

See also: *Genocide.*

BIBLIOGRAPHY

Aly, Götz. 1999. *"Final Solution": Nazi Population Policy and the Murder of the European Jews.* London: Arnold.

Bauer, Yahuda. 2001. *Rethinking the Holocaust.* New Haven, CT: Yale University Press.

Browning, Christopher R. 1992. *The Path to Genocide: Essays on Launching the Final Solution.* Cambridge, Eng.: Cambridge University Press.

Friedlander, Henry. 1995. *The Origins of Nazi Genocide: From Euthanasia to the Final Solution.* Chapel Hill: The University of North Carolina Press.

Gutman, Israel, ed. 1990. *The Encyclopedia of the Holocaust.* New York: Macmillan.

Hilberg, Raul. 1985. *The Destruction of the European Jews,* revised and definitive edition. New York and London: Holmes and Meier.

Rosenbaum, Alan S., ed. 2001. *Is the Holocaust Unique? Perspectives on Comparative Genocide,* 2nd edition. Boulder, CO: Westview Press.

Seltzer, William. 1998. "Population Statistics, the Holocaust, and the Nuremberg Trials." *Population and Development Review* 24(3): 511–552.

William Seltzer

HOMEOSTASIS

In the field of demography, the term *homeostasis* refers to the way in which populations control their long-term growth. Drawing on concepts of self-regulating systems in biology, demographic homeostasis usually is regarded as a phenomenon in which interrelated social, cultural, and economic institutions ensure that the long-term rate of population growth is close to zero. During the demographic transition of the last 200 years, there has been a huge expansion in the human population. In contrast, the centuries that preceded the transition were characterized by much more modest population growth. Thus, the study of homeostasis focuses primarily on the pre-transitional era. However, with the end of the demographic transition in sight during the twenty-first century, it is likely that homeostasis will become a topic of research interest in the future.

Terminology

For almost two centuries those trying to explain the nature of equilibrating mechanisms in populations have looked to the economist T. R. Malthus (1766–1834) for inspiration. Malthus proposed that competition between individuals is the basis of the equilibrating mechanism and that population balance can be arrived at through two possible means: the positive check of worsening mortality and the preventive check of reduced fertility.

The first edition of Malthus's *Essay* (1798), written in the style of a polemical pamphlet, with a limited exposition of theory and little supporting evidence, expressed this contrast with particular starkness and emphasized the positive check of mortality. Later, better-documented editions tended to stress the role of the preventive check through the mechanism of delayed marriage. In either case the model remained austere, with total population size being the key regulating element. Thus, the Malthusian model often is referred to as being based on density dependence. Because it includes mechanisms by which countervailing forces work to keep a population in balance with its resource base, it sometimes is characterized as showing negative feedback. Both density dependence and negative feedback are features of population control systems that can be described as homeostatic. In fact, these terms are used so interchangeably in the context of population dynamics that they can be regarded as near synonyms.

There are two forms of evidence that suggest the existence of homeostatic mechanisms in human populations: the fact that observed growth has been near zero over most of human history and detailed assessments of the observed strength of homeostatic forces.

Slow Growth

Although the nineteenth and twentieth centuries saw a remarkable growth in human numbers (especially since around 1950), population growth over the greater part of human history must have been very close to zero. In light of the long duration of human prehistory, growth must have been close to zero during the Paleolithic era. Even the expansion of human numbers that took place with the development of agriculture, starting about 10,000 years ago, involved only marginally higher growth rates. As Joel E. Cohen puts it, "Before the several local inventions of agriculture, local human populations grew at long-term rates just above zero. Where agriculture was invented, local human populations grew ever so slightly faster" (Cohen, p. 32). However, events that occurred during this period cannot be quantitatively documented.

Although it most likely never will be possible to make reliable estimates of world population size before the last 200 years or so, there are some populations in which the ratio of facts to deductive reasoning is sufficiently favorable to make tolerably robust estimates of population growth for the last 2,000 years. The best documented of these cases are Europe and China, both of which show periods of growth, decline, and stagnation at various times during the last two millennia. Until the relatively recent past, however, even episodes of growth took place at modest rates compared with modern experience, and the growth rate over the very long run was extremely low. For example, the average annual growth rate in China from 2 to 1500 C.E. was in the neighborhood of 0.03 percent.

That long-term stability partly masks shorter-term fluctuations. In addition to explaining the factors leading to very slow growth, models of population change must consider the fluctuations. However, it is not easy to distinguish the cultural, economic, political, and environmental causes of such swings. Analyses of fluctuations in both European and Chinese history now generally emphasize nondemographic factors such as the degree of political stability and climatic change. In many cases periods of growth appear to be associated with eras of political stability, whereas times of generalized social unrest saw population declines. Possibly the most sophisticated analysis of this phenomenon is found in C. Y. Cyrus Chu and Ronald D. Lee (1994), who used data for China. Similarly, in Europe the demise of the Western Roman Empire appears to have been associated with a long-term decline in population size.

In contrast to the slow growth of settled populations, the potential for rapid growth clearly exists for all populations but seems to be realized only in some circumstances. In particular, rapid growth in pre-transitional populations appears to be restricted to places and eras where a population was able to settle new territory that previously was either not settled or thinly settled. Such expansions often were associated with the spread of alternative forms of farming or other technological innovations that allowed more effective exploitation of natural resources. A variation on this situation occurred in areas where catastrophic mortality from diseases introduced by new settlers devastated the indigenous population, effectively rendering the land thinly settled (Crosby 1986).

Tests of Homeostasis

Malthusian ideas and terminology are so widely employed in describing both long- and short-term population movements that it is common to find them used routinely in both historical and contemporary discussions of economic-demographic relations. However, the strength of these simple density-dependent mechanisms rarely has been tested for human populations. With European historical data, researchers are in a position to do this. Using European data, Lee (1987) has concluded that only a very small proportion (0.5 percent) of year-to-year changes in settled agricultural populations can be attributed to simple density-dependent mechanisms.

On a short-term basis this means that homeostasis is overwhelmed by a multitude of other factors. However, as Lee goes on to note, "It is essential to realise that as long as there is any trace at all of density dependence, no matter how weak, this tug, by its systematic persistence, comes to dominate human population dynamics over the long run, if not the short" (Lee 1987, p. 452). Thus, homeostatic mechanisms can be seen to operate in a long-term perspective, but they do this through such complex and indirect pathways that their effects are difficult to detect.

Socioeconomic Mechanisms

The potential for population growth must have been kept in check by powerful forces at most times. One potential force is, of course, high mortality and there is certainly evidence of spectacular mortality crises in the historical record. The return of bubonic plague to Europe in the middle of the fourteenth century, for example, is thought to have killed around a third of that continent's population. Even more dramatically, the arrival of Europeans in the Americas, Australia, and the Pacific islands led to the demographic collapse of indigenous populations. Such disasters may be attributed largely to the introduction of new diseases and the occurrence of so-called virgin-soil epidemics (Crosby 1986). However, they also may indicate the effects of the collapse of one form of social order and its replacement with another and even deliberate genocide.

In spite of the dramatic nature of such crises and their undoubted importance in the historical demography of the Americas, Australia, and the Pacific islands, it is not clear how significant events of this kind have been in regard to long-term demographic change in general. Historical evidence from Europe and Asia mostly indicates less extreme mortality and much less extreme fluctuations in population size, suggesting that control over fertility and opportunities for migration were more significant than was catastrophic mortality (Liu et al. 2001, Livi-Bacci 1993). The most persuasive interpretation of the data on long-term population growth, therefore, would seem to be that human societies developed regulatory mechanisms that kept long-run population growth rates close to zero.

The best-documented examples of these mechanisms come from Western Europe and East Asia. Although there was considerable local and regional variation in the nature of pretransitional demographic regimes, the overall range of experience seems broadly similar in the Asian and European populations that have been studied to date. Total fertility generally was in the range of four to six children (i.e., well below any theoretical maximum), whereas life expectancy at birth ranged between 20 and 40 years.

Although the overall ranges of mortality and fertility in Asian and European populations had much in common, that cannot be said for their social, economic, and cultural contexts. Different patterns of social behavior, as well as differences in ecological factors, disease environments, and political stability, shaped the demographic equilibriums, and both fertility and mortality were subject to different sets of determinants. For example, Asian marriage patterns generally bore no relation to the so-called West European model, in which both men and women married late and many people remained single. Similarly, deliberate infanticide, which was almost unknown in Europe, played a visible role in some parts of Asia. Patterns of sex-specific mortality also differed markedly between Western Europe and parts of Asia.

In all cases, however, it is clear that extensive systems of demographic and economic interaction and elaborate social conventions shaped the process of reproduction. Moreover, in addition to social norms, individuals and couples thought about and took action that affected their childbearing. This seems to be especially evident in China, where there is a long history of collective intervention in demographic matters of various kinds, including fertility. Thus, Zhongwei Zhao notes, "As early as the Tang (618 to 907 AD) and Song (960 to 1279 AD) periods, ideas and practice of limiting family size were already discussed and recorded in the works of some scholars" (Zhao, p. 214).

Origins

Consideration of these matters inevitably raises the question of how the institutions that underpin homeostasis arise and are sustained. Within demography there are two main schools of thought. One, which is found in the work of E. A. Wrigley (1978), stresses the role of unconscious rationality in generating homeostatic patterns. In this way of thinking, just as the "invisible hand" of classical economics guides markets even when individuals are unaware of its presence, analogous forces steer social arrangements toward homeostatic equilibriums. The second school, most succinctly presented by Ron Lesthaeghe (1980), gives greater emphasis to conscious "short-term goal setting" on the part of the elite groups that set the prevailing moral guidelines and controlled the economic bases of society. According to this line of reasoning, these institutions are best seen as instruments of social control, and the equilibrating mechanisms also are viewed as methods of social differentiation.

An approach to the question of origins that links individuals and populations and has been influential in anthropology in recent years is the Darwinian evolutionary perspective, as seen in the work of Laura Betzig and her colleagues (1988). This approach draws on modern evolutionary ideas of "inclusive fitness" and "kin-selection" to investigate the role of evolutionary forces in determining human fertility patterns. A problem with a Darwinian approach is the manifestly Lamarckian nature of much cultural transmission, in which acquired characteristics are transmitted just as easily as inherited characteristics are. An unanswered question is how social institutions that favored low growth or homeostasis could have evolved in the absence of "group selection." As James W. Wood states, "It is very unlikely that special behavioral and institutional mechanisms have evolved *in order* to restrain population growth or regulate population size. But that does not mean that factors do not exist that have that effect, even if it is not the reason for their existence"(Wood, p. 101).

Alternatives

In contrast to Malthus's ideas of negative density dependence, Ester Boserup (1965, 1981) proposed that increasing population density stimulated technological progress in pre-transitional populations, leading to positive density dependence. Her ideas have been synthesized with those of Malthus by Lee (1986), who shows that both can be accommodated within a wider model of the interaction between population and economic growth. Lee's ideas have been developed by Wood (1998), who generalizes the "Malthus and Boserup model" to deal with a broad definition of well-being and explicitly considers the question of variance and population heterogeneity.

See also: *Demographic Transition, Evolutionary Demography; World Population Growth.*

BIBLIOGRAPHY

Betzig, Laura, Monique Borgerhoff Mulder, and Paul Turke, eds. 1988. *Human Reproductive Behaviour: A Darwinian Perspective.* Cambridge, Eng., and New York: Cambridge University Press.

Boserup, Ester. 1965. *The Conditions for Agricultural Growth: The Economics of Agrarian Change under Population Pressure.* Chicago: Aldine.

———. 1981. *Population and Technological Change: A Study of Long-Term Trends.* Chicago: University of Chicago Press.

Chu, C. Y. Cyrus, and Ronald D. Lee. 1994. "Famine, Revolt and the Dynastic Cycle: Population Dynamics in Historic China." *Journal of Population Economics* 7: 351–378.

Cohen, Joel E. 1995. *How Many People Can the Earth Support?* New York and London: Norton.

Crosby, Alfred W. 1986. *Ecological Imperialism: The Biological Expansion of Europe, 900–1900.* Cambridge, Eng., and New York: Cambridge University Press.

Galloway, Patrick R. 1986. "Long Term Fluctuations in Climate and Population in the Pre-Industrial Era." *Population and Development Review* 12: 1–24.

Lee, Ronald D. 1986. "Malthus and Boserup: A Dynamic Synthesis." In *The State of Population Theory: Forward from Malthus,* ed. David Coleman and Roger S. Schofield. Oxford and New York: Blackwell.

———. 1987. "Population Dynamics of Humans and Other Animals." *Demography* 24: 443–465.

Lesthaeghe, Ron. 1980. "On the Social Control of Human Reproduction." *Population and Development Review* 6: 527–548.

Liu, Ts'ui-jung, et al., eds. 2001. *Asian Population History.* Oxford and New York: Oxford University Press.

Livi-Bacci, Massimo. 1993. *A Concise History of World Population.* Oxford and New York: Blackwell.

Malthus, T. R. 1990. *An Essay on the Principle of Population,* (1798) ed. Patricia James. Cambridge, Eng., and New York: Cambridge University Press.

Wood, James W. 1998. "A Theory of Preindustrial Population Dynamics: Demography, Economy and Well-Being in Malthusian Systems." *Current Anthropology* 39: 99–135.

Wrigley, E. A. 1978. "Fertility Strategy for the Individual and the Group." In *Historical Studies of Changing Fertility,* ed. Charles Tilly. Princeton, NJ: Princeton University Press.

Zhao, Zhongwei. 1997. "Demographic Systems in Historic China: Some New Findings from Recent Research." *Journal of the Australian Population Association* 14: 201–232.

Chris Wilson

HOMICIDE AND SUICIDE

Homicide and suicide are significant public health problems that entail heavy social and economic costs. Intentional violence, self-directed and directed at others, was estimated by Christopher J. Murray and Alan D. Lopez to account in 1990 for 2.7 percent of the world's loss of disability-adjusted life years (DALYs), projected to rise to 4.2 percent in 2020.

In 1990, according to World Health Organization (WHO) data, the age-standardized suicide rate per 100,000 persons in 48 countries averaged 15.6 for males and 5.7 for females. Male rates ranged from a high of 52.2 in Hungary to a low of 0.1 in Egypt, and female rates from 17.5 in Sri Lanka to 0.5 in Bahrain. At roughly the same point in time, age-standardized homicide death rates ranged from 1 to 2 per 100,000 in most Western European countries to 9.9 per 100,000 in the United States and nearly 20 per 100,000 in Brazil and Mexico. The distributions used for age standardization are not dissimilar, and so the homicide and suicide death rates are roughly comparable. Although homicide mortality and homicide offender rates are conceptually different, they are often used interchangeably.

Suicide and especially homicide are of special interest insofar as they concern young persons. In virtually all societies the peak age of homicide mortality and commission lies in the range of 18 to 29 years, whereas the peak occurrence of suicide mortality is among the elderly. It is therefore of concern that in many countries, over time, the youth advantage (over the elderly) in terms of suicide rates has weakened and the youth disadvantage in terms of homicide rates has become more pronounced. Because other forms of mortality are low at young ages (in developed countries), suicide and homicide account for a large proportion of all young lives lost.

Suicide

Theories to explain national differences in suicide rates are biological, psychological, or social. The first seem to hold little water because of the huge cross-national variation in basic parameters such as the male–female suicide ratio. In most countries the male suicide rate exceeds the female; China appears to be the one significant exception. One reason that male suicide rates exceed female rates is that males of all ages are likely to choose more lethal methods of self-destruction. A venerable psychological theory holds that both suicide and homicide result from an undifferentiated violent impulse that is turned inward or outward, depending on social conditions. However, if this is so, one would expect suicide and homicide rates to be inversely correlated in an international cross section, whereas they are not.

This leaves social theory, in which the work of the sociologist Emile Durkheim continues to leave a heavy imprint. In basic Durkheimian theory suicide increases as social integration and social regulation—the extent to which behavior is governed by the group—decrease. More generally, Durkheim's hypothesis was that suicide rates vary inversely with the degree of involvement in social life. Subsequent researchers emphasized the impact of social status, which weakens external restraints and thus might be expected to be positively related to the propensity to kill oneself, and the virtuous role of "status integration," or the absence of role conflict. Suicide rates are positively correlated with gross domestic product (GDP) per capita in an international cross section; it might be argued that this is consistent with the Durkheimian hypothesis and its later elaborations. However, there is no correlation between the rate of economic growth in preceding decades and the suicide death rate even though one might expect rapid growth to be associated with the weakening of restraints and accelerated role change.

Differences in national suicide rates are large and stable over time. The most striking international pattern is that suicide rates in Muslim and Catholic countries are significantly lower for both men and women. Immigrants tend to retain the suicide rates of the country of origin. In the United States, Hispanic suicide rates are lower than European-American rates; the reasons cited include a greater role for the extended family, the Catholic religion, and fatalism. The suicide rate among African Americans is also lower than that among European Americans, a difference that has been variously ascribed to greater religiosity and the stronger role of the extended family among African Americans.

Suicides among elderly people are characterized by depression, often associated with acute or chronic illness and/or the loss of a spouse or companion. Another characteristic of elderly suicides is the high ratio of successful to attempted suicides. In most developed countries elderly suicide rates declined between the mid-1980s and mid-1990s after an increase in many of them in the previous decade.

This decline in elderly suicide stands in contrast to the trend in suicides among the young. In the United States age-specific suicide rates among adolescents and young adults (age 15 to 24) tripled between 1950 and 1995. Some of this increase may reflect greater willingness to label self-inflicted deaths among the young as suicide; however, there is little doubt that the data reflect a real phenomenon. As the young have fared worse than the old, males have fared worse than females. Whereas male suicide rates rose in most countries between 1970 and 1984, female suicide rates remained stable.

Homicide

Although experts dispute the particulars, there is little doubt that there has been a massive long-term decline in the prevalence of lethal interpersonal violence. Whereas homicide in advanced nations is largely confined to the poor, in premodern societies it was equally common over the entire social spectrum. The proposed explanation is that as development and modernization proceed, legal means of resolving disputes become available to those who have the resources to pursue them. In some countries declining homicide rates may be related to the long-term decline in the use of alcohol. Data for European countries for the period 1950–1995 show a strong positive relationship between alcohol sales and the homicide rate, with a greater impact on male than on female homicide. The association was especially strong in Northern Europe, with its culture of binge drinking.

Current theories of homicide stress the role of poverty. International cross-sectional analysis shows that homicide rates are positively correlated with the degree of income inequality, with the relationship strongest in wealthy democracies. This lends support to the relative deprivation theory of homicide, in which aggression is held to be spurred by a sense of frustration and relative poverty. A related result is that homicide rates are inversely correlated with the strength of welfare state institutions. Whereas in the United States the entry of the baby boom cohorts into adolescence during the 1960s was clearly reflected in rising aggregate homicide rates, the same compositional effect was not observed in the welfare states of Western Europe. However, work in the United States has shown that the statistical correlation between poverty and homicide persists even when measures of access to social capital, a variable not entirely distinct from the strength of the welfare state, are taken into account. There is also evidence, both from cross-sectional European studies and from U.S. time series that homicide mortality is linked to the weakening of traditional family structures.

Because its homicide rate is so high, the United States has been the focus of special attention. In the United States in 1990 the African-American homicide crude death rate was 38.8 per 100,000, the Hispanic-American crude rate was 15.5, and the European-American crude rate was 5.7. Roughly speaking, the trend in age-standardized U.S. homicide rates was a decline from the 1930s until the 1960s, followed by a rise until the 1990s and then a decline to levels not seen since the 1960s. Increases during the 1960s apparently reflect, in part, an effect by which relatively large cohorts of young persons experience higher homicide mortality than do relatively small ones. This would be consistent with the work of economist Richard Easterlin, who argues that relatively large cohorts fare worse along many dimensions than relatively small ones. The dramatic increase in U.S homicide rates during the 1980s and the equally dramatic decline during the 1990s were closely tied to gun deaths among black teenage males and the crack cocaine epidemic.

Homicide, Suicide, and Firearms

Much of the public health literature on homicide and suicide is concerned with the role of firearms, especially handguns. Studies relating gun control laws to homicide and suicide rates in the United States have tended to be inconclusive because the link between the legal regime and the actual prevalence of firearms is not strong either temporally or in cross section. International cross-sectional data, however, clarify the relationship. Firearm-related suicide and homicide rates vary markedly among countries, as do the proportions of homicide and suicide rates accounted for by firearms. The rate of household gun ownership is positively related to the gun-homicide death rate as well as to the proportion of homicides committed with a gun, and the corresponding correlations are even more significant for suicides. There are no inverse correlations between household gun ownership and the non-gun homicide and suicide death rates; that is, there are no offsetting substitution effects by which lower gun ownership might be associated with higher non-gun violent death rates. In cross-sectional international data, there is a significant positive correlation between firearm prevalence and the male youth suicide rate and an extremely strong correlation between firearm prevalence and the firearm youth suicide rate for males as well as females. In general, firearms accounted for a much higher proportion of male youth suicides than female youth suicides.

Conclusion

Homicide and suicide are not leading causes of death; however, they rank high on the list of causes of young persons' deaths. As an important source of potentially avoidable mortality, they merit close study by demographers, epidemiologists, public health experts, and others concerned with population health.

See also: *Crime, Demography of; Infanticide.*

BIBLIOGRAPHY

Blumstein, Alfred, Frederick P. Rivara, and Richard Rosenfeld. 2000. "The Rise and Decline of Homicide—and Why." *American Review of Public Health* 21: 505–541.

Cooney, Mark. 1997. "The Decline of Elite Homicide." *Criminology* 35(3): 381–407.

Johnson, Gregory R., Etienne G. Krug, and Lloyd B. Potter. 2000. "Suicide among Adolescents and Young Adults: A Cross-National Comparison of 34 Countries." *Suicide and Life-Threatening Behavior* 30(1): 74–92.

Killias, Martin. 1993. "International Correlations between Gun Ownership and Rates of Homicide and Suicide." *Canadian Medical Association Journal* 148(10): 1721–1725.

Krahn, Harvey, Timothy F. Hartnagel, and John W. Gartrell. 1986. "Income Inequality and Homicide Rates: Cross-National Data and Criminological Theories." *Criminology* 24(2): 269–295.

Krug, Etienne G., K. E. Powell, and L. L. Dahlberg. 1998. "Firearm-Related Deaths in the United States and 35 Other High- and Middle-Income Countries." *International Journal of Epidemiology* 27: 214–221.

Lester, David. 1997. "Suicide in an International Perspective." *Suicide and Life-Threatening Behavior* 27(1): 104–111.

MacKellar, F. Landis, and Masako Yanagasita. 1995. "Homicide in the U.S.: Who's at Risk?" *Population Trends and Public Policy* 21: 1–20.

Messner, Steven E., and Richard Rosenfeld. 1997. "Political Restraint of the Market and Levels of Criminal Homicide: A Cross-National Application of Institutional Anomie Theory." *Social Forces* 75(4): 1393–1416.

Murray, Christopher J., and Alan D. Lopez. 1996. *The Global Burden of Disease.* Cambridge, MA: Harvard University Press.

O'Brien, Robert, Jean Stockard, and Lynn Isaacson. 1999. "The Enduring Effects of Cohort Characteristics in Age-Specific Homicide Rates, 1960–1995." *American Journal of Sociology* 104(4): 1061–1095.

Pampel, Fred C., and Rosemary Gartner. 1995. "Age Structure, Socio-Political Institutions, and National Homicide Rates." *European Sociological Review* 11(3): 243–260.

Pampel, Fred C., and John B. Willamson. 2001. "Age Patterns of Suicide and Homicide Mortality Rates in High-Income Nations." *Social Forces* 80(1): 251–282.

Pearson, J. L., Y. Conwell, J. Lindesay, Y. Takahashi, and E. D. Caine. 1997. "Elderly Suicide: A Multinational View." *Aging and Mental Health* 1(2): 107–111.

Range, Lillian M., Mark M. Leach, Daniel McIntyre, Pamela B. Posey-Deters, Michelle S. Marion, Stacey H. Kovac, James H. Baños, and Joseph Vigiln. 1999. "Multicultural Perspectives on Suicide." *Aggressive and Violent Behavior* 4(4): 413–430.

Rosenfeld, Richard, Steven E. Messner, and Eric P. Baumer. 2001. "Social Capital and Homicide." *Social Forces* 80(1): 283–309.

Rossow, Ingeborg. 2001. "Alcohol and Homicide: A Cross-Cultural Comparison of the Relationship in 14 European Countries." *Addiction* 96(Supplement 1): S77–S92.

Stafford, Mark C., and Ralph A. Weisheit. 1988. "Changing Age Patterns of U.S. Male and Female Suicide Rate, 1934–1983." *Suicide and Life Threatening Behavior* 18(2): 149–163.

F. Landis MacKellar

HOUSEHOLD COMPOSITION

The United Nations Statistics Division defines a household as a residence unit that consists of one or more persons who make common provision for food and other essentials for living. Unlike a family, which comprises only persons related through blood, adoption, or marriage, a household may include members who are not related. While different concepts of household are sometimes adopted, the United Nations definition is widely used for both data collection and demographic research.

The household is one of the most important human socioeconomic institutions, with functions that vary both across regions and over time. In many historical populations, a household was not only a residence group but also a socioeconomic unit within which production, consumption, reproduction, early childhood socialization, and many other activities took place. Many of these functions are still important in contemporary households. It is this multifaceted character that makes the household an appealing subject of study to many social scientists.

Household composition is a description of the household according to certain characteristics of its membership, such as age, relationship to the head of the household, and number of marital pairs or nuclear families it contains. (A nuclear family is a married couple, or a couple—or a single parent—together with unmarried offspring.) In addition to indicating the household structure, these descriptions are useful in revealing why such residence groups are formed in a particular way, how they function in the society, and their socioeconomic consequences.

The investigation of household composition generally uses data from population censuses or sample surveys. In historical studies, census-type materials such as lists of inhabitants or household registers are frequently used. Family reconstitution data and genealogical records shed light on potential residential patterns, but they do not usually include information on household composition.

Historical research on household composition progressed rapidly in the second half of the twentieth century, and studies show remarkable variations in household composition prior to the twentieth century. As pointed out by John Hajnal and others, households in northwest Europe (encompassing the British Isles, the Low countries, German-speaking areas, northern France, and Scandinavia including Iceland but excluding Finland) were generally between four and five persons in size, included in most cases a single nuclear family, and rarely any more distant relatives, but might have non-relatives present. In eastern and southern Europe, in contrast, scholars have noted that it was common for the newly married to live with the parents of one of the spouses, and an appreciably higher proportion of households consisted of two or more married couples. In some Asian populations (e.g. China, India, Japan) the proportion of complex households—defined as those with one nuclear family plus other relatives or other nuclear families—was also considerably higher than in northern and western Europe.

Significant changes in household composition have taken place in many developed countries since the late nineteenth century. As a general trend, the household has become simpler in structure and smaller in size. In England, for example, between 1891 and 1981 the proportion of complex households fell from above 15 percent to less than 5 percent, and the proportion of single-person households increased from 7 percent to 22 percent. During the later part of this period, nonmarital cohabitation also rose rapidly: by the late 1980s, nearly a quarter of women aged 20 to 24 lived in such households. In Sweden, proportions of single-person households and of households comprising cohabiting couples were even higher. Similar changes were observed in most developed countries. The result of these trends has been a continual shrinkage in the average size of households, from around five persons per household at the end of the nineteenth century to two to three persons per household at the end of the twentieth century.

The transition in household composition has been directly related to the following factors. First, there has been a considerable change in people's reproductive behavior. During the twentieth century, in particular its second half, the proportion of women remaining childless increased and the level of fertility of those having children decreased. In many developed countries, the total fertility rate fell to well below the replacement level. As a result, the average number of children present in a household is much lower than in the past. Second, there has been a significant change in people's attitude toward marriage. Since the mid-twentieth century, nonmarital cohabitation has been increasingly accepted by society. Divorce has become far more common, and there is less stigma attached to remaining single. All these changes contribute to the increase in single-person households, one-parent households, and consensual unions. Thirdly, there is also a noticeable decrease in propensities for coresidence between parents and their married children, and between nuclear family members and their distant relatives. Before the twentieth century, the proportion of complex households formed through such relationships was around 10 to 20 percent in England, and higher than this in many other countries; living arrangements of this kind were rare by the beginning of the twenty-first century. This change is partly a result of higher income levels and, among the elderly, improved health, allowing more people to live alone and independently when such an arrangement is preferred.

Similar trends have been found in some less-developed countries. In China and South Korea, for example, household size has also become smaller and its structure simpler in recent years. But the change in household composition in most less-developed countries has been slow and the pattern of change less clear. John Bongaarts found that in the 1990s, household size and composition in many of these countries were markedly different from those recorded in the developed countries, but similar to those observed in the second half of the nineteenth century in Europe and North America. As far as household size is concerned, the world is still very diverse: Average household size ranges from seven persons in Algeria and Oman to just above two persons in Sweden. In most of the less-developed countries, the average size of households is still between four and seven persons.

Examining household composition can reveal much about a society, but its limitations should not be ignored. The composition of a household identified from cross-sectional data is only a snapshot taken at a particular point in the process of household development. The dynamics of this process need to be studied to understand the household formation system and its outcomes. Furthermore, households are not socially isolated but exist within broader networks of kin and other social ties. Although the household is a fundamental unit, many socioeconomic activities take place in a wider context (e.g., a lineage or a group of kin-related households). Knowledge of these wider networks is important for a full understanding of household formation and composition.

See also: *Family: History; Family Life Cycle; Historical Demography; Laslett, Peter.*

BIBLIOGRAPHY

Bongaarts, John. 2001. "Household Size and Composition in the Developing World in the 1990s." *Population Studies* 55: 263–279.

Hajnal, John. 1983. "Two Kinds of Pre-Industrial Household Formation Systems." In *Family Forms in Historic Europe,* ed. Richard Wall, Jean Robin, and Peter Laslett. Cambridge, Eng.: Cambridge University Press.

Laslett, Peter. 1983. "Family and Household as Work Group and Kin Group: Areas of Traditional Europe Compared." In *Family Forms in Historic Europe,* ed. Richard Wall, Jean Robin, and Peter Laslett. Cambridge, Eng.: Cambridge University Press.

Lesthaeghe, Ron. 1995. "The Second Demographic Transition in Western Countries: An Interpretation." In *Gender and Change in Industrialized Countries,* ed. Karen Oppenheim Mason, and An-Margritt Jensen. Oxford: Clarendon Press.

United Nations. 1998. *Principles and Recommendations for Population and Housing Census (Revision 1).* New York: United Nations.

Wall, Richard. 2001. "The Transformation of the European Family across the Centuries." In *Family History Revisited: Comparative Perspectives,* ed. Richard Wall, Tamara Hareven, and Joseph Ehmer. Newark: University of Delaware Press.

Zhongwei Zhao

HUMAN ECOLOGY

Ecology in its most inclusive sense is the study of the relationship of organisms or groups of organisms to their environment. It perceives all life as a system of relationships that has been called the "web of life," of which every species forms a part. Human ecology is a branch of general ecology. It holds the view that humans, like all other organisms, are related to each other on the basis of a "struggle for existence" in an environment with finite limitations for supporting life. Struggle includes all activity (whether in competition, conflict, or cooperation) to survive and reproduce within these constraints.

Like every other species, humans must find a niche in their largely self-constructed web of life in order to gain a livelihood. In doing so they must make use of the resources and submit to the constraints imposed by the environment in which they find themselves. Unlike classical economics, which tends to view this process as one of individual adaptation, human ecologists insist on adaptation as a group: a collective phenomenon in which the main players are households, families, neighborhoods, and communities.

Environment

The environment is a sweeping concept that is defined to include all forces and factors external to an organism or group of organisms. The organism is responsive to the environmental conditions that are relevant to its needs and makes use of its existing technology. However, since the environment exists independently of any individual or species, it has no propensity to favor the needs of one organism or group of organisms (including humans) in preference to others. Consequently, in the short run humans must adapt to the conditions of the existing environment. In the long run they may modify ("build") the environment in ways that make life more secure and enjoyable. This too is a type of adaptation.

Because humans have genetic mental and physical capabilities for adaptation that far exceed those of any other animal, they are able to devise tools to assist in the exploitation of the environment in their struggle for survival. Furthermore, they have an unmatched ability to store past experience in memory and in a variety of records and possess a constructive imagination to guide their adaptive efforts. The magnitude of these differences from other animals is so great that it becomes the basis for a separate discipline of human ecology.

The exposition of human ecology as a distinct social science discipline is closely linked with the work of the sociologists Amos Hawley (b. 1910) and Otis Dudley Duncan (b. 1921).

All branches of ecology concur that adaptation is a group rather than an individual struggle. Membership in a compatible group is a condition of survival. Human ecology not only subscribes to this view but makes it a basic principle. In this view populations that occupy a particular sector of the environment (a habitat) adapt by organizing territorially delimited human communities. This is accomplished through the use of tools and technologies that derive from human ingenuity and cumulatively learned capabilities. The relationship of a population to its habitat is generally conceived as one of balance between human numbers and the opportunities for living.

Classical ecology sees three or four variable factors involved in the process of adjustment to the environment. Hawley postulates three: (1) population size, (2) the material or resource environment, and (3) the organization of the population. Within the third category Duncan distinguishes between social organization and technology to formulate the fourfold POET acronym of the "ecological complex": Ecological adjustment is a function of *p*opulation, *o*rganization, *e*nvironment, and *t*echnology.

Because demography is the study of population, there is much overlap in subject matter and research between human ecology and demography. Demography tends to be concerned with the renewal processes of large human population aggregates such as nation-states. Human ecology tends to focus on the detailed socioeconomic composition of population and its distribution over environments. It is an eclectic or "holistic" discipline that borrows freely from the theories and empirical research of such disciplines as sociology, evolutionary biology, economics, geography, demography, political science, and the physical sciences, integrating them with its own distinctive viewpoint. Some have characterized this viewpoint as social Darwinian.

Spatial Aspects of Ecological Organization

An important activity of all studies of ecology, particularly human ecology, is the portrayal by means of maps, graphs, and statistics of the distributions and densities of population in space. Mistakenly, some have defined human ecology solely or primarily as the descriptive study of spatial variations and patterns. However, the use of mapping and spatial analysis in studies of human ecology is guided by the more profound desire to understand ecological organization, interaction, and environmental adaptation. Ecology posits three basic factors to explain spatial patterning:

1. Interdependence among persons. People who depend on one another daily must be closer together than are those who exchange services less frequently.
2. Dependence on the physical environment. To gain its livelihood, a community must have access to raw materials, water, agricultural products, and other essential goods. In primitive situations this dependence is on the local habitat, and in more advanced societies it involves a wider sphere, via adjoining communities and particular ones located far away.
3. Friction of space. Technology facilitates the movement of goods, people, services, information, and money over substantial distances. Travel and transport of materials and persons from their place of origin to a desired destination require both time and energy, imposing "frictional" costs. The efficiency of transportation and communication measures this friction. Time and transport costs become important factors in determining the location of all types of firms and organization and also of private residence. Reduction in friction permits their wider scatter.

Urban, Rural, and Metropolitan Ecology

As commerce and industry develop, the larger centers (towns) become more dominant over settlements in the surrounding territory, and people travel there to exchange products and services. Such "central places" developed along convenient transportation points: rivers, seashores, or areas where favorable resources existed, at the intersection of routes (breaks in transportation). With advancing technology and population growth, the number of such dominant cities (to which the term *metropolis* is commonly applied) has multiplied manyfold. Moreover, as central places expand, they tend to spill over their legal boundaries into the adjacent territory, giving rise to increasingly diverse outlying satellite urban places and residential areas collectively known as suburbs or metropolitan rings.

Each city center interacts continuously with an extensive territory beyond its legal boundaries. The territory over which a particular center exercises dominance through a geographic division of labor is its hinterland. The intensity of interaction between the center and a point in the hinterland diminishes with distance from the center. The total community area may be divided into a primary area (daily commuting, retail shopping, intense interaction) and a secondary area of lesser dominance where many services are performed by local (subdominant) centers. The term *metropolitan area* (central city and its suburbs) is assigned to the former, and the term *metropolitan hinterland* to the latter. The outer boundary to this hinterland cannot be defined precisely; it is a zone within which the sphere of influence of one center is counterbalanced by the competing influence of an adjoining center, which varies for each of a wide range of indicators.

Under conditions of advanced technology manufacturing enterprises have considerable freedom in choosing a location. Location near the central business district may be unimportant for such an enterprise, particularly if its product is distributed nationwide or internationally. In contrast, retail and personal service enterprises are population-sensitive: They must locate near the sites where the people who consume their products and services live or work. More specialized units of this class, such as department stores, and stores selling narrower ranges of goods (jewelry, musical instruments, expensive clothing), as well as firms providing specialized financial, legal, or other professional services, seek a highly accessible location such as the city center or large outlying shopping centers. Single-purpose units such as filling stations, grocery stores, drugstores, laundries and dry cleaners, restaurants, churches, schools, and health facilities tend to settle in the neighborhoods to provide their clients with easy access.

Some very large metropolitan areas are renowned for serving a worldwide clientele, dominating other metropolitan centers. Familiar examples are New York, London, Paris, and Tokyo. Other large cities may be dominant within a nation or region. Still other metropolitan places may serve much smaller regional areas but provide linkages to the broader national and international network.

Although in industrialized countries a disproportionate share of the population may live in metropolitan areas and suburbs, by far the larger share of the physical environment consists of sparsely settled nonmetropolitan and rural areas. Some human ecologists cover all such categories; others tend to specialize, being primarily urban, suburban, or rural in their focus.

Ecological Change

A universal ecological process is temporal change, an irreversible alteration of an existing pattern of ecological relationships. Although most ecological processes tend to produce equilibrium and balance between interacting organizations and groups, change in ecological organization (whether as a result of small cumulative increments or sudden and drastic "shocks") is ever present. Change may come from alterations in population, the environment, technology, or social organization.

The principal mechanism of ecological change is nonrecurring spatial mobility. Recurrent mobility—habitual routine round-trip movements—produces little change. In fact, it promotes stability and equilibrium. One-way journeys (migration) signal ecological change. By studying the causes of migration, ecologists seek to study both the underlying causes and the resulting adjustment that occurs. It is important to know not only why migrants think they have moved but also the environmental conditions or characteristics that are present in cases where migration occurs and are lacking in cases where migration is absent or rare. The causes of migration may be categorized as "push" and "pull" factors: in their simplest forms, an excess of numbers in the area of origin and underpopulation in the area of destination.

The problem of overpopulation has long been a central concern of human ecologists. It exists in places where the number of persons in a given habitat is perceived to be excessive in relation to the opportunities for life and livelihood. Overpopulation may come about through sustained rapid population increase. However, it can also result from a temporary or long-term reduction in the food supply, the exhaustion of a natural resource, or the closing of a major local source of employment.

Some of these symptoms seem to be manifest in a substantial share of the world's living spaces, caused at least partially by the nature of global economic organization and regional disparities in fertility and population growth. Migration is technically a solution to overpopulation but raises other problems: It may be seen as threatening population balance in areas where a high level of prosperity has been achieved. Overpopulation may diminish as the conditions that generate it are corrected. A new phenomenon—underpopulation, or failure to maintain replacement—is also of interest to students of human ecology. Explaining this phenomenon, as for many other topics of human ecology, requires study of collectively held beliefs, opinions, and expectations.

Human Ecology and Collective Beliefs

In its classical formulation human ecology strongly discounted the influence of individual psychological phenomena on group behavior. More recently, there has been agreement that collective beliefs—beliefs shared by a large segment of a group—may underlie ecological changes that cannot be satisfactorily explained by environmental, organizational, or technological factors alone. Dominant beliefs about religion, economic organization (capitalist, collective), and status (class) exclusiveness as well as racial-ethnic preferences and antagonisms are examples.

See also: *Central Place Theory; Cities, Systems of; Lösch, August; Rural-Urban Balance.*

BIBLIOGRAPHY

Anderton, Douglas L., Richard E. Barrett, and Donald J. Bogue, eds. 1997. *The Population of the United States.* New York: Free Press.

Blau, Peter M., and Otis D. Duncan. 1978. *American Occupational Structure.* New York: Free Press.

Bogue, Donald J., and Elizabeth J. Bogue, eds. 1976. *Essays in Human Ecology.* Chicago, IL: Community and Family Study Center, University of Chicago.

Duncan, Otis D. 1983. *Metropolis and Region.* New York: AMS Press.

Duncan, Otis D., Howard Schuman, and Beverly Duncan. 1973. *Societal Change in a Metropolitan Community.* New York: Russell Sage Foundation.

Hawley, Amos H. 1950. *Human Ecology: A Theory of Community Structure.* New York: Ronald Press.

———. 1979. *Societal Growth: Processes and Implications.* New York: Free Press.

———. 1986. *Human Ecology: A Theoretical Essay.* Chicago, IL: University of Chicago Press.

Donald J. Bogue

HUNTER-GATHERERS

The term *hunter-gatherer* refers to an adaptation in which people subsist almost entirely on plants and prey they take in the wild. Except for some less self-reliant groups in the late twentieth century, hunter-gatherers produce nearly all the food they consume with gear of their own making, acquiring relatively little by means of trade. Therefore, the size, distribution, and density of hunter-gatherer populations are conditioned by the environments those peoples inhabit and the knowledge and technologies at their command and have varied dramatically over time in response to changes in both factors.

From the Pleistocene to the Holocene

The boundary between the Pleistocene (Ice Age) and Holocene (modern) epochs, about 11,600 B.P. (i.e., years before the present time), marks a major divide in this variability. The populations of archaic human hunter-gatherers of the Pleistocene (notably *Homo habilis, H. erectus,* and *H. neanderthalensis*) were presumably low as a consequence of their limited skills and intellectual abilities. Hunter-gatherer populations may have grown larger and denser after the emergence of anatomically modern humans in Africa (about 150,000 B.P.) and certainly did so after the appearance of the essentially modern behavior repertoire that signals the Upper Paleolithic (about 40,000 B.P.). However, despite essentially equal technological and intellectual abilities, Upper Paleolithic hunter-gatherer populations of the late Pleistocene never grew as large or dense as their Holocene counterparts. This was due to climate.

In comparison to the comparatively quiescent Holocene, Pleistocene climate changed frequently and abruptly, often going from nearly glacial to nearly interglacial conditions within a decade or two. Compounding this situation, atmospheric concentrations of carbon dioxide, which is essential to plant growth, were so low during the last 50,000 years of the Pleistocene that overall plant productivity and seed yields were only two-thirds of those in the Holocene. This combination of chaotic climatic change and low environmental productivity severely limited the opportunities of Pleistocene hunter-gatherers to develop stable, intensive adaptations capable of supporting large populations. As documented in the Middle East (Natufian culture) and Japan (Jomon culture), when rising carbon dioxide levels increased environmental productivity near the end of Pleistocene, a few hunter-gatherer groups developed more intensive and plant-dependent adaptations that supported larger and more sedentary populations. Rapid climate change, however, continued to limit these tendencies until the Holocene.

Responses to Climatic Change

Some hunter-gatherers responded almost instantly and in revolutionary ways to the onset of the stable, productive Holocene climatic regime. Jomon (Japan) hunter-gatherers intensified the use of plants, shellfish, and fish to support large, permanent settlements in a heavily populated landscape. Some hunter-gatherers in the Middle East, in contrast, shifted to part-time agriculture and began to compete for resources and space with the remaining hunter-gatherers, who were forced either to retreat and displace other hunter-gatherers or to work harder to glean more costly resources from shrunken territories.

Though its timing varies, this pattern of hunter-gatherer intensification eventually was repeated everywhere during the Holocene. The behavioral details differ depending on local resources, but the trend is always toward maximizing the rate at which these resources are acquired per unit of space, producing more nucleated, sedentary, and densely settled populations. This form of maximizing is a response to competition. Without competition, hunter-gatherers usually maximize the rate at which resources are acquired per unit of time by minimizing the amount of time expended in their acquisition.

Time-minimizing hunter-gatherers are highly mobile, quickly leaving locations where resources have begun to diminish in search of others where returns are higher. Population growth increases the chances that another group has depleted these other prospective locations. This reduces the potential rewards of moving and increases the tendency to stay put and maximize the total amount of resources acquired from a smaller area by adding more costly roots, seeds, and small prey to the diet. In this way, the larger trajectory of hunter-gatherer intensification in the Holocene (including incipient agriculture) may be interpreted as a response to global population growth made possible by global climate change. The hunter-gatherers observed by anthropologists are representative of only the end of this trajectory, not of hunter-gatherers in general.

To illustrate this point, the population densities and maximum social group sizes of ethnographic hunter-gatherers are an order of magnitude larger, and their median and minimum territory sizes an order of magnitude smaller, than is likely for any time in the Pleistocene or early Holocene (Table 1). Ethnographic fertility and mortality more closely approximate values that seem reasonable for the late Pleistocene–early Holocene, although Pleistocene infant mortality probably was higher and total fertility probably was lower. In any case, the rapid population growth of some Eurasian hunter-gatherers almost immediately after the onset of the Holocene suggests that Pleistocene hunter-gatherers were capable of the same thing when rebounding from environmental disasters, growing rapidly at annual rates that may have ranged between 1 percent and 3 percent during short periods of optimal climate.

The Timing of Population Changes

The timing of hunter-gatherer intensification varies greatly within the Holocene. In contrast to their counterparts in Eurasia, where intensification occurred relatively early, hunter-gatherer populations in southern Africa, Australia, and much of North and South America remained relatively low well into the Holocene, rising rapidly to historically observed numbers only 3,000 or 4,000 years ago. Technology and environment seem lesser obstacles to these transformations than is the development of social

TABLE 1

Major Demographic Characteristics of Ethnographic Hunter-Gatherers

	Median	Maximum	Minimum	Sample Size	Source
Population					
Density (per square mile)	0.29	10.06	0.01	339	Binford 2001: Table 5.01
Total population	876	14,582	23	339	Binford 2001: Table 5.01
Total territory (square miles)	3,631	254,936	31	339	Binford 2001: Table 5.01
Social Group Size					
Smallest residential group	16	70	5.6	227	Binford 2001: Table 5.01
Largest residential group	46	650	19.5	297	Binford 2001: Table 5.01
Largest aggregation	158	1,500	42.0	213	Binford 2001: Table 5.01
Fertility and Mortality					
Males/100 females	100.0	230	30	93	Kelly 1995: Table 6-1
Total fertility rate*	5.50	8.50	0.81	42	Kelly 1995: Table 6-1
Birth interval (years)	3.3	5.4	2.3	11	Kelly 1995: Table 6-7
Mother's age at first birth (years)	19.3	22.8	15.9	9	Kelly 1995: Table 6-7
Mother's age at last birth (years)	35.0	39.0	26.3	10	Kelly 1995: Table 6-7
Weaning age (years)	2.5	4.5	1.0	30	Kelly 1995: Table 6-8
% mortality before first year	20.0	34.0	8.0	14	Kelly 1995: Table 6-9
% mortality before fifteenth year	42.0	61.0	6.0	23	Kelly 1995: Table 6-9

*Mean number of births per female

SOURCE: Binford (2001) and Kelly (1995).

conventions enabling the holding of land and hoarding of resources, without which individuals are insufficiently rewarded for the extra labor they must invest to intensify resource production. The many cases of late Holocene intensification make it clear that hunter-gatherer populations are probably always close to the limits imposed by environment, technology, and behavior but that the force of population growth is not a major source of innovations that breach those limits. (If it were, intensification would occur uniformly early.)

Simulations by Gary Belovsky (1988) and Bruce Winterhalder and colleagues (1988) show how hunter-gatherers and their resources are linked in a dynamic feedback cycle that makes population growth self-correcting. When resources are abundant, hunter-gatherer populations rise until resources are depleted, which causes the population to fall. As the population continues to fall, resources rebound, starting the cycle again. The whole cycle takes something like 90 years. Thus, hunter-gatherer populations are resource-limited but not static, and groups under the same limits may vary substantially in size, depending on which stage of this cycle they are in. These simulations also suggest that because intensive harvesting prevents resources from rebounding, hunter-gatherers who limit their foraging efforts will often maintain higher population densities than will hunter-gatherers who do not.

See also: *Environmental Impact, Human; Evolutionary Demography; Indigenous Peoples; Nomads; Prehistoric Populations.*

BIBLIOGRAPHY

Belovsky, Gary E. 1988. "An Optimal Foraging-Based Model of Hunter-Gatherer Population Dynamics." *Journal of Anthropological Archaeology* 7: 329–372.

Bettinger, Robert L. 2001. "Holocene Hunter-Gatherers." In *Archaeology at the Millenium,* ed. G. Feinman and T. D. Price. New York: Kluwer/Plenum.

Binford, Lewis R. 2001. *Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building Using Ethnographic and Environmental Data Sets.* Berkeley: University of California Press.

Keeley, Lawrence H. 1988 "Hunter-Gatherer Economic Complexity and 'Population Pressure': A Cross-Cultural Analysis." *Journal of Anthropological Anthropology* 7: 373–411.

Kelly, Robert L. 1995 *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways.* Washington, D.C.: Smithsonian Institution Press.

Winterhalder, Bruce, W. Baillargeon, F. Cappelletto, R. Daniel, and C. Prescott. 1988. "The Population Ecology of Hunter-Gatherers and Their Prey." *Journal of Anthropological Archaeology* 7: 289–328.

Robert L. Bettinger

Encyclopedia of POPULATION

EDITED BY
Paul Demeny
Geoffrey McNicoll

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I

IMMIGRATION, BENEFITS AND COSTS OF

There was a resurgence of immigration in the United States and in many other countries in the last third of the twentieth century. By the year 2002, about 175 million persons—or roughly 3 percent of the world's population—resided in a country different from where they were born. Nearly 6 percent of the population in Austria, 17 percent in Canada, 11 percent in France, 17 percent in Switzerland, and 10 percent in the United States was foreign-born. One central concern has motivated economic research on international migration: what is the economic impact of international migration on the *host country*?

The Skills of Immigrants

The skill composition of the immigrant population, and how the skills of immigrants compare to those of natives, determines many of the economic consequences of immigration on the host country. Unskilled immigrants will typically compete for jobs with unskilled natives; skilled immigrants will compete with skilled natives. A host country benefits from immigration because it can import workers with scarce qualifications and abilities. Immigrants, though, make different demands than the native-born on the many programs that make up the welfare state, which tend to redistribute resources from high-income workers to persons with less economic potential.

Many studies have attempted to document trends in the skill endowment of the immigrant population in host countries, and to examine how that skill endowment adapts to economic and social conditions through the process of assimilation. The earliest studies used cross-section data sets to trace the age-earnings profiles of immigrants and native-born workers in the United States. A cross-section survey allows the comparison of the current earnings of newly-arrived immigrants (measured at the time of the survey) with the current earnings of immigrants who migrated years ago. Typically, these cross-section studies found that the earnings of newly-arrived immigrants were substantially lower than the earnings of immigrants who had been in the host country for one or two decades. Researchers interpreted the cross-section data to mean that newly-arrived immigrants lack many of the skills valued by host-country employers, such as language and educational credentials. As immigrants learn about the host country, their human capital grows relative to that of the native-born, and economic assimilation occurs in the sense that immigrant earnings "catch up" to the earnings of natives.

This "assimilationist" interpretation draws inferences about how the earnings of immigrant workers evolve over time from a single snapshot of the population. Suppose, however, that today's immigrants arrive with less skills than those who arrived twenty years ago. Because of these intrinsic differences in skills across immigrant cohorts, one cannot use the current labor market experiences of those who arrived 20 or 30 years ago to forecast the future earnings of newly arrived immigrants. If there are skill differentials among immigrant cohorts at the time they entered the host country, a cross-section survey yields an incorrect picture of the assimilation process.

Many studies, using either longitudinal data or repeated cross-sections, have calculated the rate of economic assimilation and measured the importance of cohort effects in host countries. In the United States, the immigrant waves that entered the country in the 1980s and 1990s were relatively less skilled than the waves that entered in the 1960s and 1970s. Immigrants in the United States do experience some economic assimilation, but the rate of assimilation is unlikely to be sufficiently high to permit recent cohorts to catch up to their native-born counterparts.

Labor Market Effects

Economic theory predicts that the entry of immigrants into a particular labor market will lower the wage of competing workers (workers who have the same types of skills as immigrants), and increase the wage of complementary workers (workers whose skills are more in demand because of immigration's effect on labor market conditions).

In many host countries, immigrants cluster in a limited number of geographic areas. In 1990, in the United States, 42 percent of immigrants lived in just five metropolitan areas—New York, Miami, Chicago, and Los Angeles and nearby Anaheim—but only 13 percent of the native-born U.S. population lived in those localities. Many empirical studies exploit this clustering to identify the labor market impact of immigration by comparing labor market conditions in "immigrant cities" with conditions in markets untouched by immigration. These studies typically correlate some measures of economic outcomes for native workers with a measure of immigrant presence in the locality, and usually report a correlation that is near zero. This evidence is then interpreted as indicating that immigration has little impact on the labor market opportunities of the native-born.

The short-run perspective of this type of research can be misleading. Over time, native workers and employers will likely respond to the entry of immigrants. Native-owned firms see that cities flooded by immigrants tend to pay lower wages, and often relocate to those cities. The flow of jobs to areas of high immigrant presence helps cushion immigration's adverse effect on the wage of competing workers in those localities. Similarly, workers living in areas not directly affected by immigration will choose not to move to the cities penetrated by immigrants, and some native-born workers living in the immigrant cities will seek better opportunities elsewhere.

Such effects on the internal migration of native-born workers and jobs within the host country spread out the impact of immigration across the entire host country. A comparison of the employment opportunities of native workers in different localities might show little or no difference because, in the end, immigration affected *every* city, not just the ones that actually received immigrants.

Because local labor market conditions may not provide valuable information about the economic impact of immigration, a number of studies have attempted to measure the impact at the national level. The factor proportions approach compares the host country's actual supplies of workers in particular skill groups to those it would have had in the absence of immigration, and then uses outside information on how wages respond to changes in labor supply to simulate the wage consequences of immigration. During the 1980s and 1990s, when the immigrant flow to the United States was relatively less skilled, the factor proportions approach finds that immigration had an adverse impact on the relative wage of native-born workers who are high school dropouts at the lower end of the skill distribution.

Fiscal Impacts

Income differences across countries are the dominant influence on a person's migration decision. The most important of these are wage differences that arise in the labor market, but the safety net provided by the welfare state may also have an influence. Welfare programs can generate two distinct types of "magnet" effects, with potential implications for public expenditures: welfare programs may attract persons who otherwise would not have emigrated, and might discourage immigrants who are not successful in the host country's labor market from returning to their home countries. Despite the prominence given to these magnet effects in the immigration policy debate, there is little empirical evidence that either supports or refutes the existence of them.

Most of the existing studies have focused instead on documenting the extent of welfare use by immigrant households. In the United States, there has been a rapid rise in immigrant welfare use. In 1970, immigrants were slightly less likely to receive cash benefits than native-born people. However, by 1998, over 10 percent of immigrant households received cash benefits, as compared to 7 percent of native households.

Some studies have also examined the magnitude of the income transfer to the immigrant population that occurs through the welfare state. An influential 1997 study conducted by the U.S. National Academy of Sciences attempted to calculate the fiscal impact for two major immigrant-receiving states, California and New Jersey. The study included an item-by-item accounting of expenditures incurred and taxes collected, and calculated how immigration affected each of these entries. Immigration increased the annual state and local taxes of the typical native household by $1,200 in California and by $200 in New Jersey. Much of the short-run fiscal impact of immigration is in the form of expenditures in public schooling. Immigrant families tend to have more children than native families, and the schooling provided to immigrant children—such as bilingual education—is often more expensive than the schooling provided to natives.

Economic Benefits

The native-born benefit from immigration in many ways. Immigrants buy goods and services, and native-owned firms and native-born workers profit by providing these to new consumers. Immigration may also increase the productivity of some native workers. Less-skilled immigrants, for example, can perform many of the service tasks in a modern industrialized economy, freeing up time for native-born workers to engage in activities where they are more productive. Immigration can also lower the price of many goods and services, benefiting consumers in the host country.

It is difficult to calculate these measurable benefits from immigration unless one has a model of the host country's economy detailing how the various sectors are linked. Such a model could simulate how the economy changes when the labor market is expanded by large numbers of immigrant workers, and would record the ripple effects of immigration on other sectors of the economy.

A number of studies use the "textbook model" of a free-market economy—in which wage and employment levels are set by the interplay between the supply of workers and the demand for workers—to examine the economic benefits from immigration. This model isolates two main effects of immigration. First, because immigrants increase the number of workers, there is additional competition in the labor market and the wage of native workers falls. Second, at the same time, native-owned firms gain because they can now hire workers at lower wages, and many native consumers gain because the lower labor costs eventually lead to cheaper goods and services. It turns out, however, that the gains accruing to the persons who use or consume immigrant services exceed the losses suffered by native-born workers, and hence society as a whole is better off. The difference between what the winners win and what the losers lose is called the "immigration surplus," and reflects the gain in national income accruing to the native-born as a result of immigration.

Applied to the United States, however, this model suggests that the net benefit from immigration is quite small. If a 10 percent increase in labor supply lowers the wage by 3 percent, the immigration surplus is on the order of 0.1 percent of gross domestic product (GDP)—about $10 billion in 2002. Moreover, this small average net gain disguises the fact that there may be substantial wealth transfers from native-born workers to the capitalists who employ the immigrants.

Effects on Source Countries

Although much of the existing research focuses on how immigrants alter economic opportunities in the host country, they also alter economic opportunities in the source countries. Emigration might drain certain types of workers from particular countries. (The highly-skilled component of such migration is popularly labeled the "brain drain".) Against this, immigrants transfer substantial funds from the host to the source countries. Despite the sizable impact that international migration might have on the global distribution of wealth, the economic effects on the source countries have not been studied systematically.

See also: *Cost of Children; Immigration Policies; Migration Models.*

BIBLIOGRAPHY

Altonji, Joseph G., and David Card. 1991. "The Effects of Immigration on the Labor Market Outcomes of Less-Skilled Natives." In *Immigration, Trade, and the Labor Market,* ed. John M. Abowd and Richard B. Freeman. Chicago: University of Chicago Press.

Borjas, George J. 1985. "Assimilation, Changes in Cohort Quality, and the Earnings of Immigrants." *Journal of Labor Economics* 3: 463–489.

———. 1995. "The Economic Benefits from Immigration." *Journal of Economic Perspectives* 9: 3–22.

Borjas, George J., Richard B. Freeman, and Lawrence F. Katz. 1997. "How Much Do Immigration and Trade Affect Labor Market Outcomes?" *Brookings Papers on Economic Activity* pp. 1–67.

Card, David. 1990. "The Impact of the Mariel Boatlift on the Miami Labor Market." *Industrial and Labor Relations Review* 43: 245–257.

Chiswick, Barry R. "The Effect of Americanization on the Earnings of Foreign-Born Men." *Journal of Political Economy* 86: 897–921.

Smith, James P., and Barry Edmonston, eds. 1997. *The New Americans: Economic, Demographic, and Fiscal Effects of Immigration.* Washington, D.C.: National Academy Press.

George J. Borjas

IMMIGRATION, UNAUTHORIZED

Unauthorized migration is the international movement of people through irregular or extralegal channels. At their destinations such people are often termed "illegal" or "undocumented" immigrants. States have the sovereign right to regulate entry into their territories, but the sheer volume and tenacity of unauthorized migrants speak to the tenuousness of any state's ability to exert complete control over cross-border movements. In exercising their prerogative, states attempt to identify foreigners' residence either as legal, according to their particular immigration laws, or illegal. Migration is deemed unauthorized if: (1) the migrants in question avoided inspection by crossing borders clandestinely or if they traveled with fraudulent documents (e.g., falsified visas or counterfeit passports); (2) if migrants have overstayed the time limit of a legally obtained non-immigrant temporary visa; or (3) if they have violated explicit visa conditions, e.g., obtaining employment while holding a student visa. In most of the world arrival as a non-immigrant (tourist, student, temporary laborer, etc.) and staying beyond the legally sanctioned period is the most common source of unauthorized immigration. In the United States, however, the majority of undocumented migrants have entered without inspection over land borders with Mexico and Canada.

The International Organization for Migration (IOM) (2000, p. 46) estimates that smugglers, paid by migrants to arrange transportation to the country of destination, assist more than 50 percent of unauthorized migrants. In addition, a substantial number of women and children, estimated to number between 700,000 and 2 million per year globally, are "trafficked"—that is, kidnapped, coerced, or deceived into migrating, then sold or indentured in the country of destination.

If discovered by immigration authorities, unauthorized migrants are generally required to depart voluntarily or become subject to involuntary deportation to the country of most recent citizenship or to the country through which they entered (the transit country). In the United States there is a process of "expedited exclusion" to combat the high incidence of repeat unauthorized entry: first-time unauthorized offenders are barred from reentry for five years; second-time or subsequent offenders are disqualified for twenty years. Unauthorized migrants apprehended within the country are often detained in custody until a decision on their immigration status is reached.

Unauthorized migration is a volatile political, social, and economic issue in many destination countries. Supporters of tighter controls on migration often portray the unauthorized international movement of people as a strain on receiving countries' social service budgets as well as a threat to the job security and wages of the domestic labor force. Country-specific studies on such economic effects, however, have been inconclusive. Even so, the late 1990s saw a decline in the number of countries offering social services, including health care, to unauthorized migrants.

Unauthorized Labor Migration

Due to the surreptitious character of unauthorized migration, unauthorized migrants are more likely than legal migrants to be employed in low-skilled, low-paid positions that require no documentation, credentials, or licenses. For example, in the United States a major portion of the undocumented migrant population is employed in industries such as meatpacking, construction, housekeeping, childcare, and agricultural work.

As demand for low-skilled labor rises in developed countries, employers have a growing economic incentive to encourage extralegal immigration for employment in sectors where domestic labor is scarce or is unwilling to work at prevailing wage levels. This has become a contentious issue. In countries with strong labor rights traditions, the perception that undocumented migrants drive down wages has mobilized unions and union supporters against government leniency. Whether, for the economy as a whole, unauthorized migrants' economic contribution outweighs the costs of the social services they receive remains unsettled.

Measurement

In all regions of the world statistics on unauthorized migration are apt to be incomplete and unreliable. Methods of assessing the size of the unauthorized population vary by country and there are often variant estimates for a single country. The most common measurement procedure is to compare census data with information on visas issued. In the United States, the census-reported foreign-born population is classified either as legal immigrant or temporary non-immigrant based on such a comparison. The census foreign-born numbers in excess of the official visa-based count are the residual foreign-born population. A portion of this residual population is assumed to be refugees and asylum seekers awaiting adjustment to permanent or protected status; the remainder is considered to be unauthorized. The accuracy of such estimates is dependent on the degree of completeness with which the census enumerates the foreign born population. Countries also rely on records of the numbers of apprehensions and deportations of illegal migrants kept by law enforcement to estimate the flow of undocumented migration.

Numbers and Trends

During the 1990s the volume of unauthorized international migrant flows increased greatly (For instance, it has been estimated that net illegal immigration to the United States in the late 1990s was half a million per year) Unauthorized migration still shows a surplus of males (just over 50%), but much less so than in the past. With large numbers of women in developed countries working outside of the home, opportunities for employment in domestic work and childcare have attracted women from developing countries, swelling both legal and unauthorized migrant numbers. Most unauthorized migrants are young, between 18 and 35 years of age. Most are from developing countries, although the IOM reports that visa overstayers from developed countries comprise a significant portion of illegal migrants in several countries, e.g., Australia and New Zealand (IOM, 2001). Selected estimates, by country, on the number of unauthorized migrants are shown in Table 1.

In each world region particular countries have become "magnets" for illegal movements of people.

Africa. Post-Apartheid South Africa emerged as a prime destination for migrants seeking work in the mining and agriculture sectors—not only from other parts of Southern Africa, but continent-wide. Because South Africa has retained restrictive immigration policies from the Apartheid period, most African migrants enter the country informally. In 1997, according to the IOM (2001, p. 136), over 3.5 million unauthorized migrant workers and about 750,000 visa overstayers were resident in South Africa. Unauthorized migrants are granted no protection under South African law, are targets of widespread violence fueled by high unemployment rates, and remain subject to immediate expulsion on apprehension.

Asia. Unauthorized migration has centered on Japan, South Korea, and Malaysia. Since 1990, these countries have imposed strict controls, backed by heavy fines, on employment of undocumented labor. In Malaysia, where most undocumented migrants are Indonesians, employed in factories, on plantations, and as domestic workers, sanctions are imposed on both workers and their employers—enforced more strongly during periods of economic downturn.

Western Europe. An IOM report indicates that in the late 1990s it is believed that over 500,000 migrants from Asia, Eastern Europe, Africa, and the Middle East were being smuggled into the European Union annually (IOM, 2001). The stock of undocumented migrants in Europe was estimated at 3 million. Historically, a large majority of migrants from both developing and developed countries seeking to work or settle in Europe chose the United Kingdom, Germany, France, Belgium, the Netherlands, and Switzerland as their final destination. In the early 1990s these countries adopted strict immigration laws; in consequence, migration flows shifted to the south—with Turkey favored as a transit route to the

TABLE 1

Unauthorized Migrants in Selected Countries: Estimated Numbers and Proportions of the Total Population, around 2000

Country (Year)	Estimated Unauthorized Migrants (thousands)	Unauthorized Migrants as Proportion of Total Population (percent)
Australia (2000)	60	0.3
Greece (1999)	264	2.5
Israel (2000)	150	3.3
Italy (1998)	300	0.5
Japan (2000)	500	0.4
Malaysia (2000)	450	2.0
South Africa (2000)	4,000	9.2
United States (2000)	8,000	2.8

SOURCES: IOM (2001); Population Reference Bureau <www.popnet.org>

EU, and Italy, Spain, and Portugal favored as destinations.

Historically, Greece, Spain, Portugal, and Italy were countries of mass emigration; they were unprepared to manage a massive influx of migrants. The increasing visibility of immigrants in these Southern European countries spurred public debate regarding how to deal with uncontrolled, unauthorized migration. Italy's 1990 Martelli Law and a 1998 presidential decree in Greece (see Amnesty below) were attempts to regulate immigration, including illegal immigration, at the national level. Both laws granted undocumented migrants, who had obtained formal sector jobs, the right to legal employment and residence. This shift in migration priorities created tensions within the EU, since the northern member states have systems in place that make it far more difficult for a non-EU citizen to stay illegally.

North America. In 2000 there were estimated to be about 8 million unauthorized migrants in the United States. The overwhelming volume of undocumented migration in the Western Hemisphere is directed to the United States, with Mexico the most frequent sender (according to the Census Bureau, 54% of undocumented migrants in the United States in 1999 were from Mexico).

Amnesty

In some countries unauthorized migrants who were long residents and employed have been allowed to obtain legal status. Under the Immigration Reform and Control Act of 1986 (IRCA), the United States granted legal permanent resident status to 2.7 million undocumented qualified migrants who had entered the United States prior to 1982 (prior to 1986 for agricultural workers). Greece implemented a similar program in 1998, issuing a presidential decree that allowed illegal workers who had entered the country prior to 1998 to become legal residents. And South Africa, between 1996 and 2000, regularized the status of over 350,000 long-standing undocumented contract workers, undocumented Southern African Development Community (SADC) citizens residing in South Africa, and Mozambican refugees.

See also: *Asylum, Right of; Immigration Policies; Labor Migration, International.*

BIBLIOGRAPHY

Athukorala, Prema-chandra, Chris Manning, and Piyasiri Wickramasekara. 2000. *Growth, Employment and Migration in Southeast Asia.* Cheltenham, Eng.: Edward Elgar Publishing.

Chiswick, Barry R. 1988. *Illegal Aliens: Their Employment and Employers.* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Crush, Jonathan, ed. 2001. South African Migration Project (SAMP). *Immigration, Xenophobia and Human Rights in South Africa.* Cape Town, South Africa: Idasa Publishing.

Fix, Michael, and Ron Haskins. 2002. "Welfare Benefits for Non-citizens." Welfare Reform Brief, No. 15. Washington, D.C.: The Brookings Institution.

Haines, David W., and Karen E. Rosenblum, eds. 1999. *Illegal Immigration in America: A Reference Handbook.* Westport, CT: Greenwood Press.

International Organization for Migration (IOM). 2001. *World Migration Report 2000.* New York: IOM and United Nations.

Meissner, Doris M., Robert D. Hormats, Antonio Garrigues Walker, and Shijuro Ogata. 1993. *International Migration Challenges in a New Era: A Report to the Trilateral Commission.* New York: The Trilateral Commission.

Stalker, Peter. 2001. *The No-Nonsense Guide to International Migration.* London: Verso Books.

INTERNET RESOURCE.

United Nations. *Convention Against Transnational Organized Crime.* [Protocols on smuggling of migrants and on trafficking in persons], <http://www.odccp.org/palermo/convmain.html>.

Adria N. Armbrister

IMMIGRATION POLICIES

Less is known about the sources and consequences of immigration policies than about the dynamics of migration flows and the behavior of migrants. Political science, the discipline best suited to explore the role of the state in stimulating, regulating, and preventing migration, long declined to take up this challenge but is making progress elucidating one of the most contentious political issues of our time.

States in the developed world are much alike in facing largely similar migration challenges and opportunities, but have had different migration histories. The majority of the world's 120 million or so voluntary and involuntary international migrants (a stock figure derived from data by country on the numbers of foreign-born residents around 1990) are in the developing world (about 66 million of the 120 million), but many seek to enter countries with more advanced political liberties, better political stability, robust economies, and generous welfare programs. These countries have aging populations that may threaten their economic and financial viability and are integrated into highly competitive regional and global economic networks. Important domestic interest groups, which have emerged in these countries, support the recruitment of the highly skilled. Furthermore, these interest groups tolerate unskilled, often illegal, migrants as a necessary feature of modern capitalism because they fill jobs disdained by natives. Liberal democratic governments, however, are loath to concede control of their borders and are accountable to electorates that consistently express unhappiness with immigration, especially from ethnically or culturally distant areas. Immigration policymaking entails managing these conflicting attitudes and deciding whether to cater to economic imperatives or to cultural and political preferences.

National Immigration Regimes

There are three types of national immigration regimes in the developed world. The United States, Canada, and Australia are the most important traditional countries of immigration. Founded by European settlers, they have long experience with immigration and allow acquisition of citizenship through naturalization or birth within their territory. The United States received about 850,000 legal immigrants per annum in the middle to late 1990s. Australia and Canada admit more immigrants in proportion to their size, however, and the foreign born make up a substantially larger share of their total populations (in 2000, 23% and 17% respectively, compared to 10% for the United States). Annual admissions in all three countries are allocated among family, economic, and refugee/humanitarian categories. The family category dominates U.S. flows; both Australia and Canada admit more skilled migrants, selected through a points system that favors individuals assessed as likely to contribute to economic growth. The United States distributes visas through a range of preference categories, only one of which is tied to skills. All three countries ceased to discriminate on the basis of national origin by the early 1970s. This last policy has produced a major shift to Third World source countries and is gradually changing the ethnic composition of their populations. Canadian and Australian policy does not consider nationality while the United States limits the number of visas granted to immigrants from any single country in a given year. Even so, because many illegal immigrants benefit from amnesty, regularization, and family reunion, Mexicans receive a disproportionate share of U.S. permanent residence visas. With the inclusion of illegal residents, the Mexican-born population in the United States was estimated to be about 8 million in 2000.

The refugee system in these countries, based on the 1951 Geneva Convention and premised on selective acceptance of stateless persons from overseas, is being altered by the sheer number of onshore asylum claimants and the court-driven expansion of the basis for asylum claims. Canada has one of the most expansive refugee systems in the world. Australia's relative geographic isolation has not prevented sizable influxes of asylum seekers and that country's efforts to deter ships bearing potential claimants and its strict policy of mandatory detention of unauthorized arrivals has drawn international opprobrium. While legal migration ordinarily provokes little controversy, illegal migration and on-shore asylum seeking are highly contentious issues. In the United States, legislation in 1986 granted amnesty to nearly 3 million undocumented migrants and imposed employer sanctions against hiring persons without legal status. In 1996 substantial new resources were concentrated at the border with Mexico to deter unauthorized entry. Nevertheless, by 2001 the illegal population had grown to an estimated 7 to 8 million. The estimates for Canada (20,000 to 200,000 overall) and Australia (about 6,000 entering per year) are much lower both absolutely and proportionately.

European countries that recruited temporary labor (guest workers) or received substantial colonial migration during the post–World War II economic expansion have a second type of immigration regime. Migrants came primarily from Southern and Eastern Europe, North Africa, Turkey, South Asia, and the West Indies—countries of close proximity or with colonial ties to host countries. They were the first significant influx of non-Europeans into Europe in modern times. Germany developed the prototypical guest worker program, but most other Northern and Western European countries also recruited temporary labor. Colonial migration was especially important in Britain, France, and the Netherlands and differed from guest worker programs in that many colonial migrants possessed or easily obtained citizenship and enjoyed preferential treatment with respect to admissions and residence.

Little thought was given to the difficulties of enforcing temporary contracts, but when the global slowdown prompted a Europe-wide recruitment halt during the period 1973–1974, only a small percentage of the immigrant workforce returned home. Employers were reluctant to lose experienced workers, and welfare institutions and courts dispensed entitlements largely without regard to citizenship. In the first fifteen years after the recruitment halt, migration declined very little since workers sent for their families, producing a secondary migration that liberal governments were unable to stem. By the 1980s most of the countries in Europe had substantial foreign-born populations and numerous second-generation "immigrant residents" who often did not or could not obtain citizenship. Discontent over the failure of governments to control foreign entries and concern about the difficulties of integrating these new populations put immigration on the political agenda in the 1980s and helped spawn right-wing political movements that became particularly strong in France, the Netherlands, Denmark, Italy, and Austria. With the admission of new primary immigrants effectively ended and the family reunion process largely complete, by the 1990s the only legal route into Europe for most prospective migrants was via political asylum. Asylum claims in the European Union (EU) member states rose dramatically, briefly peaking in 1992 at about 600,000, but then rising again in 1997. Germany received the bulk of the applications, over 438,000 in 1992 alone, according to the Continuous Reporting System on Migration of the Organisation for Economic Cooperation and Development (SOPEMI) (acronym is derived from the French name of the Organization) in 2000, but subsequently revised its liberal asylum provisions. Refugee-processing systems were overwhelmed by numbers and costs, and long backlogs developed. Most applicants were eventually rejected, but the majority of these stayed in the host countries anyway.

The final category of immigration regimes is found in Southern and Eastern European countries that have recently become states that are more likely to receive than to send immigrants, in particular Spain, Portugal, Italy, and Greece. Gateways for illegal migrants seeking entry into the EU, these countries are evolving immigration programs and bureaucracies in reaction to a rapidly escalating situation. Over a million illegal migrants may have been living in Greece in 2001, with Spain, Italy, and Portugal having smaller but substantial numbers as well.

By 2000 there were approximately 18.5 million foreigners in the EU, or about 7 percent of the total population. Children of migrants make the foreign-origin population much larger. Some 12 million Muslims live in Western Europe, most of recent immigrant origin. After long ignoring settlement issues, states began to grapple with political incorporation. The traditional immigration countries embraced formal (Australia and Canada) or informal (United States) multiculturalism with a degree of enthusiasm; the European countries, however, have had more difficulty. Even access to citizenship has been problematic. Nevertheless, an authoritative review shows that there is almost complete convergence among European states "on extending a citizenship entitlement to second-generation migrants. . .[and]. . .a more limited, but nonetheless clear, convergence in northern Europe on an inclusive definition of nationality law for first-generation immigrants" (Hansen and Weil, p. 19).

Explaining Immigration Policy

Immigration scholars are in sharp disagreement over both empirical and analytical issues. Is immigration policy pervasively restrictive or surprisingly open? Are policies converging or diverging? Have states lost control of their borders or is control capacity greater than ever? Does the scale of illegal migration reflect ineluctable pressures or absence of political will? Has immigration been a boon to the host societies, giving them new vitality, or has it created dangerous ethnic and religious tensions? Does migration pose security threats? Do anti-immigrant parties and popular prejudice endanger the rights of minorities and threaten to erode liberal constitutions? There are few commonly accepted evaluative standards, thus, researchers analyzing the same data can, and do, draw contradictory conclusions. Often, research is unacceptably shaped by the subjective values of the researcher.

The prevailing opinion of experts in this area is that immigration policy in Europe is predominantly restrictive in intent, as represented by the image of "Fortress Europe." Many researchers also describe the policies of the traditional immigration countries as prejudiced, exploitative, and hypocritical, despite the great number of admissions. Ironically, scholars who criticize restrictive policies often also argue that national states have lost control of their borders. Most specialists resist linking migration to security threats or crime, considering that argument to be politically inspired rhetoric. (The conclusions of Weiner and Guiraudon and Joppke are notable exceptions to this prevalent approach.)

Some scholars are undertaking systematic research to uncover the causes of empirical outcomes. A promising line of inquiry proceeds from the observation of a gap between the intentions and outcomes of immigration policies as noted by Wayne Cornelius, Philip Martin, and James Hollifield in 1994. Several theoretical models have been employed to address this and related questions, not one of which has yet emerged as the most persuasive.

Globalization theory, as it bears on migration, takes two forms. One perspective, focusing on the economic transformation of the world economy, holds that intensifying patterns of trade in goods, services, and capital create pressures that make mobility of labor inevitable. Traditional notions of national sovereignty and secure borders are, in this view, obsolete as states are driven by their economic goals to accommodate mass migration. Another school of thought, focusing on the growth of transnational human rights norms, argues that the traditional idea of citizenship has been transcended by more general concepts of personal rights. Embodied in treaties, endorsed by courts, and espoused by international organizations and other transnational actors, these rights are granted to long-term residents (denizens) as well as citizens and create an international norm that liberal states cannot ignore. An alternative view, described by Randall Hansen in 2002 as "embedded realism," is that the nation state is alive and well but its sovereignty is, as Christian Joppke described it in 1999, "self-limited." Subscribers to this theory stress the importance of domestic political forces. Hollifield (2000) contends that there is a "rights-based discourse" in which national courts are critical participants that legitimize migrant claims and constrain policy options. Other analyses focus on the groups that have direct interests in policy outcomes and the incentives to organize and agitate around immigration issues. The distribution of costs and benefits of immigration, in this view, gives organizational advantages to its proponents, typically producing client politics, in which well-organized interest groups negotiate policy with the authorities with minimal public participation. In 1999 Jeannette Money derived various hypotheses linking the territorial distribution of the costs and benefits of immigration to the decision of political parties to take up immigration issues. Historical institutionalists have demonstrated that contemporary migration policy decisions are path dependent, that is "a decision limits the range of available options at subsequent points and, in so doing, encourages continuity in the form of a retention of the original choice." (Hansen, p. 270) Finally, many scholars approach immigration politics from cultural perspectives. No book has had a greater impact on the field than Rogers Brubaker's *Citizenship and Nationhood in France and Germany* (1992), which explores how deeply-rooted national traditions of citizenship and nationhood yield divergent immigration and citizenship frameworks that are resistant to change.

There is a substantial body of research on anti-immigrant parties, movements, and opinion, but less on the larger question of how party systems have shaped and been transformed by immigration. There are a great number of studies analyzing the reasons why people choose to vote for extreme-right parties. Support for these parties comes predominantly from voters in the declining sectors of economies that are in the process of transforming from manufacturing to knowledge-based industries. Mainstream parties have alternated between ignoring anti-immigrant sentiment and catering to it to outflank parties on the right. Generally, discontent over immigration has harmed the electoral prospects of parties of the left more than those of the center or right. The failure of governing parties to handle immigration in a way that satisfies democratic majorities has arguably contributed to the decline of support for democratic institutions.

Toward Regional Immigration Regimes?

There is a trend toward development of multilateral immigration and asylum policies. Nowhere is this more evident than in the EU where, since 1986, the development of immigration and asylum policies has been closely tied to the effort to create a single market. Free movement for the purposes of work and relocation has been achieved for citizens of the member states, although that same freedom is denied to third-country nationals living in the EU. Border controls have largely been eliminated inside the EU, but this has required strict controls at external frontiers and necessitated an unusual degree of cooperation. In 1997 the EU adopted a convention on a common asylum policy, but harmonization in this and other areas has been difficult to achieve. The 1997 Treaty of Amsterdam contained important advances toward the "communitarization" of immigration and asylum policies by moving them into the Community "pillar." A key challenge facing migration scholars at the beginning of the twenty-first century is explaining when and why regional immigration regimes emerge, and how they differ from regimes regulating trade and finance.

Students of the politics of immigration policy have made considerable headway in understanding this complex subject, but exciting empirical, theoretical, and normative issues remain unresolved. Progress is most likely possible only if these separate aspects of the problem are kept analytically distinct.

See also: *Asylum, Right of; International Migration; Labor Migration, International; Population Policy.*

BIBLIOGRAPHY

Baldwin Edwards, Martin, and Martin A. Schain, eds. 1994. *The Politics of Immigration in Western Europe.* Newbury Park, Eng.: Frank Cass.

Betz, Hans-Georg. 1994. *Radical Right-Wing Populism in Western Europe.* New York: St. Martin's Press.

Brochmann, Grete and Tomas Hammar, eds. 1999. *Mechanisms of Control: A Comparative Analysis of European Regulation Policies.* Oxford: Berg.

Brubaker, Rogers. 1992. *Citizenship and Nationhood in France and Germany.* Cambridge, MA: Harvard University Press.

Cornelius, Wayne, Philip L. Martin, and James F. Hollifield, eds. 1994. *Controlling Immigration: A Global Perspective.* Stanford, CA: Stanford University Press.

Freeman, Gary P. 1995. "Modes of Immigration Politics in Liberal Democratic States." *International Migration Review* 112: 881–902.

Geddes, Andrew. 2000. *Immigration and European Integration: Towards Fortress Europe?* Manchester: Manchester University Press.

Guiraudon, Virginie, and Christian Joppke, 2001. "Controlling a New Migration World." In Virginie Guiraudon and Christian Joppke, eds. *Controlling a New Migration World.* London: Routledge.

Hammar, Tomas, ed. 1985. *European Immigration Policy: A Comparative Study.* Cambridge, Eng.: Cambridge University Press.

Hansen, Randall. 2002. "Globalization, Embedded Realism, and Path Dependence." *Comparative Political Studies* 35(3): 259–283.

Hansen, Randall, and Patrick Weil, eds. 2001. *Towards a European Nationality: Citizenship, Immigration and Nationality Law in the EU.* Houndsmills, Basingstoke, Eng.: Palgrave Macmillan.

Hollifield, James F. 2000. "The Politics of International Migration: How Can We Bring the State Back In?" In *Migration Theory: Talking Across Disciplines.* ed. Caroline B. Brettell and James F. Hollifield. New York: Routledge.

Joppke, Christian. 1999. *Immigration and the Nation State: The United States, Germany, and Great Britain.* Oxford: Oxford University Press.

Money, Jeannette. 1999. *Fences and Neighbors: The Geography of Immigration Control.* Ithaca, NY: Cornell University Press.

Sassen, Saskia. 1996. *Losing Control? Sovereignty in an Age of Globalization.* New York: Columbia University Press.

SOPEMI (Continuous Reporting System on Migration). 1999 and 2000. *Trends in International Migration.* Paris: OECD.

Soysal, Yasemin. 1994. *Limits of Citizenship: Migrants and Postnational Membership in Europe.* Chicago: University of Chicago Press.

Tichenor, Daniel. 2002. *Dividing Lines: The Politics of Immigration in America.* Princeton, NJ: Princeton University Press.

Weiner, Myron, ed. 1993. *International Migration and Security.* Boulder, CO: Westview Press.

Zolberg, Aristide. 1999. "Matters of State: Theorizing Immigration Policy." In *Becoming American, America Becoming.* ed. Douglas Massey. New York: Russell Sage.

Gary P. Freeman

IMMIGRATION TRENDS IN MAJOR DESTINATION COUNTRIES

International migrants are defined as persons who reside for an extended length of time or indefinitely—possibly permanently—in a foreign country. Tourists, persons who commute daily or weekly to jobs in neighboring countries, and persons employed for a short period outside their country of origin are not considered international migrants.

The minimum stay necessary for a person to be considered an international migrant differs from country to country. Official migration statistics in Germany include foreign citizens who have resided in that country for at least three months. In contrast, in Switzerland only persons who have stayed in the country for a minimum of twelve months are considered migrants. Students and temporary workers can reside for many years in the United States without being officially registered as immigrants. Unlike European censuses, U.S. censuses include data on undocumented persons who have not been granted legal residence. Inadequacies in official statistical data in many developing countries make it impossible to specify the exact number of international migrants worldwide. But commonly cited estimates for the end of the twentieth century are between 120 and 175 million people.

Historical Survey

Migration has taken place throughout history but did not become a mass phenomenon until the industrial revolution. A prerequisite to this development was the emergence of demand for industrial labor. A second prerequisite was the development of widely available and relatively inexpensive means of transportation, particularly railroads and steamships. Improved public transportation allowed large numbers of people to become mobile. This led to considerable intra-European migration and later to the recruitment of migrant workers from abroad to the metropolises and industrial centers of France, Germany, and the United Kingdom. Starting as early as the 1840s, France was the first European country to recruit foreign workers; other Western European countries did not follow its example until the mid-twentieth century.

Starting in the European age of discovery and conquest, Europe became a continent of emigration. Between 1600 and 1950, approximately 70 million people left that continent for destinations overseas. In particular, they aimed to reach North and South America, Algeria, southern Africa, Palestine, Australia, and New Zealand. Most of these emigrants were political and religious dissidents, adventurers, and above all the poor and persons without property. As early as the nineteenth century Europeans began to outnumber the indigenous people in many settlement countries.

In some respects this movement prefigured modern labor migration. It included not only migration from Europe to North and South America but also the recruitment of laborers from India and China as plantation workers in British and Dutch possessions in the Caribbean and Southeast Asia. In the late nineteenth and early twentieth centuries, Chinese laborers were recruited to work on railroad construction and as lumberjacks in the western United States and Canada. Earlier, the slave trade had brought approximately 9.5 million people—mostly residents of sub-Saharan Africa—to North and South America between the seventeenth and nineteenth centuries.

Immigrants in the Twentieth Century

Twentieth-century immigrants to the major settlement countries can be broadly categorized as refugees and expellees, migrants from former colonies, economic migrants, and "ethnically privileged" migrants.

Refugees and Expellees. In the twentieth century in Europe alone, approximately 45 million persons migrated internationally as refugees or through forced deportations. The causes of their relocation included, for example, the Russian Revolution of 1917 (1.5 million refugees), the Turkish-Greek war of 1922 (2 million forced migrants), the policies of Nazi Germany (6 million deported persons and 8.5 million forced laborers), and the new political order that followed World War II (12 million forced German migrants and 2.5 million forced Polish and Ukrainian migrants).

During the Cold War migrants from communist-ruled countries were granted asylum as political refugees in the West, although economic reasons were the primary motive for many of those migrants. Since the 1990s the proportion of asylum seekers granted permanent residence in Western Europe, the United States, and Australia has fallen markedly. Most of the world's refugees (estimated at some 15 million in 2001) are in developing countries, usually in geographic vicinity to their countries of origin.

Postcolonial migrants. Beginning in the 1950s and as a result of decolonization, many colonial settlers, government employees, and soldiers returned to the United Kingdom, France, the Netherlands, Belgium, and, in 1974–1975, Portugal. The 1990s witnessed the return migration of an estimated 5 million ethnic Russians from Central Asia, the Caucasus, and the Baltic region to Russia. Ultimately, this movement too was a result of a decolonization process.

Also since the 1950s, indigenous peoples from former colonial territories in southern and southeastern Asia, Africa, and the Caribbean have migrated to the European countries that had colonized them in search of better living conditions and to escape political and ethnic conflict. This type of migration was fostered by the demand for low-cost labor in Europe.

The European metropolitan powers originally facilitated this migration by recognizing the inhabitants of former colonies as their own citizens or as preferred immigrants. The result was a substantial movement of Irish, Indians, Pakistanis, Bangladeshis, and West Indians to the United Kingdom; Vietnamese and northern and western Africans to France; and Moluccans and Surinamis to the Netherlands.

Economic migrants. In the United States the active recruitment of workers that had begun with Chinese laborers continued with the recruitment of other temporary labor migrants, predominantly from Mexico. Between 1942 and 1964 Mexican workers were recruited through so-called Bracero programs. In contrast to regular migrants, these temporary workers were not seen as candidates for permanent U.S. residency. After 1964 large numbers of undocumented migrants arrived in the United States, mostly from Mexico and South America. Many of them became legal residents between 1986 and 1989. However, the 2000 U.S. census revealed that there were some 8 million undocumented migrants, mostly labor migrants, living in the United States. As legal immigrants to the United States and Canada have immediate access to the labor markets of these countries, regular migration to North America is also largely driven by economic motives.

In Europe, France and Switzerland have the longest history of recruiting foreign workers; in the case of France this practice dates back to the nineteenth century. In the mid-1950s other West European countries started recruiting foreign workers to do low-skilled jobs. Those labor migrants came from Italy, Spain, Portugal, and Greece and later from North Africa, Turkey, and the former Yugoslavia. Bilateral treaties between origin and destination countries provided a formal regulatory framework for those flows. Employment of migrant workers in Western Europe reached a high in the early 1970s.

After the first international oil crisis in 1973, state recruitment of workers was halted and quotas were placed on immigration from former colonial territories to Western Europe. Family unification and network migration to Western Europe resulted in continued inflows of persons from countries that previously had supplied migrant labor.

The internationalization of the European labor market in the second half of the twentieth century brought over 30 million people to Western Europe and brought persons residing in Western Europe's peripheries—such as Ireland, Portugal, and southern Italy—to its industrial centers and metropolises.

TABLE 1

Foreign-Born Population in the United States, Canada, and Australia, 1950–2000

		1950	1960	1970	1980	1990	2000
United States	Foreign-born (millions)	10.4	9.7	9.6	14.0	19.8	29.3
	Percent of total population	6.9	5.4	4.7	6.2	7.9	10.4
		1951	**1961**	**1971**	**1981**	**1991**	**1996**
Canada	Foreign-born (millions)	2.1	2.8	3.3		4.3	5.0
	Percent of total population	14.7	15.6	18.0		16.1	17.4
		1954	**1966**	**1976**	**1986**	**1996**	**2000 (est.)**
Australia	Foreign-born (millions)	1.3	2.1	2.7	3.3	43	4.3
	Percent of total population	14.3	18.4	20.1	21.1	22.8	23.3

SOURCE: U.S., Canadian and Australian censuses.

Only in Finland and Greece about one in two migrant workers stayed in Western Europe; the others eventually returned home.

In addition to legal migrant workers Western Europe received a growing number of illegal and undocumented labor migrants. Estimates from around 2000 suggest that there are more than 2 million undocumented migrants in Western and southern Europe. Many of these migrants stay for only a few months, while others manage to establish themselves. In addition, new types of international seasonal work and cross-border commuter labor have evolved, originating in a variety of source countries. The main source areas are Poland, Romania, North Africa, the Middle East, and southern Asia.

Outside Europe and North America labor migration currently occurs from southern and southeastern Asia to the Persian Gulf states and to South Africa from its bordering countries. In southeastern Asia, Malaysia and Singapore attract regional labor migrants. Brazil and Argentina receive regional labor migration from poorer Andean countries.

Ethnically privileged migrants. Several states have special migration programs for persons with the same ethnic or religious origins as the majority population. An example of a country with this migration policy is Israel. All persons who are of Jewish descent or are members of the Jewish faith are allowed to immigrate to Israel (from 1948 to 2001 there were 3 million ethnic and religious immigrants). Since 1950 Germany has granted members of the German ethnic minority in central and eastern Europe the right to immigrate to Germany and obtain German citizenship (from 1950 to 2001 there were 4 million ethnic migrants). In the 1990s Russia allowed the immigration of citizens from the successor states of the former Soviet Union (from 1990 to 2000 there were 5 million migrants); most of those migrants were ethnic Russians.

Foreign-Born and Foreign Citizens in Major Destination Countries

The most popular geographic destination of migrants is North America, followed by Western Europe, Australia, and the Persian Gulf States.

In the United States, Canada, and Australia, national censuses include statistics on the immigrant population (Table 1). The United States was home to 10 million immigrants in 1950—6.9 percent of the total population—after a long period of restrictive migration policies. By 1970 the proportion of the foreign-born had dropped to 4.7 percent. In subsequent years it increased steadily, reaching 10 percent, or 29 million immigrants, in 2000.

In Canada the share of the immigrant population hardly changed during the second half of the twentieth century, staying at around 17 percent; the absolute numbers increased significantly. In 1950 Canada had 2.1 million immigrants; in 1980, 3.3 million; and in 1996, 5 million. At the beginning of the twenty-first century a total of 34 million foreign-born people lived in North America.

In 2000 the foreign-born population in Australia was 4.3 million, amounting to 23.3 percent of the total population.

In Europe official statistics contain information only about foreign citizens with legal residency and

TABLE 2

Foreign Citizen Populations in 18 Western European Countries, 1950–2001 (in Thousands and as Percentage of Total Population)

	1950		1970–1971		1982		1990		1999–2001	
	Total	%	Total	%	Total	%	Total	%	Total	%
Austria	323	4.7	212	2.8	303	4.0	482	6.2	730	9.1
Belgium	368	4.3	696	7.2	886	9.0	903	9.0	853	8.3
Denmark	*	*	*	*	102	2.0	161	3.1	259	4.9
Finland	11	0.3	6	0.1	13	0.3	26	0.5	88	1.7
France	1,765	4.2	2,621	5.1	3,660	6.7	3,607	6.3	3,263	5.6
Germany**	568	1.1	2,976	4.9	4,667	7.6	5,338	8.4	7,297	8.9
Greece*	31	0.4	15	0.2	60	0.6	173	1.7	166	1.6
Ireland	*	*	137	4.6	232	6.6	81	2.3	127	3.3
Italy	47	0.1	122	0.2	312	0.6	469	0.8	1,271	2.2
Liechtenstein	3	21.4	7	33.3	9	34.1	11	38.1	11	34.3
Luxembourg	29	9.8	63	18.5	96	26.3	109	28.2	153	35.6
Netherlands	104	1.0	255	1.9	547	3.8	692	4.6	652	4.1
Norway	16	0.5	76	2.0	91	2.2	143	3.4	179	4.0
Portugal	21	0.2	32	0.4	64	0.6	108	1.1	191	1.9
Spain	93	0.3	148	0.4	183	0.5	279	0.7	801	2.0
Sweden	124	1.8	411	5.1	406	4.9	484	5.6	487	5.5
Switzerland***	285	6.1	1,080	17.4	926	14.4	1,127	16.7	1,459	20.1
United Kingdom	*	*	2,000	3.6	2,137	3.8	1,904	3.3	2,298	3.9
Western Europe, Total	3,788	1.7	10,857	3.3	14,694	4.2	16,096	4.5	20,416	5.2

*Reliable data are not available.
**Before 1990 data are for West Germany.
***Excluding seasonal labor migrants and employees of international organizations.

SOURCE: Council of Europe (2001); OECD/SOPEMI (2001).

do not include information on all persons who were born abroad (i.e., migrants). In most Western European countries the number of foreign citizens increased from the 1950s to the 1970s and increased again in the 1990s. This was due only in part to an actual increase in the number of new immigrants. For example, Western European countries that naturalize immigrants rapidly are home to fewer legal foreign residents than are countries with lower naturalization rates. Many European countries do not grant citizenship to native-born children with non-citizen parents. This increases the official number of foreigners living in those countries.

In 1950 fifteen European Union countries were home to 3.8 million foreign citizens (Table 2). By 1970–1971 that number had risen to almost 11 million. At the beginning of the twenty-first century, approximately 20 million foreign citizens lived in those European countries. Additionally, 8 million people—either citizens of European countries returning from stays abroad or former immigrants who had become naturalized —were living in Western Europe.

France was home to the largest foreign citizen population in 1950. In 1970 Germany hosted the largest number of foreign citizens in Europe, followed by France, the United Kingdom, and Switzerland. Foreign citizens residing in Europe were predominantly labor migrants.

At the turn of the twenty-first century, Germany was still home to the greatest number of foreign citizens, with 7.3 million people (8.9% of the total population), followed by France with 3.3 million people (5.6%), the United Kingdom with 2.3 million people (3.9%), and Switzerland with 1.5 million people (20.1%).

Other important countries of destination in 2000–2001 were Italy with 1.3 million people (2.2%), Belgium with 0.9 million people (8.3%), Spain with 0.8 million people (2.0%), Austria with 0.7 million people (9.1%), and the Netherlands with 0.7 million people (4.1%).

As a proportion of the total population, foreign citizens were most strongly represented in 1950 and in 2000–2001 in the small countries of Liechtenstein

(34.3% in 2000) and Luxembourg (35.6% in 2000). Among larger Western European countries, Switzerland had the highest percent of foreign nationals (20.1% in 2001). All other Western European countries had a foreign citizen population that was under 10 percent of the total population in 2000. Thus, among the 390 million people living in those eighteen European states, only a little over 5 percent were not citizens of the countries in which they resided; one-third of these persons came from other countries of Western Europe. If one includes the number of naturalized citizens living in Western Europe, 7 percent of the persons residing in Western Europe at the beginning of the twenty-first century were immigrants.

See also: *International Migration; Labor Migration, International; Trans-Atlantic Migration.*

BIBLIOGRAPHY

Castles, Steven, and Mark Miller. 1998. *The Age of Migration: International Population Movements in the Modern World,* 2nd edition. New York: Guilford Press.

Cohen, Robin, ed. 1995. *The Cambridge Survey of World Migration.* New York: Cambridge University Press.

Council of Europe. *Recent Demographic Developments in Europe.* Strasbourg, annual.

International Organization for Migration. 2000. *World Migration Report 2000.* Geneva: United Nations.

OECD/SOPEMI. *International Migration Trends.* Paris, annual.

Straubhaar, Thomas. 2002. "Migration im 21. Jahrhundert." *Beiträge zur Ordnungstheorie und Ordnungspolitik.* Vol. 167. Tübingen, Germany: Mohr Siebeck Verlag.

United Nations High Commissioner for Refugees. 2000. *The State of the World's Refugees: Fifty Years of Humanitarian Action.* Geneva: UNHCR, New York: Oxford University Press.

Zolberg, Aristide R., and Peter M. Benda, eds. 2001. *Global Migrants, Global Refugees: Problems and Solutions.* New York and Oxford: Berghahn Books.

INTERNET RESOURCES.

International Organization for Migration. 2003. <http://www.iom.ch>.

Migration Policy Institute. 2003. <http://www.migrationinformation.org>.

United Nations High Commissioner for Refugees. 2003. <http://www.unhcr.ch>.

RAINER MÜNZ

INDIGENOUS PEOPLES

In the year 2000 the United Nations established a Permanent Forum on Indigenous Issues as a subsidiary organ of the Economic and Social Council. Much deliberation preceded this initiative, not least because precise demarcation of the world's indigenous populations has been elusive. In the early twenty-first century there is no single and unambiguous definition of indigenous peoples; even indigenous groups may disagree about their composition. Attempts at definition tend to follow three guiding principles.

Indigenous peoples include descendants of the original inhabitants of a country

- Who have become encapsulated in their lands by a numerically and politically dominant invasive society
- Who retain a cultural difference from that society
- Who self-identify as indigenous

In describing the demographic features of indigenous peoples, the third criterion is crucial. For these peoples to exist at all in a statistical sense requires both administrative mechanisms to ascribe and record indigenous status *and* a willingness—or insistence—on the part of indigenous people to be counted as such rather than as a minority population with some distinctive characteristics (such as language, religion, or ethnicity) that differentiates it within a broader society. The degree to which these prerequisites combine to enable the compilation of demographic data varies greatly both historically and between nations. The statistical basis for a consistent global description of indigenous demography is thus tenuous at best.

Population Size

Although estimates of population size are available for most indigenous groups, the availability and quality of data on births and deaths is more sporadic. The most complete census and administrative data sources are available in North America and Australasia. With varying degrees of coverage and changing interpretations of race and ethnicity, indigenous people have been recorded in national censuses since 1870 and 1871 in the United States and Canada, since 1881 in New Zealand, and since 1901 in Australia.

In Latin America, most countries have indigenous inhabitants, but only half have a census and/or household survey program that includes information about the indigenous population. The situation in northern Europe and Russia is equally mixed: The formal acquisition of demographic data about the indigenous Saami of northern Scandinavia is still under development, but decades of Soviet administration among minority indigenous peoples of the Russian Federation has yielded basic demographic information since 1926. For countries in Africa and Asia, demographic data are also intermittent. So-called ethnic minorities have been identified in the Chinese census since 1953, and postwar censuses in India have identified separate "Scheduled Tribes" populations. Japan has arguably the longest time-series data in Asia, with regular counts of the Ainu since the early nineteenth century.

Many national governments and statistical agencies deny the existence of indigenous peoples within their borders, partly because it is difficult to establish antecedence and partly because of unresolved political tensions in defining the social basis of the nation-state. Accordingly, demographic knowledge of the indigenous San peoples of southern Africa and similar populations elsewhere emerges only from dedicated field studies.

Estimates of the number of indigenous people worldwide toward the end of the twentieth century converged on the 300 million mark, or approximately 5 percent of the world population. This number is distributed across almost half the world's countries and can be further disaggregated into some 5,300 distinct political/legal/cultural groupings described variously as "tribal," "Fourth World," or "first" nations.

Most indigenous peoples (207 million) live in Asia—overwhelmingly in China (108 million) and India (68 million)—with an estimated 50 million in Africa and 40 million in Latin America. The New World countries of Australasia and North America, which have yielded the most comprehensive and accurate data on indigenous populations, account for only a small estimated share of the global total—4.4 million, or 1.5 per cent, in 2000. Within this total the estimated size of the indigenous population in the United States (American Indian, Eskimo, and Aleut) was 2.4 million.

Indigenous Demographic Transition

The shared characteristics that define indigenous peoples are manifest in "enclave demographies" that are clearly distinct from mainstream or national demographic profiles. These characteristics derive from common historical experiences of severe population decline as a consequence of colonization by nonindigenes, followed by a period of stabilization and in some cases recuperation. In Australasia and North America rapid growth in recent decades has coincided with a shift from exclusion to inclusion of indigenous peoples in the provisions of modern states. In broad terms these phases describe an "indigenous" demographic transition along the lines of the classical model, although a significant revision is represented by the recognition of an initial, or pre-transition, phase of depopulation during the period of first contact with nonindigenes. At the beginning of the twenty-first century indigenous populations could be found in each of the phases of transition. The prospect of an indigenous mobility transition has also been studied.

Consideration of the size of indigenous populations before their encapsulation by invading groups requires a temporal cutoff point. One convenient device is to distinguish populations colonized in relatively recent times after contact with European and other intercontinental migrants from those which have been subjugated for millennia by intracontinental migrations. For the former group such a "precontact" population has been estimated at 17 million for North America, lowland South America, and Oceania in the mid-eighteenth century.

By the early twentieth century the main impact of nonindigenous settlement in those regions had been to reduce autochthonous numbers to barely 1.3 million. Casting the net wider to incorporate Russia, southern Asia, island southeast Asia, and central and southern Africa, the decline in the population of indigenous peoples could have amounted to as much as 50 million between 1780 and 1930. The causes of this population loss are well understood and include disease, frontier violence, and the loss of land by what were predominantly hunter-gatherer populations.

Demographic Transition in Australia and Canada

The existence of relatively robust time-series data for indigenous populations in Australia and Canada since the mid-nineteenth century provides an opportunity to explore the course of indigenous demographic transition. Similar overviews are available for the Maori of Aotearoa in New Zealand and for Native Americans. It is clear that indigenous populations in these New World countries have undergone a series of systematic fluctuations in fertility and mortality levels that have been uneven over space and time but ultimately comprehensive and uniform in effect. These fluctuations have been conceived of as separate but overlapping transitions from the pre-European contact period of stable growth with high mortality and fertility through a phase of postcontact population decline to a stationary state, followed by a period of high growth and finally a regime of lower natural growth based on reduced mortality and fertility.

In light of the evidence for human habitation in present-day Australia and Canada for tens of thousands of years, it is reasonable to assume that the indigenous population levels first encountered by European settlers were the product of a long-term balance between birth rates and death rates. Most analysts suggest that this stationary state was due to sustained high birth rates and death rates.

In Australia controversy surrounds the exact estimation of population size at the time of the first sustained contact with Europeans in 1788, with 300,000 as the likely minimum figure and 1 million as an upper bound. In either case a drastic decline in numbers accompanied the process of European occupation as a result of reduced fertility and rising mortality. This decline was rapid until about 1890, after which the population was probably stationary until the 1930s at roughly 20 percent of its original estimated minimum size. In Canada the precontact Indian population has been estimated at a roughly similar size (250,000). This was reduced to around 120,000 by 1900 as a consequence of introduced diseases and hostilities between native populations and invading settlers (Norris 1990).

In both Australia and Canada the first sign of further transition appeared with a rise in the birth rate to over 40 per 1,000 in the post–World War II years, falling back to around 35 per 1,000 by the 1970s and 1980s. This was accompanied in the 1960s and 1970s by a sudden and substantial drop in the death rate, which leveled off at 16 per 1,000 among indigenous Australians and 10 per 1,000 among Canadian Indians. In each case this heralded a period of rapid population increase with annual growth rates of up to 2.5 percent by the 1970s.

The current phase of transition is to a regime of lower natural increase based on reductions in both fertility and mortality. By 2000 the rate of natural increase among indigenous Australians and Canadians had fallen to 2 percent per year, although this was still four times the level of their respective national rates.

Trends in Mortality

The crude death rate for indigenous people in Australia remained high until the mid-1960s but declined sharply between 1965 and 1978, falling from 19 to 13 per 1,000. The primary cause was a precipitous reduction in the infant mortality rate (IMR) from around 100 per 1,000 births in the mid-1960s to 26 by 1981. This was a direct consequence of greatly enhanced access to the health infrastructure, especially community-based prenatal and hospital-based postnatal care. Further improvement in infant survival since the 1980s has been less impressive, with indigenous IMRs remaining around three times the Australian average. A similar decline was recorded over the same period in Canada, with the indigenous IMR falling from 42 to 15 between 1971 and 1981.

Improvement in life expectancy has been far less dramatic. In Australia the first reliable national estimates in 1981 revealed life expectancies for indigenous people of around 56 years for males and 64 years for females, some 20 years below those of the general population. This situation had not altered by 2000. In Canada the equivalent gap in life expectancy in the 1990s was eight years despite a steady improvement in indigenous mortality since the 1950s. In both countries the overall level of indigenous mortality reflects persistently higher indigenous death rates at all ages but especially in middle adulthood between 30 and 50 years of age. This lack of improvement relative to the life expectancy of the general population despite lowered infant mortality is a unique demographic phenomenon and reflects the influence of lifestyle factors as a primary cause of death among marginalized populations.

Trends in Fertility

Total fertility rates (TFRs) among indigenous women in Australia peaked in the decade 1956–1966, remained high until 1971, and then fell sharply throughout the 1970s, effectively halving the TFR from around 5.9 in the period 1966–1971 to around 3.3 in the period 1976–1981. Results from the 1996 census indicated further lowering of the TFR to 2.7, representing a drop of around 50 percent since 1971. The overall expectation is for steady progress toward replacement fertility in the early decades of the twenty-first century.

In explaining this decline in Australia, the focus has been on the effect of increased participation by indigenous people, particularly women, in mainstream institutional structures, which has altered the costs and benefits of having children. Three factors—age at leaving school, labor force status, and income—are regarded as particularly instrumental. In Canada fertility has also been lowered by delayed marriage and childbirth.

Nondemographic Factors in Population Growth

Despite reduced natural growth, recent census counts of indigenous populations in Australia and Canada reveal an apparent population explosion. Between 1971 and 1996 the census count of the indigenous Australian population increased by 200 percent, substantially above the underlying rate of natural increase. A similar discrepancy was observed in Canada. This "error of closure" reflects the contributions of a greater propensity of individuals to self-identify as indigenous, an expanded potential pool of a self-identified population as a result of outmarriage, and legislative change, notably the reinstatement and registration provisions of the 1985 Indian Act (Bill C-31) in Canada, which relaxed the rules governing entitlement to Indian status.

The current high indigenous population growth rates reflect the interplay of political, administrative, and cultural processes. In the past these processes effectively excluded or devalued indigenous representation in official statistics. In the contemporary period efforts increasingly are being made to encourage and facilitate self-identification. This means that populations that are portrayed as discrete and homogeneous for statistical and administrative purposes are in reality becoming less discrete, less homogeneous, and more difficult to quantify unambiguously. Despite this process, demographic divergence from national profiles remains a hallmark of indigenous populations.

See also: *Caste; Hunter-Gatherers; Nomads; Prehistoric Populations.*

BIBLIOGRAPHY

Bodley, John H. 1990. *Victims of Progress,* 3rd edition. Mountain View, CA: Mayfield.

Goehring, Brian. 1993. *Indigenous Peoples of the World: An Introduction to Their Past, Present and Future.* Saskatoon, Saskatchewan: Purich Publishing.

Gonzalez, Mary L. 1994. "How Many Indigenous People?" In *Indigenous People and Poverty in Latin America: An Empirical Analysis,* ed. George Psachanopoulos and Harry A. Patrinos. Washington D.C.: World Bank Regional and Sectoral Studies.

Gray, Alan. 1990. "Aboriginal Fertility: Trends and Prospects." *Journal of the Australian Population Association* 7(1): 57–77.

Hitchcock, Robert K., and Tara M. Twedt. 1995. "Physical and Cultural Genocide of Various Indigenous peoples." In *Genocide in the Twentieth Century: Critical Essays and Eyewitness Accounts,* ed. Samuel Totten, William S. Parsons, and Israel W. Charny. New York: Garland Publishing.

Kunitz, Stephen J. 1994. *Disease and Social Diversity: The European Impact on the Health of Non-Europeans.* New York: Oxford University Press.

Norris, Mary J. 1990. "The Demography of Aboriginal People in Canada." In *Ethnic Demography: Canadian Immigrant Racial and Cultural Variations,* ed. S. Shiva, Frank Trovato, and Leo Driedger. Ottawa, Ontario: Carelton University Press.

Passel, Jeffery S. 1996. "The Growing American Indian Population, 1969–1990: Beyond Demography." In *Changing Numbers, Changing Needs:*

American Indian Demography and Public Health, ed. Gary D. Sandefur, Ronald R. Rindfuss, and Barney Cohen. Washington D.C.: National Academy Press.

Pennington, Renee. 1991. *Te Iwi Maori: A New Zealand Population Past, Present, and Projected.* Auckland, New Zealand: Auckland University Press.

———. 2001. "Hunter-Gatherer Demography." In *Hunter-Gatherers: An Interdisciplinary Perspective,* ed. Catherine Painter-Brick, Robert H. Layton, and Peter Rowley-Conwy. Cambridge, Eng.: Cambridge University Press.

Smith, Leonard R. 1980. *The Aboriginal Population of Australia.* Canberra: Australian National University Press.

Snipp, Matthew C. 1997. "Some Observations about Racial Boundaries and the Experiences of American Indians." *Ethnic and Racial Studies* 20(4): 667–689.

Taylor, John. 1997. "The Contemporary Demography of Indigenous Australians." *Journal of the Australian Population Association* 14(1): 77–114.

Taylor, John, and Martin Bell. 1996. "Indigenous Peoples and Population Mobility: The View from Australia." *International Journal of Population Geography* 2(2): 153–169.

Thornton, Russell. 1987. *American Indian Holocaust and Survival: A Population History Since 1492.* Norman: University of Oklahoma Press.

John Taylor

INDUCED ABORTION

HISTORY	Etienne van de Walle
PREVALENCE	Stanley K. Henshaw
LEGAL ASPECTS	Laura Katzive Stanley Henshaw

HISTORY

Women throughout the world have probably attempted to procure abortion—premature artificial termination of pregnancy—from before recorded history. The earliest recorded version of the Hippocratic Oath (c. 500 B.C.E.) includes the physician's pledge: "I shall not give women a [fetus]-destroying pessary." This constitutes a testimony both to medical attitudes and practices in antiquity, and to the technology of the time.

Attitudes

Plato and Aristotle accepted the practice of abortion for eugenic reasons. Roman and Jewish law considered that the fetus had no independent existence and was part of the woman's body, subject to the authority of her husband. Legal conflicts originated when the termination of pregnancy was the result of violence inflicted by a third party, or was carried out by a woman against her husband's wishes. Opposition to abortion, together with opposition to infanticide, crystallized under the influence of Christianity. The Church fathers associated abortion first with magical procedures, and second with fornication and adultery, as the epitome of sexual sin. The fetus was thought to become formed or alive only after a delay, such as 40 days; a corollary of this belief was that penalties for abortion increased with the duration of gestation. Christian beliefs from the fourth century on identified this stage—40 days after conception, called "quickening"—with animation, the time when the fetus was endowed with an immortal soul; a similar belief prevailed in Islam. The distinction between abortion before and after quickening survived for a long time in canon law and civil jurisprudence (including common law in England and the United States), although it was abandoned by the Catholic Church in modern times.

Physicians of antiquity generally admitted the legitimacy of therapeutic abortion when the woman was immature or ill-formed, where pregnancy or delivery would endanger her life. Soranus, the Greek gynecologist of the second century C.E., gave recipes for abortion under these conditions, although he preferred the use of contraception for the same purpose. Soranus's position influenced the western medical tradition through Rome, Byzantium, and the translations of Arabic medical texts in the Middle Ages, and justified the publication of *Materia Medica* featuring abortive herbs and their continued availability to physicians. Although some Christian theologians accepted abortions for therapeutic reasons, most were opposed to the practice. Civil codes condemned abortion with great severity, but it remained a rare event until the nineteenth century, reserved for desperate women. Its practice spread with the need for better methods of birth control, even against the increasing opposition of physicians. During the second half of the twentieth century, early-term abortion (with various definitions of what qualifies as such) was legalized in many countries of the world. However, the moral acceptability of abortion remains controversial. Powerful movements of public opinion support the right of the fetus to life; others, equally influential, support a woman's freedom to choose the outcome of her pregnancy.

Techniques

Methods of abortion in the past either were ineffective or endangered the life of the mother. Vaginal suppositories appear to have been the most commonly used medical technique in the ancient world, because of the intuitive appeal of this route of access to the uterus; they were still mentioned in medical texts of the eighteenth century. Reference to abortive drugs in classical writings or Church pronouncements may refer either to suppositories or oral poisons, or even to spells and magic. The most frequently mentioned alternative technique consisted of violent movements, massage or blows, although milder methods like bleeding or cold baths were also cited. The use of sharp objects is rare before the seventeenth century, although various obstetrical instruments that could have been used for abortion have been described or even unearthed by archeologists. Soranus cautioned against the use of "something sharp-edged to separate the embryo." Dioscorides's second-century C.E. *Materia Medica* mentioned a number of drugs that would kill a fetus. In addition he listed more than one hundred substances that hastened delivery, expelled a dead fetus, or stimulated the menses. The latter were not abortifacients, but were supposed to act on the uterus. Learned as well as popular medicine and folklore in Europe through the medieval and modern periods attributed abortive properties to many herbal substances, including rue, artemisia, pennyroyal, ergot of rye, tansy, and saffron. A tea or potion made from savin, a species of juniper, was the most widely reputed abortifacient. These substances are implicated in many court proceedings, although it was the attempt (often unsuccessful) to procure an abortion, rather than the actual abortion, that was prosecuted. (Abortion was featured much less often in the courts than infanticide.) Similar substances are reputed as abortifacients in all world cultures, but their effectiveness has never been reliably ascertained. It seems their reputation was greatly inflated, although their popular use in the nineteenth and twentieth centuries, and their deplorable reputation among physicians, suggest that attempts at abortion through oral means were sometimes successful.

Other techniques, such as injections and the use of sharp instruments to kill the fetus, became increasingly common from the seventeenth century in Europe. In the early nineteenth century, most professional abortionists who were prosecuted on the basis of existing penal codes appeared to belong to the medical professions and to use uterine sounds and curettes. By the end of the century, some relatively proficient abortionists operated underground. The numerical importance of abortion during the fertility transition is a matter of controversy.

Throughout most of history, abortion must have been a dangerous and rare procedure, probably practiced almost exclusively outside of marriage, and with little impact on fertility. With the development of antisepsis the procedure of dilatation and curettage could be performed with relative safety by skilled medical personnel. The introduction of methods of early abortion during the second half of the twentieth century—by vacuum aspiration, as well as chemical procedures such as the administration of prostaglandins—coincided with the widespread legalization of abortion, and the blurring of the boundaries between contraception (particularly its post-coital forms) and abortion.

See also: *Birth Control, History of; Infanticide.*

BIBLIOGRAPHY

Brodie, Janet Farell. 1994. *Contraception and Abortion in 19th-Century America.* Ithaca, NY: Cornell University Press.

McLaren, Angus. 1984. *Reproductive Rituals: The Perception of Fertility in England from the Sixteenth to the Nineteenth Century.* London: Methuen.

Noonan, John, ed. 1970. *The Morality of Abortion: Legal and Historical Perspectives.* Cambridge, MA: Harvard University Press.

Potts, Malcolm, Peter Diggory, and John Peel. 1977. *Abortion.* Cambridge, Eng.: Cambridge University Press.

Van de Walle, Etienne. 1999. "Towards a Demographic History of Abortion." *Population. An English Selection* 11: 115–132.

Etienne van de Walle

PREVALENCE

The term "abortion" as used in this article refers to the induced termination of a pregnancy with intent other than to produce a live birth. An abortion may be induced legally or illegally, according to the laws of each country. It is to be distinguished from spontaneous abortion, including stillbirth, which is a natural outcome for a small proportion of pregnancies.

Sources of Data

The most accurate sources of information on the incidence of induced abortion are official statistics in countries where abortion is legal. In most of these countries, abortions are required to be reported to health authorities. However, the completeness and accuracy of reporting and the quantity and quality of the resulting tabulations vary widely among and even within countries. Reporting is probably most complete where a procedure for authorization is prescribed by statute and where abortions are required to be performed in hospitals or other facilities subject to official licensure.

In countries where no statistics are kept because abortion is illegal or there is no reporting system, a number of methods have been used to estimate the incidence of abortion. Household surveys yield minimum estimates because underreporting of abortions is common, even where the procedure is legal. These estimates may nevertheless be useful where abortion is widely practiced and accepted. Several studies have estimated abortion rates from the number of women treated in hospitals for abortion complications. These estimates rely on assumptions about the proportion of treated complications that result from induced rather than spontaneous abortions, the proportion of women needing treatment who seek hospital care, and the proportion of induced abortions that cause complications requiring treatment. A third approach is to survey the providers of abortions; this is rarely possible in countries where abortion is illegal. A fourth approach is to infer the abortion rate from the difference between the fertility rate and natural fertility, taking into account the reduction in fertility caused by contraceptive use, women not in unions, and rates of infecundity. This method, however, is extremely sensitive to the assumed rate of natural fertility and to small errors in calculating the impact of the other factors.

TABLE 1

Estimated Number of Abortions by Legal Status, Abortion Rate Per 1,000 Women Aged 15–44, and Percentage of Pregnancies Ending in Abortion, by Region and Subregion, 1995

	Number of abortions (millions)				% of
	Total	Legal	Illegal	Rate	pregnancies*
Total	45.5	25.6	19.9	35	26
Developed regions	10.0	9.1	0.9	39	42
Developing regions	35.5	16.5	19.0	34	23
Africa	5.0	**	5.0	33	15
Eastern Africa	1.9	**	1.9	41	16
Middle Africa	0.6	**	0.6	35	14
Northern Africa	0.6	**	0.6	17	12
Southern Africa	0.2	**	0.2	19	12
Western Africa	1.6	**	1.6	37	15
Asia	26.8	16.9	9.9	33	25
Eastern Asia	12.5	12.5	**	36	34
South-central Asia	8.4	1.9	6.5	28	18
South-eastern Asia	4.7	1.9	2.8	40	28
Western Asia	1.2	0.7	0.5	32	20
Europe	7.7	6.8	0.9	48	48
Eastern Europe	6.2	5.4	0.8	90	65
Northern Europe	0.4	0.3	**	18	23
Southern Europe	0.8	0.7	0.1	24	34
Western Europe	0.4	0.4	**	11	17
Latin America	4.2	0.2	4.0	37	27
Caribbean	0.4	0.2	0.2	50	35
Central America	0.9	**	0.9	30	21
South America	3.0	**	3.0	39	30
Northern America	1.5	1.5	**	22	26
Oceania	0.1	0.1	**	21	20

*Abortions divided by abortions plus births
**Fewer than 50,000
Note: Developed regions are Europe, Northern America, Australia, New Zealand, and Japan; all others are considered developing. Regions are as defined by the United Nations.

SOURCE: Henshaw et al. (1999).

Incidence

With appropriate caution regarding the high margin of error, it has been estimated that 46 million abortions were performed worldwide in 1995—about 26 million legal abortions and 20 million that were illegal (see Table 1). (The true numbers could be several million higher or lower.) This estimate implies an average annual rate of 35 abortions per 1,000 women aged 15 to 44. Cumulated, the estimate would mean that women, on average, have close to one abortion

TABLE 2

Abortion Rate per 1,000 Women Aged 15–44, and Percentage of Pregnancies Ending in Abortion, in Selected Developed and Developing Countries

Country and Year	Rate	% of pregnancies[a]
Developed countries		
Netherlands, 1996[b]	6.5	10.6
Germany, 1996	7.6	14.1
Finland, 1996	10.0	14.7
Canada, 1995	15.5	22.0
England & Wales, 1996[b]	15.6	20.5
Denmark, 1995	16.1	20.3
Sweden, 1996	18.7	25.2
Czech Republic, 1996	20.7	34.0
Australia, 1995–1996	22.2	26.4
United States, 1996	22.9	25.9
Hungary, 1996	34.7	42.1
Belarus, 1996	67.5	61.9
Russian Federation, 1995[c]	68.4	62.6
Romania, 1996[c]	78.0	63.0
Developing countries, legal abortion		
Tunisia, 1996	8.6	7.8
Puerto Rico, 1991–1992	22.7	23.0
China, 1995[c]	26.1	27.4
Khazakstan, 1996	43.9	41.3
Cuba, 1996[d]	77.7	58.6
Vietnam, 1996[c]	83.3	43.7
Developing countries, illegal abortions (estimated)		
Egypt, 1996	23.0	15.7
Philippines, 1994	25.0	16.0
Mexico, 1990	25.1	17.1
Nigeria, 1996	25.4	12.0
Bangladesh, 1995[d]	28.0	18.0
Brazil, 1991	40.8	29.8

[a]Abortions divided by abortions plus births six months later (so that time of conception of pregnancies ending in abortion and birth would correspond)
[b]Residents only
[c]Reporting incomplete
[d]Includes menstrual regulation

SOURCE: Henshaw et al. (1999).

during their lifetimes. About 26 percent of all pregnancies, excluding miscarriages and stillbirths, were ended by induced abortion.

The abortion rates in developed and developing regions are broadly similar, despite the prevalence of restrictive laws in most developing countries. China, India, and Vietnam account for almost all of the legal abortions in the developing regions. Most abortions in other parts of Asia and also in Africa and Latin America are illegal.

Eastern Europe, including the Russian Federation, is the subregion with the highest abortion rate. In these countries, the lack of access to contraceptive methods and ready availability of abortion services under Communism resulted in heavy reliance on abortion to limit fertility. Western Europe, where abortion is legal and readily available, has the lowest rate. The percentage of pregnancies ending in abortion is lowest in Africa, a consequence of the region's high birth rates.

Abortion rates vary widely among countries, as indicated in Table 2. Among low-fertility countries, the level of abortion appears to be determined primarily by the availability, accessibility, and acceptability of contraceptive services. During the 1990s, the lowest recorded rate—less than 7 abortions per 1,000 women aged 15 to 44—was in the Netherlands, despite a low fertility rate and abortion services that are readily available without charge. Only 11 percent of pregnancies nationwide were ended by abortion, with only 3 to 4 percent among the Dutch-born population. The highest abortion rate ever recorded for a country was 252 per 1,000 women in Romania in 1964 and 1965.

Abortion rates are generally higher in developing countries, because of less established contraceptive use, less accessible contraceptive services, and the limited range of contraceptive methods available. The example of Tunisia, however, demonstrates that the use of modern contraceptives can keep the rate low even where abortion services are available and free. Vietnam, on the other hand, had one of the highest abortion rates in the 1990s as a consequence of a rapid drop in desired family size and limited access to modern contraceptive methods. Including abortions performed in the private sector and not counted officially, the abortion rate in Vietnam was estimated to be 111 per 1,000 women in 1996. Estimates of abortion rates in several countries where abortion is illegal are in the range of 23 to 41 per 1,000 women, and the percentage of pregnancies ended by abortion ranges from 12 to 30.

Trends

During the 1990s, abortion rates fell slowly in several Western European countries and the United States, and they fell rapidly in most of the formerly-Communist countries as contraceptive supplies and services became more available. In many developing areas, the demand for both abortion and contraception increased as desired fertility fell, marriage was delayed, and sexual activity before marriage became more common.

In developed countries, non-surgical abortion by means of mifepristone (RU-486) together with a prostaglandin became increasingly common but did not appear to affect overall abortion rates. In developing countries where abortion is illegal, misoprostol, a prostaglandin used to prevent stomach ulcers among long-term users of pain medications, is increasingly used to induce abortion, although it is not always effective. Its effect on abortion rates is unknown, but in Brazil and other countries it has reduced the number of serious complications of illegal and unsafe abortions.

See also: *Contraceptive Prevalence; Fertility, Proximate Determinants of; Spontaneous Abortion.*

BIBLIOGRAPHY

Henshaw, Stanley K., Susheela Singh, and Taylor Haas. 1999. "The Incidence of Abortion Worldwide." *International Family Planning Perspectives* 25(Supplement): S30–S38.

Henshaw, Stanley K., Taylor Ann Haas, Kathleen Berentsen, and Erin Carbone, eds. 2001. *Readings on Induced Abortion, Volume 2: A World Review 2000.* New York: The Alan Guttmacher Institute.

Koonin, Lisa M., Lilo T. Strauss, Camaryn E. Chrisman, and Wilda Y. Parker. 2000. "Abortion Surveillance—United States, 1997." *Morbidity and Mortality Weekly Report, CDC Surveillance Summaries* 49(SS–11): 1–43.

World Health Organization Division of Reproductive Health. 1998. *Unsafe Abortion: Global and Regional Estimates of Incidence of and Mortality Due to Unsafe Abortion, with a Listing of Available Country Data (WHO/RHT/MSM/97.16).* Geneva: World Health Organization.

Stanley K. Henshaw

LEGAL ASPECTS

Around the world, the widely varying legal status of abortion reflects a range of social priorities and values, including women's health, views on religion or morality, and reproductive rights. While over 60 percent of the world's population lives in countries where abortion is a woman's choice or available on broad grounds, in many countries it is a crime and the procedure is permitted by law only under limited circumstances.

In any given country, abortion may be treated in multiple legal codes, statutes, and regulations. Where abortion is or has historically been criminalized, it is usually included in the country's penal code. Numerous other sources of law, including judicial opinions and health codes, may elaborate upon and sometimes moderate criminal laws, delineating the circumstances in which abortion may be legally performed. Abortion's legal status may also be affected by "general principles" of law, which are widely recognized legal norms used to interpret legislation. Many countries that ostensibly prohibit the procedure under all circumstances may permit life-saving abortions under the general principle of necessity, which justifies actions taken reasonably to save one's life or the life of another.

Abortion laws within one country also may vary according to jurisdiction. Several countries, including Australia, Canada, Mexico, and the United States, have legal systems at the provincial or state level as well as the national level, creating variations in abortion regulation among jurisdictions. While constitutional guarantees in Canada and the United States provide protection for women's right to choose abortion, its legality varies by state in Australia and Mexico, where no such guarantees have been recognized.

Categories of Abortion Laws

The world's abortion laws can be classified into five broad categories, reflecting varying degrees of restrictiveness. They are described below, in order from the most to the least restrictive.

1. Abortion is prohibited entirely or permitted only to save a woman's life. This category, the most restrictive, applies to 73 countries with about one-quarter of the world's population. These countries, primarily in Africa, Asia, and Latin America, include Brazil, Chile, Colombia, Ireland, Iran, Indonesia, Kenya, the Philippines, Senegal, Syria, and Uganda. In some countries in this category, including El Salvador and Guatemala, criminal prohibitions of abortion are supported by constitutional provisions protecting life from the moment of conception.
2. Abortion is permitted only when a woman's life or physical health is in jeopardy. Laws in this only slightly less restrictive category

apply in 33 countries, affecting nearly 10 percent of the world's population. Argentina, Bolivia, Peru, Morocco, Saudi Arabia, Pakistan, Thailand, Poland, Burkina Faso, and Zimbabwe are among the countries in this category. While some of the laws in this category may be interpreted to permit abortion on mental health grounds, none does so expressly.

3. Abortion is explicitly permitted on the grounds of mental as well as physical health. Laws in this category are in effect in 19 countries with just over 2.5 percent of the world's population. These include Israel, Malaysia, Portugal, Spain, Ghana, Namibia, and New Zealand. The term "mental health" is potentially open to broad interpretation; it can, for example, address the psychological distress associated with pregnancy resulting from rape or incest in situations where abortion on these grounds is not explicitly recognized in the law.
4. Abortion is permitted on socioeconomic grounds. These laws are in force in 14 countries accounting for nearly 21 percent of the world's population, including Great Britain (not Northern Ireland), India, Japan, and Zambia. They typically permit consideration of a woman's economic resources, her age, her marital status, and the number of children she has. Such laws tend to be interpreted liberally and, in their implementation, may differ very little from laws in category 5.
5. Abortion is permitted without restriction as to reason during a prescribed period of the pregnancy. In most countries, this period corresponds to the first 12 or 14 weeks of the pregnancy. Among the 52 nations in this category, representing about 41 percent of the world's population, are most industrialized countries, including the United States, Canada, China, Vietnam, France, Germany, Italy, the Russian Federation, and South Africa. Countries that require a woman to affirm that she is in a state of "distress" or "crisis" in order to terminate a pregnancy—like Belgium, France, and Hungary—have been included in this least restrictive category, because it is the woman herself who ultimately decides whether she qualifies for an abortion.

Additional Grounds and Requirements

Countries that fall into any of the five categories described above may permit abortion on other grounds, such as in cases of rape, incest, and fetal impairment. Likewise, a country may place additional legal restrictions on abortion. These may include requirements that women obtain permission for abortion from spouses or parents, conditions on the type of providers who may perform abortions and the facilities in which they may be provided, mandatory counseling and waiting periods, constraints on abortion advertising, and restrictions on public funding for abortion. Where son preference is widespread, some countries have adopted legal measures to prevent the practice of sex-selective abortion. India has prohibited prenatal sex determination for the purpose of sex-selective abortion and, more recently, China and Nepal have adopted similar provisions while also prohibiting sex-selective abortion itself.

Even where abortion laws are highly restrictive, criminal prosecutions of abortion providers and patients may be rare or inconsistent. Similarly, laws providing for legal abortion do not guarantee access to the service for all women who qualify under the law.

Trends over Time

Abortion laws are not static. A global trend toward liberalization began during the latter half of the twentieth century and has continued into the twenty-first century, albeit with some signs of a restrictive counter-trend in Latin America and Central Europe. Some countries, such as Malaysia and Ghana, have made incremental steps toward liberalization, maintaining abortion's criminal status while recognizing therapeutic and/or juridical grounds for abortion. Other countries, such as Nepal and Cambodia, have rejected longstanding criminal bans on abortion in favor of laws that are among the world's least restrictive.

In societies that have traditionally placed a high value on fertility, abortion is often illegal and the prohibition is supported by strong social norms. Women in these societies who seek to limit their family size because of changing economic and social conditions often turn to illegal abortions performed by poorly trained practitioners. The need to protect women's health from unsafe abortion providers has historically been the main impetus for liberalizing abortion laws. Other motivations for reducing abortion restrictions have included bringing the law into conformity with practice, responding to demographic considerations, and, most recently, recognizing women's reproductive rights.

The world is likely to see further liberalization of abortion laws in the years to come, as reform movements develop momentum in countries around the world. In national and international forums, governments have shown increasing recognition of the costs of restrictive abortion laws, which are borne not only by the women immediately affected, but also by their families, communities, and societies.

See also: *Feminist Perspectives on Population Issues; Reproductive Rights.*

BIBLIOGRAPHY

Rahman, Anika, Laura Katzive, and Stanley Henshaw. "A Global Review of Laws on Induced Abortion, 1985–1997." *International Family Planning Perspectives* 24(2): 56–64.

INTERNET RESOURCES.

United Nations Department for Economic and Social Development. 1999. *Abortion Policies: A Global Review.* <http://www.un.org/esa/population/publications/abortion/abortion.htm>.

United Nations Population Fund and Harvard Law School. 2002. *Annual Review of Population Law.* <http://www.law.harvard.edu/programs/annual_review/annual_review.htm>.

LAURA KATZIVE
STANLEY K. HENSHAW

INFANT AND CHILD MORTALITY

During the twentieth century almost all countries experienced decreases in child mortality rates. However, the timing and pace of the decline varied substantially. Sustained reductions in child mortality began in the nineteenth century in Europe, North America, and Japan and continued gradually throughout the twentieth century. Major declines in other parts of the world generally began only after World War II. Mortality reductions in Asia, Latin America, and Africa were usually much more rapid than they had been in countries that began mortality declines earlier. By 1999 there were great variations in child mortality among countries. For example, although fewer than 0.5 percent of children died before the fifth birthday in Iceland, more than 33 percent died by age five in Niger.

Since the 1960s the decline in child mortality sometimes has appeared to have stagnated. One such period was 1975–1985, when many poor countries experienced severe debt crises and other problems, such as economic recovery from the oil crisis of 1973–1974. Recent evidence suggests that child mortality has continued to decline in most countries since 1980. However, during the 1990s the HIV/AIDS epidemic halted or reversed declines in child mortality in some eastern and southern African countries. For example, in Zimbabwe in the period 1990–1994 there were 80 deaths under age five per 1,000 live births. By 1999 that rate had increased to 118 deaths per 1,000 live births.

Measuring Infant and Child Mortality

Mortality rates often are calculated separately for the neonatal period (from birth to age 28 days) and the postneonatal period (from 1 to 11months of age). Infant mortality rates, which measure the probability of death in the first year of life, are the sum of neonatal and postneonatal mortality rates. The under-5 mortality rate (U5MR) refers to deaths from birth up to a child's fifth birthday. Each rate is calculated as the number of deaths in the specific age group per 1,000 live births. For example, a U5MR of 150 indicates that there are 150 deaths before the fifth birthday for every 1,000 live births, or that 15 percent of children die before age five. Estimates of infant and child mortality rates for every country are produced regularly by the United Nations Population Division.

Causes of Death and Morbidity

Causes of death vary substantially by age during the first five years of life. Deaths in the neonatal period are likely to be caused by "endogenous" conditions such as congenital malformations, chromosomal abnormalities, and complications of delivery, as well as by low birthweight. Deaths during the postneonatal period and between ages one and four years are likely to be caused by "exogenous," or external, factors such as infectious disease, accidents, and injury. As mortality rates decline, both postneonatal mortality rates and rates for one- to four-year-olds decline more rapidly than does neonatal mortality. The reason for this is that improved living standards, better health care, and public health programs have greater effects on exogenous causes of death than on endogenous causes.

As mortality rates decline, deaths under age five typically become more concentrated in the neonatal period until the infant mortality rate reaches about 20 deaths per 1,000 live births. With further reductions in infant mortality below this level this pattern generally reverses and child deaths become less clustered in the neonatal period as better prenatal, delivery, and postnatal care reduce mortality in the first month of life.

The leading causes of death for young children vary considerably, depending on the overall level of mortality. In countries with higher mortality rates infectious and parasitic diseases, especially acute respiratory infections (ARIs) and diarrheal disease, are the most important causes of death after the first month of life. In 1995 more than 50 percent of deaths among children under age five in poorer countries were due to ARIs, diarrhea, measles, or malaria. In low-mortality countries such as the United States the primary causes of death under age five are generally accidents, injuries, and perinatal conditions. In 1999 the leading causes of death in the United States were (1) in the neonatal period, congenital malformations and chromosomal abnormalities and complications of delivery, low birthweight, and a short gestation, (2) in the postneonatal period, sudden infant death syndrome (SIDS), congenital malformations and chromosomal abnormalities, accidents, and circulatory diseases, and (3) for one- to four-year-olds, accidents, congenital malformations and chromosomal abnormalities, cancers, homicide, and heart disease. In the year 2000 the cause-of-death structure in poor countries, in which infectious diseases are still a major cause of death, was very similar to that in the United States around 1900, when the U5MR was almost 200 deaths per 1,000 live births.

Reasons for Child Mortality Decline and Differential Child Mortality

The dramatic decline in mortality rates at all ages during the last 200 years in most human populations can be attributed to four broad causes: (1) increases in household income and associated improvements in nutrition, housing quality, and standards of living, (2) investments in public works (e.g., sanitation systems, garbage disposal, water quality, roads) and public health interventions (e.g., quarantines, mosquito eradication, vaccination), (3) changes in beliefs about disease causation and concomitant behavioral changes (e.g., hygiene, better treatment of illness), and (4) improvements in medical technology (e.g., pharmaceuticals, medical practices, vaccine development).

These factors all significantly reduced infant and child mortality and morbidity. Better living standards improved the diet of mothers and young children and reduced children's exposure to infectious organisms. Public works and public health programs further reduced exposure to infections and disease vectors (e.g., mosquitoes and other carriers), and vaccinations increased children's resistance to infection. Changes in beliefs about disease causation have substantially changed the way families and medical personnel care for infants and young children. For example, widespread knowledge that germs (e.g., bacteria and viruses) cause infectious diseases has led to improved hygiene particularly in food preparation for children, which has substantially reduced the prevalence of childhood diarrheal infections in low-mortality countries. Advances in medical technology have greatly improved the prevention and treatment of childhood illnesses, although this effect occurred mostly after World War II.

Extensive research has shown that socioeconomic status, particularly family income and maternal education, affects children's risk of illness and death. Poor, uneducated parents have more difficulty preventing their children from becoming ill and treating or seeking treatment for illness when it occurs. It has been suggested that socioeconomic status affects child health through five proximate determinants:

1. Maternal fertility patterns;
2. Environmental contamination;
3. Nutrient deficiency;
4. Personal illness control; and
5. Injury.

Certain maternal fertility patterns, including having children at very young (under 15 years) or very old (over 40 years) maternal ages, high parity (having had a large number of previous births), and having a child after a short time interval since the last birth (less than 24 months), appear to reduce children's survival chances, particularly when mothers are malnourished and high-quality prenatal and maternity care are not readily available.

Because infectious diseases are a major cause of child illness and death in high-mortality countries, environmental contamination in the household puts children at higher risk. Environmental contamination includes inadequate hand washing before food preparation and the feeding of children; contaminated water, clothing, and air; allowing children to put dirty objects in their mouths; and exposure to vectors of disease such as mosquitoes. Nutrient deficiency is important because malnutrition makes children more vulnerable to disease. Common types of malnutrition in poor children include inadequate caloric intake, protein-calorie malnutrition (inadequate caloric and protein intake), and micronutrient deficiencies (e.g., anemia and inadequate vitamin A intake). Breastfeeding provides an essential source of sanitary and complete nutrition for infants, particularly those who live in poverty. Personal illness control includes taking advantage of preventive measures such as immunizations, prenatal care, and malaria prophylaxis and treating illnesses promptly either through effective home remedies (such as oral rehydration therapy for the treatment of diarrhea) or by seeking help from medical personnel.

Sex Differences

In almost all populations mortality rates at all ages are lower for females than they are for males. Almost universally, girls have lower neonatal, postneonatal, and U5MR mortality rates than do boys. Research suggests that the differences are due to female genetic and biological advantages over males (Perls and Fretts 1998). Nonetheless, because the sex ratio at birth is generally about 105 male babies to 100 female babies, the number of boys in a population generally slightly exceeds the number of girls throughout childhood.

In a few cases, such as northern India, Pakistan, and Bangladesh, girls experience higher child mortality than do boys. Higher female child mortality also was observed historically in some European populations. This unusual pattern generally results from poorer care, less food, and less health care for girls than for boys. In these populations families coping with poverty may decide to invest their limited resources more heavily in sons, who are more likely to remain with the parents throughout their lives, than in daughters, who traditionally marry into other families at an early age.

The Role of Policy

Public policies have had both indirect and direct effects on child mortality and morbidity. Those with indirect effects include: (1) economic development policies that improved living standards and diet; (2) compulsory education, particularly for girls, which has changed the role of children in families and has led to higher levels of educational attainment for mothers; and (3) investments in transportation, communications, and public works projects, which have reduced the costs of transporting food, increased mobility and the diffusion of ideas and information, and provided clean water and sanitation.

International, national, local, and international agencies have attempted to improve child health directly through a wide array of programs and policies. For example, in the late 1800s and early 1900s New York and other American cities introduced milk stations where pasteurized milk was made available for children and eventually mandated commercial milk pasteurization. They also licensed midwives, implemented compulsory vaccination for schoolchildren, removed tuberculosis patients from their households, and provided widespread health education, including the promotion of breastfeeding.

Since World War II international agencies and national governments have coordinated efforts to improve children's health in African, Asian, and Latin American countries. These efforts have included improving access to health care, especially in rural areas; immunization campaigns; nutritional supplementation programs; and insecticide spraying to kill mosquitoes. In the 1980s international agencies and donors funded a series of child survival programs in low-income countries. Those programs were based on a set of "selected primary health care" measures that would have a substantial effect on child health but would not depend on the existing health care system in poor countries. Those efforts included child immunization programs, the distribution of oral rehydration packets, growth monitoring for children to detect malnutrition, and education programs to encourage breastfeeding. Some national programs also include nutritional supplementation for pregnant and breastfeeding women, malaria prophylaxis for pregnant women and children, and the distribution of "safe motherhood" kits.

An evaluation of these programs suggests that although immunization programs were often quite effective, some important causes of childhood illness and death, such as ARIs and diarrhea, cannot be reduced by selective primary health programs alone. Since the late 1990s the World Health Organization has been promoting a more comprehensive approach to improving child health in poor countries. Known as the Integrated Management of Childhood Illnesses (IMCI), this program includes three major elements: (1) improving the case management skills of health-care personnel, (2) improving overall health systems, and (3) improving family and community health practice. By June 2001 IMCI had been implemented in most Asian, Middle Eastern, and Latin American countries and in the countries of the former Soviet Union. Many African countries were also beginning implementation.

See also: *Causes of Death; Health Transition; Maternal Mortality; Mortality Decline; Mortality Differentials, by Sex.*

BIBLIOGRAPHY

Ahmad, Omar B., Alan D. Lopez, and Mie Inoue. 2000. "The Decline in Child Mortality: A Reappraisal." *Bulletin of the World Health Organization* 78(10): 1,175–1,191.

Ewbank, Douglas C., and James N. Gribble, eds. 1993. *Effects of Health Programs on Child Mortality in Sub-Saharan Africa.* Washington, D.C.: National Academy Press.

Mosley, W. Henry, and Lincoln C. Chen. 1984. "An Analytic Framework for the Study of Child Survival in Developing Countries." *Child Survival: Strategies for Research. Population and Development Review* 10(supplement): 25–48.

Pebley, Anne R. 1993. "Goals of the World Summit for Children and Their Implications for Health Policy in the 1990s." In *The Epidemiological Transition: Policy and Planning Implications for Developing Countries,* ed. James N. Gribble and Samuel H. Preston. Washington, D.C.: National Academy Press

Preston, Samuel H., and Michael R. Haines. 1991. *Fatal Years: Child Mortality in Late Nineteenth-Century America.* Princeton, NJ: Princeton University Press.

World Health Organization, Department of Child and Adolescent Health and Development (WHO/CAH). 1999. *IMCI Information.* Geneva: WHO publication WHO/CHS/CAH/98.1A Revision 1.

INTERNET RESOURCES.

Anderson, Robert N. 2001. "Leading Causes of Death for 1999." *National Vital Statistics Report* 49(3): 1–88. United States National Center for Health Statistics. <http://www.cdc.gov/nchs/data/nvsr/nvsr49/nvsr49_11.pdf>.

Hill, Kenneth, and Rohini Pande. 1997. "The Recent Evolution of Child Mortality in the Developing World." Arlington, VA: BASICS, Current Issues in Child Survival Series. <http://www.basics.org>.

Perls, Thomas T., and Ruth C. Fretts. 1998. "Why Women Live Longer Than Men." *Scientific American* June. <http://www.sciam.com/1998/0698womens/0698perls.html>.

United Nations, Population Division. 2001. *World Population Prospects: The 2000 Revision.* New York: United Nations. <http://www.un.org/esa/population/publications/publications.htm>.

Anne R. Pebley

INFANTICIDE

Although the term is sometimes used to denote the willful killing of children of any age, infanticide usually refers to the newborn; infanticide occurs mostly soon after birth. There are broadly speaking two kinds of infanticide. The first is practiced as a method of family formation; the second occurs mostly outside of marriage, to avoid the shame of illegitimate births.

Infanticide as Tool of Family Formation

In Greek and Roman antiquity, the decision to kill a child was a prerogative of the family head. Evidence about its practice is largely anecdotal, often in the form of narratives about famous men who were abandoned at birth and saved from death, such as Oedipus or Romulus and Remus, the mythical founders of Rome. Typical grounds for killing a child, such as physical impairment or the unwanted sex of the child, could only be recognized after delivery. Infanticide by exposure was practiced in Sparta for eugenic reasons, and was approved for similar reasons by Aristotle. It is speculated that female infanticide was practiced widely in antiquity, although statistical evidence in the form of imbalance of the sex ratio is ambiguous. Historian John Boswell, in his study published in 1988, hypothesized that child abandonment in antiquity was a benign form of population control, allowing people who did not welcome the arrival of a child to entrust it to "the kindness of strangers" desirous of adopting it. The inference is questionable, since most children could not survive without access to human milk, and the availability of a nurse at the time a child was found could not be taken for granted, even though mythical stories often involve the intervention of animals such as goats or she-wolves.

Christian and Jewish influences were largely responsible for the condemnation of deliberately caused infant death in the West, but infanticide was widely practiced in ancient Asian societies, and its importance is attested by historical studies on Tokugawa Japan and imperial China, and by testimonies on nineteenth-century India. Female infanticide dominated, particularly among the poor, and was justified by the fact that daughters would contribute little to their family of origin, while sons were responsible for the care of parents in old age and for performing familial rites. Neglect, harsh treatment, and preferential male feeding led to the higher mortality of girl babies, and might be considered a form of infanticide.

Infanticide to Conceal a Birth

The second type of infanticide, practiced by unmarried mothers right after delivery in order to avoid shame, prevailed in Western countries and is still encountered in the early twenty-first century. In the past, concealing a pregnancy and killing or abandoning the infant was the most readily available method of "birth control" for unmarried women. However, its effect on population numbers must have been small. In most countries of Europe, legal codes dating back to the Middle Ages prescribed punishment by death for women convicted of infanticide, but in practice the penalty was typically less severe. In the sixteenth and seventeenth centuries, the authorities of several countries passed legislation designed to regulate the unruly poor and impose strict norms of morality. In England, for example, a serious attempt was made to control extramarital relations and deter bastardy as a way of avoiding a potential burden on local finances. In Germany, unmarried mothers were mostly seduced maidservants, who were banished from the community.

Concealing the pregnancy and the birth was a desperate reaction. Royal edicts in France and England created a presumption of infanticide, punishable by death, when an unreported extra-marital pregnancy resulted in miscarriage or death of the infant. By the eighteenth century the severity of the penalty seemed to deter juries from convicting a woman whose child had died. In most countries, there was a relaxation of attitudes, and systems aiming at the protection of infants rather than at the punishment of mothers were set in place.

Foundling Hospitals

The first foundling hospitals were created in Italy as early as the thirteenth century. Some were eventually created in France too, and "tours" (revolving doors where a child could be abandoned without any questions asked) were installed in churches and hospitals. It is sometimes assumed that the extraordinarily high mortality rate of children in foundling hospitals amounted to the institutionalization of infanticide, but it is a more plausible explanation that the institutions failed in their mission because of the technical difficulty of keeping children alive without reliable access to a supply of maternal breast milk. Abandonments grew in numbers together with the institutions designed to cope with the practice. Paris in the late eighteenth century, with a population of half a million, admitted more than 7,000 foundlings a year, but at least a third of those came from out of town. By the beginning of the nineteenth century, many large Western cities had institutions for foundlings recording sizable populations (there were between three and four thousand foundlings per year in New York in the 1870s) and a mortality well over 50 percent of admissions was common.

The Italian system in the early nineteenth century was characterized by a multiplicity of "tours" even in rural churches, and foundling homes with very high mortality. Unmarried mothers would nurse children other than their own before they were reintegrated in their communities, where the birth would have been kept secret. Men rarely assumed responsibility for their illegitimate offspring. In English-speaking countries, however, the responsibility for the care of illegitimate children was to the extent possible shifted to the mother and father of the child.

Demographic Effects

The demographic impact of infanticide was probably small. Some writers have suggested that it constituted an important check on population growth, but this is based on assumptions rather than recorded facts, in an area that is notoriously difficult to investigate and document. Actual condemnations for infanticide remained infrequent in all periods, and were mainly restricted to extra-marital relations. The controversy concerning the quantitative importance of infanticide hinges on the frequency of the practice among married couples. There it took the form of neglect, making it difficult to distinguish from high mortality from poverty and natural causes. The church and civil authorities expressed concern about overlaying (the accidental smothering of infants sleeping with their parents) and other accidental deaths, but it may well be that they were implicitly accusing poor parents of responsibility for deaths that in the twenty-first century would be blamed on unidentified causes, such as the sudden infant death syndrome. There is little evidence of differential female mortality in this context.

See also: *Birth Control, History of; Induced Abortion: History; Sex Selection.*

BIBLIOGRAPHY

Boswell, John. 1988. *The Kindness of Strangers: The Abandonment of Children in Western Europe from Late Antiquity to the Renaissance.* New York: Pantheon Books.

Fuchs, Rachel G. 1984. *Abandoned Children: Foundlings and Child Welfare in Nineteenth-Century France.* Albany: State University of New York Press.

Hoffer, Peter C. and N.E.H. Hull. 1981. *Murdering Mothers: Infanticide in England and New England 1558–1803.* New York: New York University Press.

Kertzer, David I. 1993. *Sacrificed for Honor. Italian Infant Abandonment and the Politics of Reproductive Control.*. Boston: Beacon Press.

Rublack, Ulinka. 1999. *The Crimes of Women in Early Modern Germany.* Oxford: Clarendon Press.

Etienne van de Walle

INFERTILITY

Infertility—the biologically-based inability to conceive, also referred to in the literature as infecundity—is of enormous concern to those immediately affected. In affluent societies it is the focus of intensive remedial efforts by physicians and medical researchers. In the developing world, it has been relatively neglected: attention to fertility issues has been overwhelmingly directed to the problem of limiting the number of births. This imbalance only began to change with the shift in family planning programs toward an emphasis on reproductive health, as signaled in the *Programme of Action* of the 1994 United Nations International Conference on Population and Development. Reproductive health care, according to this statement, includes safe delivery, prevention and appropriate treatment of infertility, abortion, and treatment of reproductive health conditions. Each of the conditions included within reproductive health care affects infertility.

Definitions and Measurement

The clinical definition of infertility is the absence of conception after 12 months of regular, unprotected intercourse. The World Health Organization (WHO) definition is the same except that it specifies a period of 24 months. (The discrepancy occurs because in clinical practice it is important to initiate treatment as early as possible, while in research it is important to reduce the number of fertile women falsely classified as infertile.)

Demographers define infertility as the inability of a sexually-active woman who is not using contraceptive methods to have a live birth. Demographers have shifted the endpoint from conceptions to live births because it is difficult to collect complete data about conceptions in population-based studies. The fertility surveys that are typically used in demographic analyses of infertility usually contain complete birth histories but no information about abortions and stillbirths. Because it is difficult to assess exposure from such data, demographic estimates of infertility need to be based on relatively long periods of exposure to childbearing. Based on simulation studies, demographers recommend using seven years of exposure to measure childlessness and five years to measure subsequent infertility (that is, to be considered infertile, a non-contracepting, sexually-active woman who has a child must not have another birth within five years, counting from the month after the last birth). The proportion of women subsequently infertile at five-year age intervals provides a measure of the age pattern of infertility in the population.

Infertility is measured from information about the woman, and infertility of the woman cannot be distinguished from infertility of the couple. The cause of infertility may be the infertility of the woman's sexual partner(s).

Infertility may be divided into primary infertility, which denotes infertility of women who have never conceived, and secondary infertility, which denotes infertility of women who have conceived at least once. According to the demographic definitions, primary infertility is approximated by childlessness and secondary infertility by the proportion subsequently infertile measured for women with children.

Infertility in Societies with Little Contraception

On average, less than 3 percent of all couples are biologically unable to have children: primary infertility is relatively rare in most populations. In terms of country averages, the proportion of currently married women ages 25 to 49, in first union, married over five years that are childless ranges from 1.7 to 2.5 percent in Asia, from 0.9 to 2.8 in Latin America, from 2.2 to 2.8 in North Africa, and from 0.9 to 2.3in sub-Saharan Africa.

Secondary infertility varies over a wider range. Most estimates of its level refer to sub-Saharan Africa, where some countries have particularly high prevalence. For instance, among women aged 20 to 44, secondary infertility is estimated at 25 percent in Central African Republic and 21 percent in Mozambique; in contrast, the level is 5 percent in Togo. The African data indicate that secondary infertility is consistently as high or higher in urban areas in comparison to the corresponding rural areas. Furthermore, women married more than once, women in polygamous unions, and women who initiated sexual relations in their early teenage years tend to have higher infertility, suggesting that sexual practices and sexually transmitted diseases (STDs) are main causes of infertility in the region. Further evidence on the role of STDs comes from a 1979–1984 WHO multi-center study of infertile couples, which recorded a two- to three-fold higher level of bilateral tubal occlusion or other tubal damage in sub-Saharan Africa than in Asia, the Eastern Mediterranean, and Latin America. This finding suggests a higher incidence of infertility in sub-Saharan Africa caused by infections from STDs, such as chlamydia and gonorrhea, and complications following delivery and abortion (induced abortion is illegal in most of Africa). Hence, in sub-Saharan Africa the causes of secondary infertility are often *acquired*: they result from infectious factors that can be prevented. Primary infertility is modest relative to secondary infertility, probably because sub-Saharan women start childbearing early and they have one or more children before they become infertile.

Infertility in Societies with Widespread Contraceptive Use and Later-Age Childbearing

It is not possible to provide accurate country-level estimates of infertility in populations with widespread contraception, because in these societies fertile women have the number of children they want, and subsequently they use contraception to prevent further unwanted births. As a result, samples of non-contraceptors contain disproportionate numbers of women with lower fecundability and women who have postponed childbearing to older ages. Estimates of the prevalence of infertility in contracepting populations should therefore be treated with caution. In the United States, the 1995 National Survey of Family Growth found that about 10 percent of women reported fertility problems (defined as at least 36 months preceding the survey without a pregnancy), a slight increase over the 1970s and 1980s. The higher proportion of older women trying to have a child in 1995 may explain this trend in infertility.

American women seeking infertility services are a select group that is more likely to be married, to have a high income, and to have private health insurance. Most of these women receive low-technology interventions. With use of modern technologies, it would be possible to provide genetically related offspring to 80 percent of infertile couples, and pregnancy to a further 10 to 15 percent using donated gametes. However, worldwide only a small fraction of infertile couples can afford such treatment.

See also: *Childlessness; Fecundity; Reproductive Technologies.*

BIBLIOGRAPHY

Arnold, Fred, and Ann K. Blanc. 1990. *Fertility Levels and Trends.* Columbia, MD: Demographic and Health Surveys, Institute for Resource Development/Macro Systems, Inc.

Bentley, Gillian R., and C. G. Nicholas Mascie-Taylor, eds. 2000. *Infertility in the Modern World: Present and Future Prospects.* Cambridge, Eng.: Cambridge University Press.

Cates, Willard, Robert T. Rolfs, and Sevgi O. Aral 1990. "Sexually Transmitted Diseases, Pelvic Inflammatory Disease, and Infertility: An Epidemiologic Update." *Epidemiologic Review* 12: 199–220.

Cates, Willard, Tim M. M. Farley, and P. J. Rowe. 1985. "Worldwide Patterns of Infertility: Is Africa Different?" *Lancet* II: 596–598.

International Conference on Population and Development. 1995. "Programme of Action of the 1994 International Conference on Population and Development." *Population and Development Review* 21: 187–215 and 437–463.

Larsen, Ulla. 2000. "Primary and Secondary Infertility in Sub-Saharan Africa." *International Journal of Epidemiology* 29: 285–291.

Larsen, Ulla, and Jane Menken. 1989. "Measuring Sterility from Incomplete Birth Histories." *Demography* 26: 185–201.

Stephen, Elizabeth H., and Anjani Chandra. 2000. "Use of Infertility Services in the United States: 1995." *Family Planning Perspectives* 32(3): 132–137.

Ulla Larsen

INFLUENZA

Influenza (flu) is an important cause of morbidity and mortality. Flu is caused by infection with the influenza virus, a member of the Orthomyxoviridae family. Infection leads to illness, typically lasting a week, characterized by fever, sore throat, cough, headache, runny nose, and fatigue. Mild cases of flu can result in the common cold. In the medically more severe cases of flu, and in all fatal cases, a secondary pneumonia arises as a complication.

Flu is spread from person to person through sneezing and coughing. Influenza is zoonotic, that is, it has an animal origin, with avian and porcine strains able to jump species. The flu genome consists of eight single strands of RNA, which means that new strains can arise whenever an individual is infected with two existing strains. To be effective, flu vaccines, formulated on the basis of surveillance of early cases, must be given every year because of these constantly-changing strains.

Influenza is an epidemic disease in several respects. There is great year-to-year variability in morbidity, mortality, and incidence, and more intense periods are labeled as epidemics. New strains spread in epidemic style across regions, documented in a rich body of work by medical geographers, using both historical and modern data. There are occasional pandemics—severe outbreaks, global in scope; twentieth century pandemics occurred in 1918, 1946–1947, 1957, and 1968.

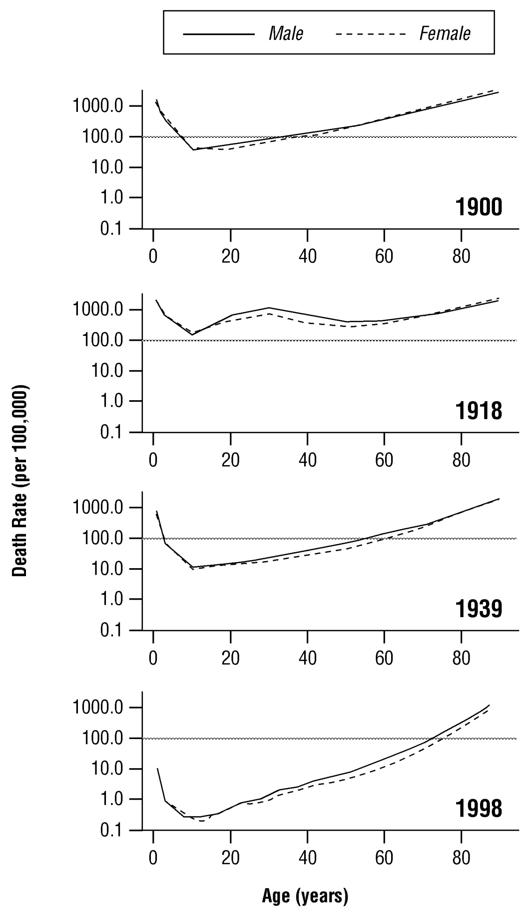
Age Profiles of Mortality

Figure 1 shows the age profile of death rates (per 100,000 population) for influenza and pneumonia (combined) for males and females in the United States in the years 1900, 1918, 1939, and 1998. Since fatal cases of influenza involve pneumonia, it is customary for statistical bureaus to merge influenza and pneumonia in published vital statistics. The patterns in the figure illustrate notable aspects of influenza demography and yield insight into mortality patterns more generally. To permit comparisons, all four panels in the figure are drawn to the same scale, with a horizontal rule across each panel at a mortality level of 100 per 100,000.

The influenza mortality rates exemplify three major mortality age patterns, named after letters of the alphabet: U, W, and J. In 1900, the pattern is U-shaped (sometimes called V-shaped), with peak

FIGURE 1

Death Rates by Age and Sex for Influenza and Pneumonia (combined), United States, 1900, 1918, 1939, and 1998



SOURCE: US National Center for Health Statistics.

mortality at the upper and lower ranges of the age distribution. Though influenza occurs at all ages, mortality is concentrated among the youngest and oldest. A similar pattern is seen in 1939, except that the base of the U (but not the top prongs) has descended to a lower level and remains below the 100 per 100,000 line until a much later age. The 1939 panel represents the end of the pre-antibiotic era. Flu, being a viral disease, is not treatable with antibiotics, but secondary pneumonias often involve or are exacerbated by bacterial coinfection, which can be treated with antibiotics.

The mortality pattern in 1918 is completely atypical, even for a pandemic. Due to that year's epidemic of hypervirulent influenza, the pattern is W-shaped, with a peak at middle age in addition to peaks at infancy and old age. Such a pattern is unusual among biological causes of death: tuberculosis is perhaps the closest parallel. The entire mortality curve in 1918 lies above the 100 per 100,000 line, reflecting the severity of the epidemic. The male excess death rate, in absolute terms, was also exceptionally high in 1918, particularly at the middle-age peak of the W-pattern. The leading explanation for the decline in death rates above age 35, which gives rise to the W shape, is that at least one flu strain that was circulating in the late nineteenth century was similar to the 1918 strain, and had imparted partial immunity to those who, by 1918, were above age 35; in demographic terms, it is a cohort-effect explanation.

Since 1950, influenza death rates in developed countries have declined more at young ages than among the elderly, transforming the U shape into a J shape, as seen in the 1998 data.

The 1918 Epidemic

The 1918 influenza epidemic was an important event not only in the history of influenza, but also in world demographic history. Usual estimates are 20 to 40 million deaths worldwide, with great uncertainty because much of the world did not have vital registration in 1918. By the measure of its death toll and its global reach, it was the biggest epidemic of any disease in the twentieth century. In the United States, the estimate is 550,000 deaths (0.5% of the population), with about one-fourth of the population having had recognizable cases of flu. The 1918 epidemic is sometimes called the "Spanish flu." It is not thought to have had a Spanish origin, but since Spain, as a neutral power, did not censor newspapers during World War I, early accounts of the flu came from Spain. There is debate about whether the epidemic began in the United States and then spread to Europe and the rest of the world, or vice versa. Late twentieth and early twenty-first century studies, using modern laboratory techniques and preserved tissue samples, have focused on deciphering the molecular basis for the virulence of the 1918 strain, so far without conclusive results.

There is a hypothesis, based on data from the United States, that the 1918 influenza epidemic had a selective effect. Specifically, the suggestion is that many of those who died of flu in 1918 already had chronic illness (most notably, tuberculosis, highly prevalent at the time). The supporting evidence is that after 1918, death rates, especially from tuberculosis, dropped relative to their pre-1918 trend. The logic is that if the 1918 victims had already been sicker than average, then the post-1918 population would be healthier and therefore death rates should decline. It is rare to see such selection effects in the population at large, but the magnitude of the 1918 epidemic was large enough to be exploited as a natural experiment (i.e., a natural event which mimics an actual experiment in certain respects).

As noted, there has been little reduction in influenza and pneumonia death rates above age 80, in contrast to younger ages, which have seen dramatic declines. With the worldwide population aging, influenza is certain to remain an important cause of death for many years to come. Moreover, the possibility of another pandemic of hypervirulent influenza, comparable to that of 1918, cannot be ruled out.

See also: *Diseases, Infectious; Epidemics.*

BIBLIOGRAPHY

Crosby, Alfred W. 1989. *America's Forgotten Pandemic: The Influenza of 1918.* Cambridge, Eng.: Cambridge University Press.

Kilbourne, Edwin D. 1987. *Influenza.* New York: Plenum.

Kolata, Gina. 1999. *Flu: The Story of the Great Influenza Pandemic of 1918 and the Search for the Virus That Caused It.* New York: Farrar, Straus and Giroux.

Noymer, Andrew, and Michel Garenne. 2000. "The 1918 Influenza Epidemic's Effects on Sex Differentials in Mortality in the United States." *Population and Development Review* 26(3): 565–581.

Pyle, Gerald F. 1986. *The Diffusion of Influenza: Patterns and Paradigms.* Totowa, NJ: Rowman & Littlefield.

ANDREW NOYMER

INTERGENERATIONAL TRANSFERS

An intergenerational transfer is the transmission of something from a member of one generation to a member of another. Unlike an exchange, loan, or purchase, there is no expectation that the recipient will repay the giver either directly or indirectly. Often, this refers to a transfer across generations of kin, for example from a grandparent to a grandchild. However, generation is a loosely-defined concept, and it can simply mean a different age group; a public sector intergenerational transfer could be said to occur between a 25-year-old taxpayer and a 17-year-old student in a public high school.

Although transfers do not involve a quid pro quo between the giver and the receiver, they may instead involve an understanding or at least an expectation that the recipient will make a similar transfer to someone in a symmetric position. For example, children may receive transfers from their parents with an implicit understanding that they will in turn make similar transfers to their own children when they are adults. Alternatively, adult children may support their elderly parents with the implicit understanding that their children will support them in their old age.

Intra-family intergenerational transfers are important in all societies. Examples are child-rearing costs borne by parents; costs of higher education borne by parents; end-of-life bequests to children or grandchildren; economic support of elderly parents by their children; time spent by adult children caring for or managing the care of their elderly parents. But significant intergenerational transfers can also be mediated through the public sector. Examples are tax receipts used to provide public education, state-run pension schemes, and other publicly financed payments or in-kind services to particular groups. In the United States, Social Security, Medicare, Medicaid, and various programs providing child benefits, welfare payments, and unemployment insurance exemplify such arrangements. Still other intergenerational transfers are imposed indirectly by the public sector, such as when governments incur debt today for consumption-type expenditures (rather than capital items)—debt which must be repaid or serviced by future generations.

Why Study Intergenerational Transfers?

While intergenerational transfers are pervasive in all societies, with the rise of the modern welfare state, there has been an increase in public sector transfers and a decrease in private transfers. Study of these transfers is important for many reasons, as they affect individuals, families, and whole populations.

Transfers have a major influence on the interpersonal distribution of income, because a high proportion of total household income is reallocated from the earner to some other person, either through public or private channels. Beyond the distribution of income, transfers are important in the study of families. A major component of the costs of rearing children is borne by parents. Although the level of such transfers is subject, within certain limits, to parents' discretion, they constitute a crucial element in parental fertility decisions. If parents intend to leave a bequest for each child, the level of these intended bequests is also a part of the cost of child rearing. Decisions about the level of private costs, or the size of the transfer to children, also determine the human capital of the next generation. The greater share of elder care is also provided by relatives, rather than by alternative institutional arrangements.

A further reason to study transfers is that the patterns of intergenerational transfers, both public and private, are a major determinant of the financial consequences of changing population age distributions, and specifically of population aging.

Private transfers can add to, substitute for, or be crowded out by public transfers. To design policy, and to understand the impact of existing age-based or need-based policies, it is essential to understand and quantify these processes of substitution and crowding out. In particular, the interaction between public and private transfers depends in part on the motives for private transfers—for example whether they are motivated by altruism (in which case there should be a high degree of substitution and crowding out, because altruists care about the well-being of another person rather than about the transfer itself) or by exchange (in which case there should be very little crowding out, because there is an obligation to repay).

Patterns of intergenerational transfers in traditional societies may play a key role in shaping fertility decisions and trigger the onset of secular trends (as is argued, for example, in John Caldwell's theory of the demographic transition). Patterns of transfers in preindustrial societies also may play an important role in evolutionary processes affecting fertility and mortality. Theorists suggest, for example, that the elderly contribute to the reproductive fitness of their children and grandchildren, which may explain why humans have such long post-reproductive survival.

Theorists like Laurence Kotlikoff and Lawrence Summers argue that the desire to make familial intergenerational transfers, particularly bequests, may be the dominant motive for saving, investment, and capital formation in industrial countries—more so than the life cycle saving motive.

Public Sector Transfers

Development of the modern theory of intergenerational transfers began with a seminal paper by Paul Samuelson published in 1958. Samuelson showed that in a world without durable goods, in which workers wished to provide for consumption in old age, the competitive market for borrowing and lending would lead to a negative interest rate with high consumption when young, and very little consumption when old. Life-cycle utility would be correspondingly low. However, if the population enacted a binding social compact according to which workers would transfer income to the old, without any expectation of being repaid by *them,* but with the assurance that they would be similarly treated when they were old, then consumption could be more evenly distributed across the life cycle, and life-cycle utility would be higher. In place of the negative rate of interest provided by the market outcome, people would earn through the transfer system an implicit rate of return equal to the population growth rate (plus, in a more realistic context, the rate of productivity growth). Thus intergenerational transfers supported by a social compact could make everyone in every generation better off.

Systems of this sort are called pay-as-you-go, or PAYGO, because the obligations created are not backed up by assets accumulated in a fund; rather, future payments of benefits come from future contributions by future workers. Such a system is politically easy to start—at least when the age distribution of the population is such that the size of the working-age population is much larger than that of the old-age population (hence modest per-capita contributions by the former can provide generous per-capita benefits for the latter)—because all current and future generations apparently gain. These systems are very painful to end, however, because if the compact is terminated the last generations of workers end up making transfers to the elderly but receive nothing in their own old age. At any time during its operation, such a transfer system has an implicit debt that is owed to those who have already paid in, thus acquiring an entitlement for later support.

Traditional familial support systems for the elderly are PAYGO transfers, but are sustained by individual values and social norms instead of a formal social compact (although private transfers can sometimes be reinforced by law, as is the case in Singapore). Public pension systems in much of the industrial world, including the U.S. Social Security system, are operated on a pay-as-you-go basis. The transition from a family support system to a public system is relatively painless, since the implicit debt to be repaid is just transferred from one system to the other.

Slow population growth and rising life expectancy make both familial and public pension systems much less attractive compared to such systems in a situation when population is growing rapidly and expectation of life in old age is short. Nonetheless, despite growing dissatisfaction with such arrangements generated by the emergence of demographic conditions marked by slow population growth and longer life expectancies, and the appeal of potentially higher rates of return available from other kinds of investments, the systems cannot be shut down or converted to privately-funded systems without repaying the implicit debt. For families, such a shift would mean that one generation would have to support both its aging parents and save for its own retirement. For current public sector programs, the existing implicit debts are typically huge—often one, two, or three times the size of the country's annual gross domestic product—and often larger than the existing explicit government debt. Nonetheless, a number of countries, mostly in Latin America and most notably Chile, have made or initiated the transition to a funded system.

In the late 1980s Gary S. Becker and Kevin M. Murphy developed an influential theoretical construct that would link the provision of public education and public pensions, so as to bring about an efficient level of investment in education when parents' altruism is insufficient to ensure such a level, and institutions that would enforce repayment of intergenerational familial loans do not exist. The introduction of a modified public pension system would compel the children who received the education to repay their parents through their contributions to the system, and no generation would get a windfall gain or suffer a loss.

Family Intergenerational Transfers

Transfers to and from children and the demographic aspects of such transfers are discussed in a substantial literature. Caldwell argued that "in all primitive and nearly all traditional societies the net flow [of wealth] is from child to parent" (1976), and that this net flow motivated high fertility. At some point, labeled the "great divide," the direction of flow reverses as children become costly rather than assets in modern industrial settings. At that point, in narrowly economic terms it would be rational to have no children; positive fertility results from the psychic utility children represent for parents. Caldwell's wealth flows theory has been criticized by behavioral ecologists, who argue that species have evolved to maximize reproductive fitness by transferring resources from parent to child, and that parents would not use children merely as a means to supply family labor or to support them in old age. Arguing in this vein, Hillard Kaplan reported in 1994 that in a hunter-gatherer group in the Amazon Basin, even the oldest members of the population make transfers to their children and grandchildren, and the more of these they have, the greater the transfers they make. Thus transfers are downward rather than upward, counter to Caldwell's claim. Ronald Lee also found that in agricultural and pre-agricultural societies, the net direction of total transfers is strongly downward across age, from older to younger. In modern industrial societies, however, new institutional arrangements reverse the direction of net intergenerational flow of resources, in part reflecting the generosity of public pension and health-care transfers to the elderly, and in part a result of population aging which greatly increases the proportion of elderly in the population. Even in modern industrial societies, however, *private* net flows within the family are downwards.

At the micro-level, there is extensive theoretical and empirical work on transfers to children, since transfers are equivalent to investments in child quality—a crucial element in fertility theory. There is also an extensive literature on the motivations for familial intergenerational transfers (see, for example, Cox, 1987). A debated issue is whether apparent altruistic intrafamilial transfers actually involve an implicit quid pro quo, and, therefore, are best interpreted as exchanges. Empirical findings shedding light on the answer are mixed.

See also: *Age Structure and Dependency; Caldwell, John C.; Evolutionary Demography.*

BIBLIOGRAPHY

Becker, Gary S., and Kevin M. Murphy 1988. "The Family and the State." *Journal of Law and Economics,* April: 1–18.

Caldwell, John C. 1976. "Toward a Restatement of Demographic Transition Theory." *Population and Development Review* 2: 321–366.

Cox, Donald. 1987. "Motives for Private Income Transfers." *Journal of Political Economy* 93: 508–546.

Kaplan, Hillard. 1994. "Evolutionary and Wealth Flows Theories of Fertility: Empirical Tests and New Models." *Population and Development Review* 20: 753–791.

Kotlikoff, Laurence J., and Lawrence H. Summers. 1981. "The Role of Intergenerational Transfers in Aggregate Capital Accumulation." *Journal of Political Economy* 89: 706–732.

Lee, Ronald. 2000. "A Cross-Cultural Perspective on Intergenerational Transfers and the Economic Life Cycle." In *Sharing the Wealth: Demographic Change and Economic Transfers between Generations,* ed. Andrew Mason and Georges Tapinos. Oxford: Oxford University Press.

Samuelson, Paul A. 1958. "An Exact Consumption-Loan Model of Interest With or Without the Social Contrivance of Money." *Journal of Political Economy* 66: 467–482.

RONALD LEE

INTERNAL MIGRATION

Internal migration is defined as a change in permanent residence, typically of a year or more in duration, within the boundaries of a country.

Long-Distance Migration and Residential Mobility

A distinction is made between long-distance migration and short-distance migration in which the latter is referred to by the more specialized term *residential mobility.* Long-distance moves typically are operationalized as movement across broader areas, such as metropolitan areas or states and in some cases counties. They reflect movement across labor markets and often are associated with changes in economic conditions in those larger areas. Residential mobility typically occurs within the same labor market and is associated more frequently with neighborhood and housing considerations. The distinction is important because the two types of internal migration occur at different frequencies, are associated with different kinds of explanations, and often display different selectivities with respect to individual social and economic attributes (Speare, Goldstein, and Frey 1975; Long 1988).

Data Sources

In the United States and in most developed countries the basic sources for measuring both kinds of migration derive from nationwide censuses, population registers, and large surveys. In several European countries with population register traditions (e.g., the Netherlands and the Scandinavian countries) annual migration measures for localities can be traced back for many decades.

In the United States the decennial census provides the most comprehensive source of migration data based on the five-year fixed-interval migration question ("Where did you live five years ago?") that has been included in censuses since 1960 and also was included in the 1940 census. This question allows the calculation of a variety of migration measures, such as mobility-incidence rates, and measures of in-migration, out-migration, net migration, and migration streams for places, counties, metropolitan areas, and states (Shryock 1964). These measures can be cross-classified by an array of social and economic attributes available from the census and can be used to ascertain selective migration patterns.

These census data are limited by the restricted reference period of five years before each decennial census. For example, the 2000 Census permits the assessment of migration over the 1995–2000 interval but not over the 1990–1995 interval. Another U.S. Census item relevant to measuring internal migration over longer historical periods is the question on the respondent's state of birth. This question has appeared in every decennial census since 1850 and can be used to assess long-term and current internal moves across states as well as "return migration" when cross-classified by current residence and residence five years before the census (Long 1988).

The U.S. Census Bureau's *Current Population Survey* is another important source of migration data. It contains a fixed-interval one-year migration item and is used to assess time-series patterns of migration frequency and selectivity with respect to social and economic differentials. Time-series estimates of internal migration at the county and state level also are produced by the U.S. Census Bureau. Beyond these government sources, several national panel surveys conducted by universities and research organizations have been used to infer migration patterns for specific groups. In addition, administrative records collected for other purposes (e.g., Internal Revenue Service data) can be employed to examine migration patterns.

Reasons for Moving: The U.S. Case

The long-distance/short-distance migration dichotomy is reflected clearly in the frequency of movement in the United States Because long-distance, inter–labor market migration occurs only a few times during the life course (e.g., the move to college, the first job, retirement), the annual rate of interstate migration is relatively low (3.3 percent in the period 1999–2000) in comparison to the annual rate of movement within counties (9%). Overall, about 16 percent of the U.S. population moves in a given year, and only about one in five of those moves is across state lines.

The preponderance of local moves is a response to household and family changes as well as changing needs in regard to neighborhoods and homes. Among within-county moves in 1999–2000, 64 percent were for housing-related reasons and 26.5 percent were for family-related reasons. Only 6 percent of those moves were motivated by work and job-transfer considerations. In contrast, 47 percent of moves between counties undertaken by persons with postcollege training are related to work (see Figure 1) (Schacter 2001). Climate and natural amenities are becoming increasingly important in motivating long-distance moves, especially among the retired population (Gober 1993).

By far the strongest selectivity differential associated with both long-distance migration and residential mobility is a person's age. The incidence of making each kind of move is highest for persons in their early to middle twenties and then declines precipitously during the thirties and forties, with a sometimes small upturn in the early retirement years. Among persons age 20 to 24 in the United States about one-third make a move of some kind in any given year (see Figure 2) This is twice the overall migration rate for all ages combined and reflects important life-cycle transitions such as moving to a college or to a new job (among long-distance migrants), marriage, and moving out of the parental home (among local movers).

Most other selectivity differentials are more specific to either long-distance or short-distance movers. Among long-distance movers there is strong educational selectivity in movement. College graduates, who are likely to be in a national labor market, show higher rates of movement than do those with lesser educational attainment. Among local movers there is a large difference between homeowners and renters: Homeowners tend to form long-term economic bonds to a particular location.

The recent influx of foreign-born populations to the United States has had both direct and indirect effects on internal migration. Locally, foreign-born residents tend to make several additional internal moves after they initially settle. Indirectly, the influx of foreign-born populations in selected "port of entry" metropolitan areas has tended to precipitate out-migration among established native-born residents (Frey 2003).

Explanations for Migration

Explanations for migration can be divided into two essential classes: those which explain individual decision making and those which explain aggregate migration patterns across geographic regions. Individual decision-making models of long-distance migration tend to be formulated around economists' cost-benefit model. This model assumes a rational decision-making process that weighs the economic and noneconomic costs and benefits of making a move. It has to be modified for particular population groups such as retirees and the college-bound population and for individuals in particular statuses, such as single-earner husband–wife families. These mobility models of decision making make a distinc-

FIGURE 1

Reasons for Moving in Different Mover Groups, United States, Percent of all Movers 18 and Over, 1999–2000

All Within-County Movers **Post–College Educated, Between-County Movers**

SOURCE: Schacter (2001).

tion between "the decision to move" and "the choice of destination" in which the former decision implies some kind of disruption in family status or housing need (Speare, Goldstein, and Frey 1975).

Aggregate models of long-distance migration can be used to explain net migration levels for specific areas, migration streams across pairs, and matrices of areas. The latter models tend to have a strong geographic base related to the classic "gravity model," in which migration is directly related to the number of opportunities at a destination but inversely related to the distance between the origin and the destination (Speare, Goldstein, and Frey 1975). This model has been modified to take into account various economic and noneconomic opportunities. Aggregate models that explain net migration as a dependent variable take both cross-sectional and time-series forms (Greenwood 1981).

Consequences of Internal Migration

The consequences of internal migration have been addressed from a variety of disciplinary perspectives. The demographic consequences of internal migration processes for spatial population change are treated in a formal demographic model developed by Andrei Rogers (Rogers 1995). Rogers and his associates at the International Institute for Applied Systems Analysis also have developed techniques, including model age–migration schedules, for making population projections of subnational areas that take explicit account of internal migration streams.

See also: *Migration Models; Resettlement; Temporary Migration; Thomas, Dorothy Swaine; Urbanization.*

BIBLIOGRAPHY

DeJong, Gordon, and Robert W. Gardner, eds. 1981. *Migration Decision Making: Multidisciplinary Approaches to Microlevel Studies in Developed and Developing Countries.* New York: Pergamon Press.

Frey, William H. 2003. *Who Moves Where: A 2000 Census Survey.* Washington, D.C.: Population Reference Bureau.

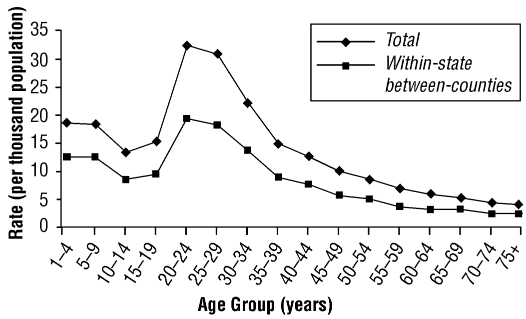
Gober, Patricia. 1993. "Americans on the Move." *Population Bulletin* 48(3). Washington, D.C.: Population Reference Bureau.

Greenwood, Michael J. 1981. *Migration and Economic Growth in the United States.* New York: Academic Press.

Long, Larry. 1988. *Migration and Residential Mobility in the United States.* New York: Russell Sage Foundation.

FIGURE 2

Long and Short Distance One-Year Migration Rates by Age*, United States, 1998–1999



*Migration rates for 1998–99 among U.S. residents aged 1 year and above; total includes within-state, between-county movers.

SOURCE: *U.S. Census Bureau Current Population Survey*, March, 1999. <www.Ameristat.org>

Rogers, Andrei. 1995. *Multiregional Demography: Principles, Methods, and Extensions.* New York: Wiley.

Schacter, Jason. 2001. "Why People Move: Exploring the March 2000 Current Population Survey." *Current Population Reports* P23–204. Washington, D.C.: U.S. Census Bureau (May).

Shryock, Henry S. 1964. *Population Mobility within the United States.* Chicago: Community and Family Studies Center, University of Chicago.

Speare, Alden, Jr., Sidney Goldstein, and William H. Frey. 1975. *Residential Mobility, Migration and Metropolitan Change.* Cambridge, MA: Ballinger.

William H. Frey

INTERNATIONAL MIGRATION

The history of international migration over the last five centuries can be divided into four periods.

The Four Periods of Migration

During the mercantile period, from 1500 to 1800, the dominant flows were out of Europe and stemmed from processes of colonization and economic growth under mercantile capitalism. Over the course of 300 years, Europeans came to inhabit large portions of the Americas and some portions of Africa and Asia in numbers that were modest but sufficient to establish dominion.

During that period European emigrants fell into three classes: a relatively large number of agrarian settlers, a smaller number of administrators and artisans, and an even smaller number of plantation entrepreneurs. Although the number of Europeans involved in plantation agriculture was low, this sector had a profound impact on the size and composition of populations in the Americas, since the most important source of plantation labor was African slaves, some 10 million of whom were forcibly exported to the New World before the closing of the slave trade in the early 1800s.

The industrial period began early in the nineteenth century with the economic development of Europe and the spread of industrialism to former colonies in the New World. From 1800 to 1929, 48 million people left Europe in search of new lives in the Americas and the area now known as Oceania. (Many of them eventually returned; thus, net migration was appreciably smaller.) Among those emigrants 85 percent went to five destinations—the United States, Canada, Argentina, Australia, and New Zealand—with the United States receiving 60 percent. Key sending countries were Great Britain, Italy, Norway, Portugal, Spain, and Sweden, all of which exported a significant share of their population increase during the period of industrialization.

Mass emigration from Europe was brought to a halt in 1914 by the outbreak of World War I and definitively ended by the economic crash of 1929. The years 1930–1960 were a period of limited international migration. The Great Depression stopped virtually all such population movement during the 1930s, and in the 1940s international migration was checked by World War II. What mobility there was largely involved displaced persons and was mostly unrelated to the rhythms of economic growth and development. This pattern persisted well into the 1950s.

The period of postindustrial migration began around 1960 and constituted a sharp break with the past. Rather than being dominated by outflows from Europe to a handful of former colonies, international migration became a truly global phenomenon as the number of migrants expanded and the sources of supply shifted from Europe to the developing countries. Before 1930, 85 percent of all international migrants originated in Europe. Since 1960, 85 percent have come from Latin America, the Caribbean, Asia, and Africa. The variety of destination countries has grown to encompass all developed countries, including all the countries of the European Union, the oil-exporting countries of the Persian Gulf, Canada, the United States, Australia, Japan, and the Asian "tigers" of Singapore, South Korea, Hong Kong, and Malaysia. By 2000 a total of around 175 million persons were living outside their countries of birth, 45 percent in developed countries and 55 percent in developing countries.

Data Collection

The study of international migration is complicated by serious data problems. The definition of an "immigrant" varies from country to country and is bound up in legal codes, politics, and sometimes xenophobia. The collection of data on international entries and exits is sporadic and incomplete and is the responsibility of different agencies in different countries. Although data on numbers and characteristics of the foreign-born, or of "foreigners" in some other sense, are generally available from national statistical offices, standards of enumeration and definitions of who is included vary across countries.

Estimates of net international migration flows for major sending and receiving countries for which reasonably good quality data exist—the English-speaking traditional immigration countries and countries in Western Europe—are presented in Table 1 for periods somewhat different from those referred to above.

The United Nations Population Division has developed a set of standards for the classification of international migrants and publishes a regular series of reports on trends and patterns based on its reworking of national statistical data. According to these data, at the turn of the twenty-first century roughly a third of all international migrants were in Asia, a quarter were in North America and another quarter were in Europe, 13 percent were in Latin America and the Caribbean, and 4 percent were in Oceania. International migrants amounted to around 2.4 percent of the global population. The highest rates of out-migration were in Latin America, the Caribbean, the Pacific Islands, Southeast Asia, and South Central Asia. The highest rates of in-migration were in Australia–New Zealand, North America, Western Europe, and Western Asia (principally the Persian Gulf states). As a percentage of all residents, foreigners constitute 18 percent of the population in Oceania, 10 percent in North America, 4 percent in Europe, 3 percent in Africa, 2 percent in Latin America, and 1 percent in Asia.

TABLE 1

Net Migration: Western Europe, and Western Offshoots, 1870–1998
(Thousands)

	1870–1913	1914–1949	1950–1973	1974–1998
France	890	236	3,630	1,026
Germany	−2,598	−304[a]	7,070	5,911
Italy	−4,459	−1,771	−2,139	1,617
United Kingdom	−6,415	−1,405[b]	-605	737
Other[c]	−1,414	54	1,425	1,607
Total Western Europe	−13,996	−3,662	9,381	10,898
Australia	885	673	2,033	2,151
New Zealand	290	138	247	87
Canada	861	207	2,126	2,680
United States	15,820	6,221	8,257	16,721
Total Western offshoots	17,856	7,239	12,663	21,639

Note: (a) 1922–1939; (b) excludes 1939–1945; (c) includes Belgium, Netherlands, Norway, Sweden, and Switzerland. Minus sign indicates outflow.

SOURCE: Maddison (2001).

Categories of International Migration

International migrants fall into four basic categories, depending on whether they leave voluntarily or involuntarily and whether they are well or poorly endowed with human capital. Involuntary migrants who lack skills and education are classified as refugees. Their out-migration is prompted directly or indirectly by persecution, threat of violence, or extreme deprivation and typically is directed toward a neighboring state. Involuntary migrants with significant human capital generally travel to nonadjacent states as asylum seekers; their departure is motivated by a fear of violence or persecution. Because of their education and in some cases their financial resources, they are better placed to gain entry to liberal, developed nations and to pursue claims for asylum. Voluntary migrants who lack human capital generally are classified as labor migrants. Their movement is motivated by economic aspirations, and so the flow is from less to more developed nations. Skilled immigrants carry significant amounts of human capital, and their migration decisions reflect the desire to maximize returns to their investments in skills, training, and education.

Just as markets for financial capital have globalized in recent years, so have markets for human capital. Although flows of human capital are predominantly from less to more developed countries, there is also significant mobility of skilled workers among the developed countries and among developing countries, as well as from developed to developing regions.

Only about 10 percent of the world's international migrants are refugees. Most refugee movement occurs among developing countries. Refugee migration tends to be localized and generally stems from civil conflicts within nations or the disintegration of a state. Although Africa contains only 13 percent of the world's people, it has a third of its refugees, mainly in sub-Saharan countries with weak and divided state structures inherited from colonial regimes. Another 36 percent of all refugees reside in Asia, mainly in the Middle East, Pakistan, and Southeast Asia. Finally, 25 percent are in Europe, principally in the former Yugoslavia and Soviet Union. Precise information on refugees is difficult to obtain; what little exists is tabulated by the United Nations High Commissioner for Refugees. There is little theoretical basis for predicting future trends.

Of the remaining international migrants, nearly 90 percent are workers (and their families) who left their countries of origin for economic reasons. They are predominantly unskilled.

Theories of International Migration

Theoretical work has sought to explain the movement of economic migrants in terms of (1) the structural forces that promote emigration, (2) the structural forces in destination countries that attract migrants, (3) the motivations, goals, and aspirations of those who respond to macrostructural forces by becoming international migrants, (4) the social and economic structures that connect areas of out- and in-migration, and (5) the responses of specific states to the resulting flows of people.

The frameworks that different analysts have drawn on are neoclassical economics, the new economics of labor migration, segmented labor market theory, world systems theory, social capital theory, and the theory of cumulative causation. World systems theory gives an account of the structural forces that promote out-migration from developing countries. Together, world systems theory, segmented labor market theory, and neoclassical economics explain why developed countries attract immigrants. Social capital theory and world systems theory explain how structural links emerge to connect areas of origin and areas of destination. Neoclassical economics and the new economics of labor migration deal with the motivations of the people who become international migrants in response to these forces. The theory of cumulative causation describes how international migration promotes changes in personal motivations and socioeconomic structures to give immigration a self-perpetuating, dynamic character. Finally, recent contributions to political economy offer a basic framework for understanding the role of state policy in determining the size and composition of international flows.

A Synthesis of Theoretical Approaches

Integrating the various theories in light of the empirical evidence yields the following synthetic account. Contemporary international migration originates in the social, economic, political, and cultural transformations that accompany the penetration of markets into nonmarket or premarket societies (as hypothesized under world systems theory). In the context of a globalizing economy, the entry of markets and capital-intensive production methods into peripheral areas disrupts existing social and economic arrangements and brings about the displacement of people from their customary livelihoods, creating a mobile population of workers who actively search for new ways of earning income, managing risk, and acquiring capital.

One means by which these people seek to assure their economic well-being is by selling their labor. Because wages are higher in urban than in rural areas, much of this process of labor commodification is expressed in the form of rural–urban migration. Such movement occurs even when the probability of obtaining an urban job is low, because when multiplied by high urban wages, the low employment probabilities yield expected incomes above those in rural areas. Wages are even higher, of course, in developed countries overseas, and the larger size of these wage differentials inevitably prompts some people to seek work abroad, often in geographically distant countries.

International wage differentials are not the only factor motivating people to migrate, however. Many households struggling to cope with the jarring transformations of economic development and market creation use international migration as a means of managing risk and overcoming barriers to capital and credit (considerations treated in the so-called new economics of labor migration).

In developing countries, markets (or government substitutes) for insurance, capital, credit, and old age security are poorly developed or nonexistent. Households turn to international migration to compensate for these market failures. By sending members abroad to work, households diversify their labor portfolios to control the risks stemming from unemployment, crop failure, and price uncertainty. Work abroad may also permit households more successfully to accumulate cash for large consumer purchases or productive investments or to build up savings for retirement. Whereas the rational actor posited by neoclassical economics takes advantage of a geographic disequilibrium in labor markets to move abroad permanently to achieve higher lifetime earnings, the rational actor assumed by the new economics of labor migration seeks to cope with market failure by moving abroad temporarily and repatriating earnings in the form of regular remittances or lump-sum transfers.

Whereas the early phases of economic development promote emigration, postindustrial transformations in high-income countries create a bifurcation of labor markets. Jobs in the primary labor market provide steady work and high pay for native workers, but those in the secondary labor market offer low pay, little stability, and few opportunities, thus repelling native residents and generating a structural demand for immigrant workers (treated by segmented labor market theory). This process of labor market bifurcation is most evident in global cities, where a concentration of managerial, administrative, and technical expertise leads to a concentration of wealth and a strong ancillary demand for low-wage services (as described in world systems theory). Unable to attract native workers for such service jobs, employers turn to immigrants and initiate immigrant flows directly through formal recruitment (segmented labor market theory).

Although instrumental in initiating immigration, recruitment becomes less important over time because the processes of economic globalization that create mobile populations in developing regions also generate a demand for their services in global cities and create links of transportation, communication, politics, and culture that make the international movement of people increasingly cheap and easy (world systems theory). Immigration also is promoted by foreign policies and military actions taken by core nations to maintain international security, protect foreign investments, and guarantee access to raw materials; these entanglements create links and obligations that generate ancillary flows of refugees and military dependents.

Once an immigration stream begins, it displays a strong tendency to continue through the growth and elaboration of migrant networks (social capital theory). The concentration of immigrants in certain destination areas creates a "family and friends" effect, which channels later cohorts of immigrants to the same places and facilitates their arrival and initial settlement. If enough migrants arrive under the right conditions, an enclave economy may form that further augments the specialized demand for immigrant workers (segmented labor market theory).

The spread of migratory behavior within sending communities sets off ancillary structural changes, shifting distributions of income and land and modifying local cultures in ways that promote additional international movement. Over time the process of network expansion tends to become self-perpetuating because each act of migration causes social and economic changes that promote additional international movement (theory of cumulative causation). Receiving countries may implement restrictive policies to counter rising tides of immigrants, but those measures create a lucrative niche into which enterprising agents, contractors, and other middlemen move to create migrant-supporting institutions, providing migrants with another infrastructure capable of supporting and sustaining international movement (social capital theory).

During the initial phases of emigration from any sending country the effects of capital penetration, market failure, social network expansion, and cumulative causation dominate in determining the international flows, but as the level of out-migration reaches high levels and the costs and risks of international movement drop, movement is determined increasingly by international wage differentials (neoclassical economics) and labor demand (segmented labor market theory). As economic growth occurs in sending regions, international wage gaps gradually diminish and well-functioning markets for capital, credit, and insurance come into existence, progressively lowering the incentives for emigration. If these trends continue, a country ultimately becomes integrated into the international economy as a developed, capitalist country, at which point it undergoes a migration transition. Massive net out-migration tails off, and the country itself is seen as an immigration destination; it becomes both a sender and a receiver of migrants.

These theoretical considerations go far toward explaining the initiation and perpetuation of international migration. The considerable regional variation in actual migration patterns stems from the fact that all national governments intervene in these flows to influence their size and composition. Sending countries, despite frequently voiced worries about the loss of human capital ("brain drain"), on balance have a strong interest in encouraging international migration as a means of acquiring capital, securing foreign exchange, relieving unemployment, and building skills. At the same time, however, migrant-receiving countries may be increasingly selective in their migrant intake or pursue more restrictive immigration policies.

Immigration and State Capacity

Globalization and technological change have combined to increase income inequality and unemployment in the world and have served to increase both the absolute and relative numbers of people seeking to enter the developed countries as immigrants. This process gives rise to more restrictive policies in the developed world. However, the ability of states to regulate and control the volume and composition of immigration is constrained by a variety of factors. Globalization itself limits the power of nation-states to control transnational movements of labor as well as those of capital, goods, and information. Similarly, the emergence of an international regime protecting human rights constrains the ability of governments and political leaders to respond to the racial and ethnic concerns of voters or to impose harshly restrictive measures on immigrants or their dependents. These constraints are particularly salient in nations with well-established constitutional protections for individual rights and strong, independent judiciaries.

Ultimately, the ability of immigrant-receiving states to impose restrictive immigration policies successfully depends on five main factors: the size of the potential flow, the degree of centralized power and relative efficiency of the national bureaucracy, the extent to which individual rights are constitutionally protected, the relative strength and independence of the judiciary, and the existence and strength of a historical tradition of immigration. The interplay of these factors determines a state's efficacy in restricting immigration.

Efficacy can be seen as a point on a continuum. At one extreme are countries, such as the Gulf states, which counter a moderate demand for entry with powerful centralized bureaucracies, few constitutional protections for individual rights, weak and dependent judiciaries, and no historical traditions of immigration. At the other extreme are countries such as the United States, which face a strong demand for entry with relatively weak and decentralized bureaucracies, strong constitutional protections for individual rights (including those of foreigners), a strong and independent judiciary, and a long historical tradition of immigration.

It is unclear how successful countries can expect to be in controlling immigration over the next century. Scattered evidence suggests that undocumented immigration is not unknown even in the Gulf states and is growing throughout Europe and Asia. In the United States both legal and illegal immigration continue to expand, and there is little evidence that the restrictive measures imposed so far have had much of an effect. U.S. policies have been more successful as symbolic political gestures, signaling to anxious citizens and workers that their concerns are being addressed while marginalizing immigrants socially and geographically to make them less visible. What remains to be seen is whether the majority of countries, situated at points on the continuum somewhere between the United States and the Gulf countries, will be able to regulate and control immigration over the next century.

See also: *Immigration, Unauthorized; Immigration Policies; Immigration Trends; Labor Migration, International.*

BIBLIOGRAPHY

Bongaarts, John, and Rodolfo A. Bulatao, eds. 2000. *Beyond Six Billion: Forecasting the World's Popu-*

lation. Washington, D.C.: National Academy Press.

Maddison, Angus. 2001. *The World Economy: A Millennial Perspective.* Paris: OECD.

Massey, Douglas S. 1999. "International Migration at the Dawn of the Twenty-First Century: The Role of the State." *Population and Development Review* 25: 303–323.

Massey, Douglas S., Joaquin Arango, Graeme Hugo, Ali Kouaouci, Adela Pellegrino, and J. Edward Taylor. 1998. *Worlds in Motion: Understanding International Migration at the End of the Millennium.* Oxford: Oxford University Press.

Massey, Douglas S., Jorge Durand, and Nolan J. Malone. 2002. *Beyond Smoke and Mirrors: Immigration Policy and Global Economic Integration.* New York: Russell Sage Foundation.

Zlotnick, Hania. 1998. "International Migration 1965–96: An Overview." *Population and Development Review* 24: 429–468.

Douglas S. Massey

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JOURNALS, POPULATION

Just as other scholars and scientists do, demographers attempt to establish their status in the profession and communicate their ideas and findings to colleagues by publishing in the best journals. They also prefer to be cited in those journals because scoring high in citations is helpful in acquiring research funding, negotiating contracts, obtaining invitations to high-profile conferences, and winning prizes. The field of play is limited, and so the distribution of citations is very unequal and reportedly resembles that of income. Relatively few demographers become famous; some do not leave a trace, and most never achieve more than a modest citation index.

How Demographic Knowledge Travels

In demography, and in population studies in general, it is evident where aspiring and ambitious authors should submit their manuscripts. In a study about the way demographic knowledge travels, Hendrik van Dalen and Kène Henkens show that specialized demographic journals rarely communicate with one another. Those journals play a very modest role in the construction of demographic knowledge. In fact, a majority of the articles published in second-tier journals remain uncited five years after their publication.

Among the 330 population serials that exist worldwide, only 17 have been selected by the Social Science Citation Index (SSCI) as being important for the development of the discipline. Most demographic knowledge is created in the major general journals: *Population Studies, Population and Development Review,* and *Demography.* The first of these journals is published in Britain, the other two are U.S.-based. (The last named is the journal of the Population Association of America [PAA]). From these three journals information trickles down to other regions and to the specialized journals. Language barriers are a serious problem. Except among English speakers, writing in one's native language is not helpful in gaining a world reputation. Roughly 50 percent of all articles published in the period 1990–1992 in the 17 journals analyzed by the SSCI were written by authors with a U.S. connection.

Increased Specialization

Increased specialization has been one of the dominant characteristics of demographic research since World War II. The remarkable increase in the number and range of population journals is an illustration of that phenomenon. The International Union for the Scientific Study of Population (IUSSP), which was established in 1928, has been particularly helpful in the dissemination of demographic knowledge by distributing four demographic journals to its members.

Three of those journals have existed for more than half a century: *Population* (1946, Paris), *Population Studies* (1947, London), and *Genus* (1934, Rome). All three journals cater in principle to the whole field of population studies and to all regions of the world. Migration is a topic that has never been favored by the editors of *Population Studies,* but in terms of continuity in quality, style, geographic scope, and technical standard of the published papers, that journal has an enviable reputation. The international impact of *Population* is bound to increase now that the publisher (INED—France's National Institute of Demographic Research) has decided to start publishing all papers simultaneously in English and French. Its coverage of the francophone region, the Balkans, the Baltic region, and Eastern Europe is without parallel. A valuable standard feature in *Population* is the yearly overview of recent demographic trends in developed countries. Although edited in Italy, *Genus* uses English as the preferred medium for its wide-ranging contributions to the discipline.

The IUSSP also greatly aided in the distribution of the reference journal *Population Index* (Princeton), which originally (1934—1936) was the bibliographical journal of the PAA. Unfortunately, its publication ended in 1999. Although its existing database can still be consulted electronically and most demographic journals publish book reviews and lists of the publications they receive, it will surely prove to be a great disadvantage for the discipline that an authoritative bibliographical source abstracting the contents of books, edited volumes, and a great variety of serials and working papers is no longer available. However, the creation of a central site for working papers provides some compensation.

The *Population Bulletin of the United Nations* and the *Population Bulletin* published by the Population Reference Bureau (1945) are equally longstanding and broad in orientation. Later additions to the range of journals demographers consult regularly, have on their shelves, or follow through abstracts in *Population Index* or a similar bibliographic source, most notably POPLINE, have tended to be more specialized. *The International Migration Review* (1966) and *International Migration* (1962) address a specialized audience. *International Family Planning Perspectives* (1974) and *Studies in Family Planning* (1969) also reflect a clear focus in their titles; they provide vital information for scholars concerned with population change, gender, and reproductive health in developing countries. The title of *Population and Development Review* (1975) suggests a similarly restricted orientation, but this journal has become one of the most prestigious in the field. It is eminently readable, regularly publishes topical supplements, and contributes to keeping alive the intellectual history of the discipline through its *Archives* department.

Readers with an interest in the biological aspects of the discipline can read the *Journal of Biosocial Science* (1968) and *Social Biology* (1953); for economic demographers the journals of *Family Welfare* (1954) and *Population Economics* (1987) are of prime importance. Other comparatively recent additions also are highly specialized: *Mathematical Population Studies* (1989), *Population and Environment* (1978), *Population Research and Policy Review* (1981), and *Health Transition Review* (1990) are good examples. Historical demographers; demographers concentrating on marriage, cohabitation, and the family; and those who combine studies of the family and history have their own means of communicating. Some of these publications have a long tradition (*Journal of Marriage and the Family,* 1938); others are more recent and reflect the further specialization noted above (*Journal of Family History,* 1975; *Journal of Family Issues,* 1979; *Perspectives on Sexual and Reproductive Health* (formerly *Family Planning Perspectives*), 1969.)

To cover areas where demography touches upon public health, gerontology, epidemiology, sociology, anthropology, psychology, policymaking or politics, human resources, the labor force, refugees, ethnic relations, urbanization, or prognoses, other relevant journals exist. The *Journal of Ethnic and Migration Studies* (1971), the *Revue Européenne des Migration Internationales* (1984), and the *International Journal of Population Geography* (1994) publish studies on international migration.

National and Regional Journals

Many countries have their own population journals or attempt to disseminate their findings internationally through a yearbook. The *Polish Population Review* (1991); the Hungarian *Demográfia* (1958); the Czech *Demografie* (1959); the German *Zeitschrift für Bevölkerungswissenschaft* (1975); the *Yearbook of Population Research* in Finland (1963); the Dutch-language *Bevolking en Gezin* (1971) and the English-language yearbook on the Low Countries associated with it, *Population Trends* (1975), which deals primarily with the United Kingdom; *Demography India* (1971); the Japanese-language journal *Jinko Mondai Kenkyu* (1944); the Mexican journal *Estudios Demograficos y Urbanos* (1985); and the *New Zealand Population Review* (1974) are good examples. These periodicals are required reading for regional specialists and frequently provide table headings and summaries in English.

A few of the national journals are attempting to acquire international stature. Recently retitled, the Australian Population Association's *Journal of Population Research* (1983), for example, has acquired a broad international mandate. Regional journals that are broadly focused substantively but maintain a distinct geographic focus include the *European Journal of Population* (1984), which still accepts papers in both English and French, is rather limited in size, but has improved in quality and scope; *Notas de Población* (1972) published in Chile by Celade; the *Asian-Pacific Population Journal* (1985); and the periodical *African Population Studies* (1985).

The Internet

The tables of contents of many demographic periodicals can be accessed directly on the Internet. Alternatively, they can be reviewed through the *Revue des Revues Démographiques:* Subscribers to these journals frequently are able to consult the articles in that manner. Electronic publishing probably is the direction in which several journals will go. Indeed, the online journal *Demographic Research* published by the new Max Planck Institute for Demographic Research established in Germany is available only on the Internet. In a laudable attempt to reduce the frequently long publication times of traditional journals it conducts review procedures entirely by email. Its focus to date has been slanted toward mortality and morbidity, but that is surely a temporary situation. If it also does well in citation analysis, it could set a new trend.

See also: *Bibliographic and Online Resources; Demography, History of; Population Organizations.*

BIBLIOGRAPHY

Van Dalen, Hendrik P., and Kène Henkens. 1999. "How Influential Are Demographic Journals?" *Population and Development Review* 25(2): 229–253.

———. 2001. "What Makes a Scientific Article Influential? The Case of Demographers." *Scientometrics* 50(3): 455–482.

Van Raan, Anthony F. J. 2001. "Two-Step Competition Process Leads to Power-Law Income Distributions. Application to Scientific Publication and Citation Distributions." *Physica A* 298: 530–536.

INTERNET RESOURCES.

JSTOR—The Scholarly Journal Archive. <http://www.jstor.org>.

Revue des Revues Démographiques. <http://www.cicred.ined.fr>.

University of Wisconsin–Madison Center for Demography and Ecology. <http://www.ssc.wisc.edu/cde/library/papers.htm>.

Dirk J. van de Kaa

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KEYFITZ, NATHAN

(1913–)

Nathan Keyfitz was born and educated in Montreal, Canada. In 1936, two years after receiving a Bachelor of Science degree in mathematics from McGill University, he joined the Dominion Bureau of Statistics, now Statistics Canada, as a clerk, reaching the post of senior research statistician in 1950. He also found time to seek a Ph.D. in sociology from the University of Chicago (1952). In 1959, Keyfitz's career veered toward academia—a professorship at the University of Toronto. In 1963, he was appointed professor of sociology at the University of Chicago where, at age fifty, his exceptionally productive career as a researcher in demography began. Subsequently, he held successive appointments as professor of demography at the University of California, Berkeley, and as professor of sociology at Harvard University (from 1972 to 1981). After his retirement from Harvard, he taught at Ohio State University. Subsequently, for ten years (until 1993) Keyfitz led the population program at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria.

At various times, Keyfitz also consulted, taught, or conducted research in many countries, but foremost in Indonesia—where his research and consulting activities began in the 1950s and continued intermittently over four decades. Keyfitz was president of the Population Association of America in 1970–71, and he received the Association's Mindel C. Sheps award in 1976. He is a member of the Royal Society of Canada, the American Academy of Arts and Sciences, and the U.S. National Academy of Sciences.

Keyfitz is best known for his work in mathematical demography, a branch of demography that his books largely defined for generations of students. In the early 1960s, he began to gather the literature on the application of mathematics to population, dispersed in the journals of many disciplines, and set out the findings in a uniform notation. Keyfitz gave his formulas meaning and interest by applying them to real data, making early use of the mainframe computers that were just then appearing. This work yielded his book, *Introduction to the Mathematics of Population* (1968), and a systematic compilation of country-level demographic estimates produced by his models, *World Population Growth* (1968, coauthored with Wilhelm Flieger). Somewhat dissatisfied with the rather abstract character of his initial effort, Keyfitz went on to write another book, *Applied Mathematical Demography* (1977), in which he examined "a great number of questions that could be dealt with mathematically and that involved techniques needed by demographers" (Van der Tak 1991, p. 287).

Keyfitz's influence on the field of demography and population studies is not limited to mathematical demography. Once immersed in demographic research, he broadened his research interests to substantive issues raised by population dynamics. His book *Population Change and Social Policy* (1982) collects a number of his articles and essays on topics ranging from the environmental effects of population growth to the socioeconomic implications of population aging.

See also: *Demography, History of; Renewal Theory and Stable Population Model.*

BIBLIOGRAPHY

SELECTED WORKS BY NATHAN KEYFITZ.

Keyfitz, Nathan. 1968. *Introduction to the Mathematics of Population.* Reading, MA: Addison-Wesley.

———. 1977. *Applied Mathematical Demography,* New York: Springer-Verlag.

———. 1982. *Population Change and Social Policy.* Cambridge, MA: Abt Books.

Keyfitz, Nathan, and Wilhelm Flieger. 1990. *World Population Growth and Aging: Demographic Trends in the Late Twentieth Century* (1968). Chicago: University of Chicago Press.

SELECTED WORKS ABOUT NATHAN KEYFITZ.

Van der Tak, Jean. 1991. "24. Nathan Keyfitz." In *PAA Oral History Project,* Vol. 1: *Demographic Destinies: Interviews with Presidents and Secretary-Treasurers of the Population Association of America.* Available from the author through the Population Association of America, Washington, D.C.

INTERNET RESOURCE.

Keyfitz, Nathan. 1996. "My Itinerary as Demographer and Sociologist." <http://people.ne.mediaone.net/keyfitz/itinerar.htm>.

JACQUES LEDENT

KEYNES, JOHN MAYNARD

(1883–1946)

British economist John Maynard Keynes was a civil servant in the India Office from 1906 to 1908, and a lecturer in economics at Cambridge University from 1908 to 1913. He was the editor of the *Economic Journal* from 1912 to 1945.

He joined Britain's Treasury in 1915 and was its principal representative at the Versailles Peace Conference in 1919. Believing the Versailles proposals on borders and reparations to be destructive and counter-productive, he resigned in 1919, setting out his objections in *The Economic Consequences of the Peace* (1919).

Keynes was closely associated with the Liberal Party; his influential and brilliantly written works attacked laissez-faire economics and the return to the gold standard, proposing a radically new approach to economic management. He returned to the Treasury in 1940, and in 1944 played a leading part in the Bretton Woods Conference that set up the International Monetary Fund and the International Bank for Reconstruction and Development (better known as the World Bank).

Keynes wrote extensively and influentially, producing, among others, the *Treatise on Money* (1930) and the controversial *General Theory of Employment, Interest and Money* (1936), arguably the most influential work on economics since Adam Smith's *Wealth of Nations*. The *General Theory* showed how aggregate demand, and therefore unemployment, was determined, and that economic systems at equilibrium had no necessary tendency toward full employment, not even with the most depressed wages. Because individual consumer spending could not create sufficient demand, unemployment must be cured by state demand management funded by a budget deficit.

Keynes devoted no major work specifically to population issues, but population concerns recur in his work. A neomalthusian view is prominent in the *Economic Consequences of the Peace*. There he noted that before World War I, Europe's dense population had enjoyed a high standard of living without self-sufficiency in agriculture or raw materials, relying instead on manufactured exports. He feared that such large populations could no longer be sustained following the destruction of industry and in the absence of opportunities for mass emigration.

Keynes was thus initially concerned with what he called the "Malthusian devil O of Overpopulation." This, chained up when productivity was rising, would be released when the temporarily advantageous conditions ended. Keynes campaigned against the then current pronatalist opinion, fearing that population growth would tend to reduce the standard of living, although he also feared adverse eugenic consequences if the more prudent nations, and classes, reduced their fertility before others. These views were summarized in a 1912 lecture, *Population*, not published until 2000 (in Toye's *Keynes on Population*).

In the late 1920s, Keynes changed his mind, rejecting his earlier economic pessimism and some of his Malthusian views on the perils of overpopulation. Instead he became more concerned with inadequate demand. In his 1933 biographical essay on T. R. Malthus he gave much more prominence to Malthus the economist (worried, like Keynes, about underconsumption) than to Malthus the demographer (worried about overpopulation). His Galton Lecture of 1937 was perhaps his most balanced view of population issues. In it, Keynes points to the risk that population decline—in the 1930s, for the first time in centuries, a real possibility—might unchain the other "Malthusian devil U of Underemployed resources" through excessive savings and underconsumption.

In a stationary population, he argued that the two Malthusian devils could only be kept in balance by increased consumption, more equal incomes, and low interest rates. He ended up promoting family allowances, which he had earlier condemned, while recognizing that overpopulation could exist elsewhere. Keynes was probably the most prominent economist of the twentieth century, but his inconstant efforts on population, little supported by data or technical understanding, did not show him at his best.

See also: *Population Decline; Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY JOHN MAYNARD KEYNES.

Keynes, John Maynard. 1919. *The Economic Consequences of the Peace.* London: Macmillan.

———. 1930. "Economic Possibilities for Our Grandchildren." In his *Essays in Persuasion*. New York: W. W. Norton, 1991.

———. 1930. *A Treatise on Money.* 2 vols. London: Macmillan.

———. 1933. "Robert Malthus," in his *Essays in Biography.* London: Macmillan.

———. 1936. *The General Theory of Employment, Interest and Money.* London: Macmillan.

———. 1937. "Some Economic Consequences of a Declining Population." *The Eugenics Review* 29: 13–17.

SELECTED WORKS ABOUT JOHN MAYNARD KEYNES.

Blaug, Mark. 1990. *John Maynard Keynes.* London: Macmillan with the Institute of Economic Affairs.

Blaug, Mark., ed. 1991. *John Maynard Keynes.* 2 vols. Aldershot, Eng.: Edward Elgar.

Hutchison, T. W. 1977. *Keynes versus the 'Keynesians'. . .? An Essay in the Thinking of J. M. Keynes and the Accuracy of Its Interpretation by His Followers.* London: Institute of Economic Affairs.

Keynes, Milo. 1975. *Essays on John Maynard Keynes.* Cambridge, Eng.: Cambridge University Press.

Petersen, William. 1955. "J. Maynard Keynes' Theories on Population." *Population Studies* 8: 228–246

Skidelsky, Robert. 1983–1992. *John Maynard Keynes: A Biography.* 3 vols. London: Macmillan.

Toye, John. 2000. *Keynes on Population.* Oxford: Oxford University Press.

DAVID COLEMAN

KING, GREGORY

(1648–1712)

Gregory King was one of the earliest and most accomplished exponents of political arithmetic. He is described by Richard Stone (1997, p. xxii) as "the first great economic statistician" and the "ablest follower" of John Graunt (1620–1674). Born in Lichfield, England, at age fifteen King became clerk to a leading official of the College of Arms, the body concerned with the assignment of coats of arms and with investitures and similar ceremonies. In other employment he acquired skills as a mapmaker and surveyor, a better source of income. Over subsequent years he advanced to a senior level in the profession of heraldry, eventually being appointed to the positions known as Rouge Dragon and Lancaster Herald. An often-published engraving shows him in the extravagant costume of Rouge Dragon Pursuivant.

King is known mostly for statistical investigations of the population and economy of England in his day, the innovative accounting schemes he devised for those studies, and his early specification of a demand curve. Little of this work was published in his lifetime, and all of it was in the nature of an engrossing hobby, an unpaid sideline to his many other activities.

His major work, dating from 1696 but first printed only in 1802, was *Natural and Political Observations and Conclusions upon the State and Condition of England.* The *Observations* along with King's notebooks contain an astonishing array of statistical information, sought out and systematically presented—in historian Peter Laslett's words, "the first conscious and deliberate attack on social opacity which was ever made" (1985, p. 353). The statistics on population structure include classifications of population by occupation, sex, marital status, age group, and other characteristics. A facsimile of the 1696 manuscript and together with one of the notebooks was published in 1973 in the *Pioneers of Demography* series edited by Laslett. Another, apparently earlier, version of the manuscript exists with the variant title *Observations and Conclusions, Natural and Political, Upon the State and Condition of England*.

King's estimate of the population of England and Wales in 1695—5.5 million—compares with the Wrigley–Schofield figure of 4.95 million. His estimate of the average age of the population was 27.5 years. He also produced estimates of continental and world population at the end of the seventeenth century, based on assumed densities by latitude; these accord moderately well with modern historical estimates, although that may reflect the similarity of informed guesses in the absence of much new information.

See also: *Demography, History of; Graunt, John; Petty, William; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY GREGORY KING.

King, Gregory. [c. 1695] 1973. *Notebook.* Unpublished manuscript. Facsimile in *The Earliest Classics: John Graunt and Gregory King,* ed. Peter Laslett. Farnborough, Eng.: Gregg International.

———. [1696] 1973. *Natural and Political Observations and Conclusions upon the State and Condition of England.* Unpublished manuscript. Facsimile in *The Earliest Classics: John Graunt and Gregory King,* ed. Peter Laslett. Farnborough, Eng.: Gregg International. First printed as an appendix in George Chalmers, *An Estimate of the Comparative Strength of Great Britain* (London, 1802).

SELECTED WORKS ABOUT GREGORY KING.

Glass, David V. 1965. "Two Papers on Gregory King." In *Population in History,* ed. David V. Glass and D. E. C. Eversley. London: Arnold.

Holmes, Geoffrey. 1977. "Gregory King and the Social Structure of Pre-industrial England." *Transactions of the Royal Historical Society* 27: 41–68.

Laslett, Peter. 1985. "Gregory King, Robert Malthus and the Origins of English Social Realism." *Population Studies* 39: 351–362.

———. 1992. "Natural and Political Observations on the Population of the Late Seventeenth Century England: Reflections on the Work of Gregory King and John Graunt." In *Surveying the People: The Interpretation and Use of Document Sources for the Study of Population in the Later Seventeenth Century,* ed. Kevin Schurer and Tom Arkell. Oxford, Eng.: Leopard's Head.

Stone, Richard. 1997. *Some British Empiricists in the Social Sciences, 1650–1900.* Cambridge, Eng.: Cambridge University Press.

Geoffrey McNicoll

KŐRÖSY, JÓZSEF

(1844–1906)

The nineteenth century witnessed the emergence of statistics and demography as independent and influential fields of scientific study within the social sciences at large. The increasingly rich materials produced by the census and by vital statistics provided the raw materials for analytic work, but these statistical operations, which by late in the century were routine and taken for granted by their consumers in most countries of Europe, had to be energetically promoted by imaginative statistical entrepreneurs who realized the potentially high payoff of statistics put to good use. Talent for statistical entrepreneurship and for incisive analysis were often combined in the same person. In Hungary this is exemplified by four statisticians—local variants of *eminent Victorians*—Elek Fényes (1807–1876), Károly Keleti (1833–1892), Gusztáv Thirring (1861–1941) and Kőrösy. The latter's work is distinguished by his wide ranging international engagements, both as organizer of cooperation among statisticians (he was one of the founders of the International Statistical Institute in 1885) and as a developer and promoter of analytic methods. Kőrösy was director of the Bureau of Statistics in Pest (1870–1906), and, after the unification of Pest and Buda, of the Budapest Bureau of Statistics. He was also a professor at the University of Budapest (1883–1906).

Kőrösy is the author of some 200 monographs and journal articles in Hungarian, French, German, and English. Many of these assess the changing demographic situation of Hungary and include highly innovative analyses of mortality conditions, and of behavior with respect to fertility and nuptiality and interaction between these variables, notably the effect of age at marriage on marital fertility and child survival. A collection of his demographic studies (he preferred the term "demology") appeared in 1889 in Hungarian and in 1892 in German. Difficulties in providing proper international comparisons for the structures and trends he described in these studies led him to advocate standardization of data collection methods, adoption of a uniform basic statistical nomenclature, and adoption of minimum standards of statistical coverage and publication. Especially high among his objectives was the international adoption of a plan that he worked out for a world census (1891 and 1898). He pursued the objective through successive international statistical congresses. Some of these proposals were adopted, notably those having to do with uniform procedures in collecting and tabulating census data (1899) and on statistical treatment of data regarding marital fertility (1905). His analyses of mortality were chiefly aimed at clarifying the reasons for the spread of various contagious diseases and their relationship to various societal and natural phenomena (such as housing conditions) and assessing the efficiency of specific medical treatments, such as the introduction of smallpox vaccination. Kőrösy's solutions for the problem of eliminating the effect of age distribution differences on vital rates through standardization were influential in affecting similar work in different fields and in various country population analyses.

See also: *Demography, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY JÓZSEF KŐRÖSY.

Kőrösy, József. 1874. *Az emberi élettartam és halandóság kiszámításáról* [About the Calculation of Life Expectancy and Mortality]. Budapest: Eggenberger.

———. 1881. *Projet d'un recensement du monde.* Paris: Guillaumin.

———. 1889. *Demologiai Tanulmányok* [Studies in Demology]. Budapest: Magyar Tudományos Akadémia.

———. 1889. *Kritik der Vaccinations-Statistik.* Berlin: Puttkammer-Mahlbrecht.

———. 1890. *Neue Beiträge zur Frage des Impfschutzes.* Berlin: Puttkammer-Buchdruck.

———. 1894. *Über den Zusammenhang zwischen Armuth u. infectiösen Krankheiten.* Leipzig: Veit.

———. 1894. "Mass und Gesetze der ehelichen Fruchtbarkeit." Vienna: *Wiener Medicinische Wochenschrift.*

———. 1896. "An Estimate of the Degree of Legitimate Natality." *Philosophical Transactions B.* Vol. 186, pp. 781–875. London: Royal Society of London.

———. 1897. *Die seculäre Weltzählung.* Berlin.

———. 1891, 1899, 1900. "Le recensement séculaire du monde. Etude de statistique internationale." *Bulletin de l' Institut International de Statistique,* Vol. 2. 220–251, Vol. 11(1): 220–250, Vol. 12(1): 78–79.

PÁL PÉTER TÓTH

KUCZYNSKI, R. R.

(1876–1947)

Robert René Kuczynski was a German statistician and demographer who left Nazi Germany in 1933 and settled in London, becoming a British subject in 1946. Kuczynski had joined the Berlin Statistical Office under Richard Boeckh in 1898 and became the director of the Statistical Office of Elberfeld (1904–1905) and subsequently the director of that office in Berlin-Schoeneberg (1906–1921). Between 1900 and 1902 he worked at the Census Office in Washington, D.C., and in the late 1920s he worked at the Brookings Institution in Washington.

In England, Kuczynski worked at the London School of Economics, initially as a research fellow, and in 1938 he became a reader in demography, the first academic appointment in demography at a British university. He retired from that post in 1941 and became a demographic adviser to the Colonial Office in 1944. He was a founding member of the Population Investigation Committee in 1936, as he had been (through its German section) of the International Union for the Scientific Investigation of Population Problems in 1928, and a member of the statistics committee of the Royal Commission on Population from its inception in 1944 through 1947.

An important strand in Kuczynski's work was technical and methodological. Although Kuczynski did not devise the net reproduction rate (the demographic measure indicating the number of daughters who will replace each woman, given the prevailing patterns of childbearing and mortality by age)—he attributed this measure to Boeckh, 1886—he was its major explicator and popularizer. Moreover, he was the originator of the concept of the total fertility rate (1907), which indicates the number of children per woman implied by current age-specific birth rates, assuming no mortality, and the related gross reproduction rate, which is confined to daughters only. All these measures are still widely used.

Kuczynski also conceived of what might be termed birth-order-specific total fertility rates, indicating the births of a particular order per woman implied by current age- and order-specific birth rates, assuming no mortality. Kuczynski's thinking, and calculations, stimulated discussion of the likelihood and implications of below-replacement birth rates in the Western world during the 1920s, 1930s, and 1940s.

Kuczynski was interested in application, not just technique. His published work included reviews of past population movements as well as the contemporary situation. He also wrote about the historical development of thinking about population.

See also: *Projections and Forecasts, Population.*

BIBLIOGRAPHY

SELECTED WORKS BY R. R. KUCZYNSKI.

Kuczynski, Robert R. 1928. *The Balance of Births and Deaths,* Vol. 1. New York: Macmillan.

———. 1935. *The Measurement of Population Growth: Methods and Results.* London: Sidgwick & Jackson.

———. 1937. *Colonial Population.* London: Oxford University Press.

———. 1939. *Living-Space and Population Problems.* Oxford: Clarendon Press.

———. 1948–1953. *Demographic Survey of the British Colonial Empire.* London: Oxford University Press.

SELECTED WORKS ABOUT R. R. KUCZYNSKI.

Anonymous. 1948. "Memoir: R. R. Kuczynski, 1876–1947." *Population Studies* 1: 471–472.

Anonymous. 1948. "A Bibliography of the Demographic Studies of Dr R. R. Kuczynski." *Population Studies* 2: 125–126.

Hogben, Lancelot, ed. 1938. *Political Arithmetic.* London: George Allen and Unwin.

C. M. Langford

KUZNETS, SIMON

(1901–1985)

Simon Kuznets was an economist, statistician, demographer, and economic historian. Born in Pinsk, Russia (now Belarus), he was educated in Kharkov (now Kharkiv, Ukraine), and headed a section of the bureau of labor statistics there under the Soviet government before emigrating to the United States at the age of 21. After receiving a Ph.D. from Columbia University in 1926, he joined the research staff of the National Bureau of Economic Research (NBER), where he conducted his seminal work on the estimation of national income. Both at Columbia and the NBER, he was strongly influenced by his mentor, economist Wesley C. Mitchell. From the 1950s on, the primary base for Kuznets's research was the Committee on Economic Growth of the Social Science Research Council, where he spearheaded an international program on the comparative study of economic growth. Kuznets held faculty appointments at the University of Pennsylvania (1930–1954), Johns Hopkins University (1954–1960), and Harvard University (1960–1971). He was president of the American Economic Association (1954), the American Statistical Association (1949), and was the third recipient of the Nobel prize in economics (1971) for his work on the comparative study of economic growth.

Kuznets's best-known contributions to population fall under three main heads: (1) measurement of population change; (2) analysis of interrelations between long swings in population growth and economic activity (Kuznets cycles); and (3) analysis of the long-term effect of population growth on economic growth.

Kuznets contributed to the development of new demographic data for the United States. His NBER Occasional Paper (written with Ernest Rubin) gives estimates of net immigration by decade, 1870–1940, and of the foreign-born white population by sex, annually, 1870–1939. In 1951, Kuznets and demographer and sociologist Dorothy S. Thomas initiated a study of population redistribution and economic growth. Under their joint direction, this work developed benchmark estimates of state internal migration (by Everett S. Lee), labor force (by Ann R. Miller and Carol Brainerd), and state income and manufacturing activity (by Richard A. Easterlin).

This work demonstrated conclusively that between 1870 and 1950 both international and internal migration in the United States fluctuated markedly over roughly twenty-year periods. Kuznets had earlier identified similar long swings in economic time series. In a major paper published in 1958, he brought together these two strands of work, pointing out a possible causal mechanism in which a swing in the growth rate of consumer goods output induced a corresponding movement in migration and this, in turn, caused a swing in population-sensitive capital formation. An outgrowth of this research on what came to be called Kuznets cycles was an NBER study of long swings in population and economic growth.

Demographers typically stress the adverse effects of population growth on economic growth. Kuznets adopted a more questioning stance. Based on evidence for 63 developed and developing countries from the early 1950s to 1964, he concluded that there was little empirical association between growth rates of population and output per capita, especially within the developing country bloc. Kuznets saw the basic obstacles to economic growth as arising from delays in adjusting social and political institutions, and viewed population growth, though an impediment, as of secondary importance. He was even more skeptical of the adverse effect of population growth for developed countries, and argued that more rapid population growth might promote economic development through a positive impact on the state of knowledge, the crucial factor underlying modern economic growth. This, along with Kuznets's empirical results, stimulated Julian Simon's assault on the premise of mainstream demography that population growth inevitably hinders economic development.

Most comparisons of the economic well-being of rich and poor use the distribution of income among families or households. But rich and poor families differ in size and age composition, and a meaningful comparison of economic welfare needs to allow for such differences. Beyond this, there is the question of how differences in mortality and fertility among income classes affect and are affected by the size distribution of income. These issues became the primary focus of Kuznets's research following his retirement from Harvard in 1971. This strand of Kuznets's work in demography has yet to be fully followed up.

In the discipline of economics where theory reigns supreme, Kuznets, though himself an original and creative thinker, was notable for his insistence on careful measurement and a respect for facts. In this regard he was, at heart, a demographer.

See also: *Cycles, Population; Development, Population and; Easterlin, Richard A.; Simon, Julian L.; Thomas, Dorothy Swaine.*

BIBLIOGRAPHY

SELECTED WORKS BY SIMON KUZNETS.

Kuznets, Simon. 1965. *Economic Growth and Structure: Selected Essays.* New York: Norton.

———. 1973. *Population, Capital, and Growth: Selected Essays.* New York: Norton.

———. 1979. *Growth, Population, and Income Distribution: Selected Essays.* New York: Norton.

———. 1980. "Recent Population Trends in Less Developed Countries and Implications for Internal Income Inequality." In *Population and Economic Change in Developing Countries: A Conference Report, Universities—National Bureau Committee for Economic Research, no. 30,* ed. Richard A. Easterlin. Chicago: University of Chicago Press.

———. 1989. *Economic Development, the Family, and Income Distribution: Selected Essays.* New York: Cambridge University Press.

Kuznets, Simon, and Dorthy S. Thomas, eds. 1957–1964. *Memoirs of the American Philosophical Society.* Vol. 45, 51, and 61: *Population Redistribution and Economic Growth: United States,* 1870–1950. Philadelphia: American Philosophical Society.

SELECTED WORKS ABOUT SIMON KUZNETS.

Bergson, Abram. 1986. "Simon Kuznets: 30 April 1901–8 July 1985." *American Philosophical Society Yearbook.* 134–138.

Easterlin, Richard A. 1987. "Simon Kuznets." In *The New Palgrave: A Dictionary of Economics,* ed. John Eatwell, Murray Milgate, and Peter Newman. New York: The Stockton Press.

INTERNET RESOURCE.

Fogel, Robert W. 2000. "Simon S. Kuznets: April 30, 1901–July 9, 1985," National Bureau of Economic Research Working Paper 7787. *Biographical Memoirs.* Washington, D.C.: National Academy of Sciences. <http://www.nber.org/papers/w7787>.

RICHARD A. EASTERLIN

L

LABOR FORCE

The labor force, as it is conventionally defined, is a measure of the economically active population: those persons who during a specified reference period and within a specific age range of the population are participating in the market economy by supplying labor for the production of goods and services. This concept, which was formalized in the United States during the 1930s as a way to capture the extent of joblessness during the Depression more objectively, is most relevant for modern market economies but is applied with some variations in developed and developing countries.

Definitions and Measurement

The labor force (LF), or the economically active population, can be defined as the sum of the employed population (E) and the unemployed population (U): LF = E + U.

Typically, the employed are defined for a specific age range and reference period as those who are in paid employment or self-employed, either currently at a job or with a job but not at work (e.g., on vacation or sick leave). The unemployed, also defined for the same reference period and population group, are those who are not currently in paid employment or self-employed but are available for work and actively seeking employment (or on layoff waiting to be recalled). Those neither employed nor unemployed are considered economically "inactive." Together the economically active and inactive populations constitute the total population (P) in the relevant age range. Thus the labor force participation rate (LFPR) is defined as LF/P: the ratio of the labor force (LF) to the total population (P). This measure captures the proportion of the population that is economically active at a specific point in time.

In most cases the population reference group for calculating LF, E, U, or LFPR is the working-age population, typically persons age 16 to 64. In most countries labor force statistics are based on sample surveys administered at a specific point in time to capture the primary activity status of individuals in the reference age group.

Conceptual Issues and Their Consequences

As a measure of economic activity the concept of the labor force distinguishes between economic and noneconomic uses of time and between those who are active and those who are inactive. In terms of the first distinction the emphasis on paid employment and on narrowly defined self-employment may exclude unpaid family workers who contribute to a family-owned business or farm. This distinction is more relevant at lower levels of economic development in which the agricultural sector dominates and family enterprises are more common even in the nonagricultural sector.

Because employment typically refers to any work during the reference period, no distinction is made between part-time and full-time employment, and the concept does not identify those who desire to work more hours than they actually work and are therefore "involuntarily" underemployed. In addition, most definitions of the labor force do not capture the so-called underground economy consisting of those engaged in illegal activities, and the so-called informal sector in many low-income countries may not be reflected in the recorded economic activity rates of those countries. Persons counted among the economically inactive population, P – LF, the segment that is not included in the labor force concept, are not necessarily idle. In many cases they are involved in productive activities such as child rearing, home production, volunteer efforts, acquisition of human capital through formal education, and other activities that are outside the market economy and therefore do not involve remuneration in the form of wages, a salary, or profit. In some cases time use surveys are available to gauge the allocation of time to these otherwise unmeasured activities.

The second distinction—between those actively seeking work and those not in the labor force—is largely a matter of definition. The U.S. concept of unemployment, as implemented in the government's monthly labor force survey, requires that an individual be engaged in an active job search (e.g., contacting employers in the reference period) to be classified as unemployed. Individuals who may want to work but have given up actively looking for employment, often labeled "discouraged workers," are excluded from the labor force concept. The existence of discouraged workers underlines the fact that over time the labor force is dynamic: Individuals enter the labor force by actively seeking work or obtaining a job, they remain in the labor force as employed, self-employed, or unemployed, or they leave the labor force through voluntary or involuntary departure from a job or by ceasing to look for work.

The ambiguities associated with what is defined as work or searching for work, as well as measurement errors introduced during the data collection process, mean that labor force data collected in different settings at a specific point in time are not necessarily comparable, and those data may not be comparable over time within a particular setting. Historical data in the United States before 1940 are based on the "gainful worker" concept that counted as employed only those who reported a usual occupation whether or not they were actually working. This approach tended to understate the participation rates of women, and so the measured rise in the economic activity rate of women over time (discussed below) may be overstated. Similarly, differences across countries in social, cultural, and legal norms may determine whether certain activities performed by women are counted as "economic activity" (e.g., unpaid family workers), often making female labor force measures across countries difficult to compare.

Levels and Trends

The economically active population varies across economies at a specific point in time and for the same economy over time, and the demographic composition of the labor force varies as well. In general, the process of economic development is associated with an overall rise in the measured economic activity rate as subsistence agriculture gives way to surplus agricultural production that is sold in the market and as the process of industrialization results in a pool of wage laborers. In the early stages of development a substantial proportion of the labor force is employed in the agricultural (primary) sector of the economy, in contrast to more advanced industrial economies, in which a greater proportion of the labor force is employed in the manufacturing (secondary) and services (tertiary) sectors.

Thus, the process of economic growth is associated with a shift from the primary to the secondary and eventually to the tertiary sector. In the United States, for example, the share of the labor force employed in agriculture declined steadily from 38 percent in 1900 to less than 3 percent in 2000. Since the 1970s, the proportion in manufacturing has declined, signaling the advent of the postindustrial age, and the services sector has made up the difference. In contrast, typically 40 percent or more of employment in countries classified as low-income by the World Bank is in the agricultural sector.

Female labor force patterns. With economic development, the labor force patterns can vary for different demographic groups. The economic activity rate for adult women, particularly married women, is hypothesized to follow a U-shaped pattern over the course of economic development. At low levels of development, in which certain forms of agriculture with a high demand for female labor dominate, most women participate in the labor force to a great extent, often as unpaid workers on the family farm or in small family enterprises. As incomes rise, their participation rates in the market economy decline as women increase their participation in home production, partly as a result of an income effect and often because social norms or other barriers prevent their employment in the growing manufacturing sector. With further development, women's participation in the market economy may increase as education levels and wages rise and the services sector provides more opportunities for female employment. The rise in women's labor force participation may be accompanied by other economic, social, and political transformations, such as the increased availability of market substitutes for home-produced goods, changes in family formation and the level and timing of fertility, and shifts in the power dynamics between men and women.

Tracing the upward-sloping portion of the U-shaped curve, the steep rise in the female labor force—the so-called feminization of the labor force—was one of the most significant labor force trends in the developed world in the twentieth century. In the United States, for example, about one in five women of labor force age was classified as being in the labor force in 1900; by 2000 that figure had tripled. The growth in the female participation rate accelerated during World War II and in the following decades, with a more rapid rise in the participation rate for married women than in that for single women, among whom participation rates were relatively high even in earlier times. The overall long-term growth of the female labor force has been replicated in many other developed countries, although the time path during the twentieth century differed among countries such as the United States, Great Britain, and France.

In the last decades of the twentieth century the most remarkable feature of the U.S. labor force was the increasing rates of participation among women with young children. About 70 percent of married women with one child or more participated in the labor force in 2000 compared with 40 percent in 1970, and the rate increased even faster (from 30% to 63%) for married women with children under age six. Whereas in the 1940s participation rates for women tailed off after ages 20 to 24, the life-cycle pattern for women in 2000 more closely resembled the life-cycle pattern for men, with a broad peak in the labor force participation rate at ages 25 to 44. Events, such as marriage and childbearing, that in the past would have led women to withdraw from the paid labor force, are less likely to elicit that response today.

Male labor force patterns. In high-income countries, at the same time that women have increased their rates of labor force participation, the reverse has taken place among men, largely as a result of later entry into the labor force caused by longer periods of education and earlier departure from the labor force as a result of a falling age of retirement. Again, taking the United States as an illustration, 87 percent of men of labor force age were classified as being in the labor force in 1900; by the year 2000 that percentage had fallen to 75. Among men over age 65 the reduction was from 68 percent to less than 20 percent. Similar patterns are observed in most other industrialized countries.

Over the course of the twentieth century the process and motivations for retirement changed as the secular rise in incomes and the increase in post-retirement income available through public and private pension plans allowed men to leave the labor force voluntarily to enjoy a period of leisure while living independently. This stands in contrast to earlier eras, when poor health typically might have been the primary cause for leaving the labor force and men who retired had to depend on family members for income support. In addition to rising incomes, these changes were made possible by advances in technology that reduced the price of recreation and the public provision of recreational goods and services.

The employment of children. The process of economic development also is associated with reduced rates of labor market activity for children as changes in technology and improvements in adult labor markets, along with the increased availability of (and necessity for) schooling, reduce the demand for child labor. In the United States, for example, the minimum age for being counted in the labor force was age 10 in 1900, age 14 by 1940, and age 16 by 1970. Rather than focusing on child labor per se, the debate in the United States centers on the costs and benefits for youth of participating in paid employment before reaching adulthood, and most U.S. states have some form of compulsory schooling laws and laws restricting the labor market activity of youth.

The employment of children is an issue of international concern because child labor, even at very young ages, is considerably more prevalent in many low-income countries. Although the International Labour Organization (ILO) defines age 15 as the minimum acceptable age for being economically active for most types of work, the ILO estimates that in 1995 some 120 million children age 5 to 14 were participating in full-time paid employment and another 130 million children worked part-time (ILO 1996). Despite such statistics, there is little agreement on either theoretical or policy grounds for specific courses of action in response to this situation, such as the use of international labor standards, trade sanctions, and outright bans on child labor.

See also: *Census; Occupation and Industry.*

BIBLIOGRAPHY

Basu, Kaushik. 1999. "Child Labor: Cause, Consequence, and Cure, with Remarks on International Labor Standards." *Journal of Economic Literature* 37: 1,083–1,119.

Behrman, Jere R. 1999. "Labor Markets in Developing Countries." In *Handbook of Labor Economics,* Vol. 3, ed. Orley Ashenfelter and David Card. Amsterdam: Elsevier.

Costa, Dora L. 1998. *The Evolution of Retirement: An American Economic History, 1880–1990.* Chicago: University of Chicago Press.

———. 2000. "From Mill Town to Board Room: The Rise of Women's Paid Labor." National Bureau of Economic Research Working Paper No. 7608. Cambridge, MA.

Goldin, Claudia. 1995. "The U-Shaped Female Labor Force Function in Economic Development and Economic History." In *Investment in Women's Human Capital and Economic Development,* ed. T. Paul Schultz. Chicago: University of Chicago Press.

Gruber, Jonathan, and David A. Wise, eds. 1999. *Social Security and Retirement around the World.* Chicago: University of Chicago Press.

International Labour Organization. 1996. *Economically Active Populations: Estimates and Projections, 1950–2010.* Geneva: International Labour Organization.

Killingsworth, Mark R., and James J. Heckman. 1986. "Female Labor Supply: A Survey." In *Handbook of Labor Economics,* Vol. 1, ed. Orley Ashenfelter and Richard Layard. Amsterdam: Elsevier.

Lazear, Edward P. 1986. "Retirement from the Labor Force." In *Handbook of Labor Economics,* Vol. 1, ed. Orley Ashenfelter and Richard Layard. Amsterdam: Elsevier.

Pencavel, John. 1986. "Labor Supply of Men: A Survey." In *Handbook of Labor Economics,* Vol. 1, ed. Orley Ashenfelter and Richard Layard. Amsterdam: Elsevier.

Ruhm, Christopher. 1997. "Is High School Employment Consumption or Investment?" *Journal of Labor Economics* 15(4): 735–776.

U.S. Census Bureau. 2001. *Statistical Abstract of the United States: 2001.* Washington, D.C.: U.S. Government Printing Office.

Lynn A. Karoly

LABOR MIGRATION, INTERNATIONAL

Migration for work is one of the major international migration streams. Although successful entry tends to generate international migration streams of dependents not seeking employment, and has other long-term demographic consequences, understanding such repercussions requires prior understanding of international labor migration per se.

Labor migration—as compared with admission of refugees and asylum seekers, and family reunification, which creates or reconstitutes families after one migrates—matches most directly the interests of immigrants with those of the receiving country. Indeed, the main form of international migration has been the "labor-" or work/skills-based one. It has been the dominant form of immigration to the United States in all but the most recent phase; it is the foundation and principal multiplier of the post–World War II migration to northern and western Europe; and it is the almost exclusive variant of the migration flows to the Gulf States since the 1970s, as well as to East Asian and certain South and Southeast Asian states since the 1980s.

Given the large differences in wages and opportunities between potential sending and receiving countries, labor migration streams are likely to remain very large. In the contemporary world, international migration tends to be strictly controlled by the receiving countries. Accordingly, permanent employment-based (also referred to here as "immigrant") visas issued on the ground that an employer seeks the recipient's skills are rather limited. The United States, Canada, Australia, New Zealand, and, in some ways, South Africa—the so-called traditional countries of immigration—have a history of offering permanent employment and skill-based visas as a major part of their immigration programs. The first four of these countries, as of the late 1990s, have accounted for roughly 300,000 such admissions annually—including both principals *and* their families. Few other states offer permanent immigration status up-front on the basis of skills, education, and/or fit with labor market needs.

On the other hand, *temporary* admissions of foreigners (also referred to here as "migrants") who either enter explicitly in order to work or gain a derivative right to do so have been growing rapidly. This is the primary means for gaining entry into most advanced industrial states; increasingly, it is also the means through which ever-larger proportions of permanent immigrants initially enter these states—particularly the United States but also key member-states of the European Union (EU) and Canada.

Most visas in this admission stream, whether permanent or temporary, are awarded to persons with education and skills. Admissions may also be based on a person's relevant experience for particular jobs, even in the absence of formal skills.

Most states follow a few more or less similar routes of selection and admission. They have mechanisms for admitting foreign workers for certain types of employment, both permanently and temporarily, and employ similar screening mechanisms for these admissions.

Skilled Migration: Converging Practices in Drawing on the Global Labor Pool

One component of the employment- or skill-based system of labor migration is temporary admission. This is gaining in popularity across states, with often-similar procedures being adopted. This increasing convergence is in large part the result of the reality of multilateral arrangements, such as those relating to trade-in-services, that are anchored on the principle of "national treatment" or reciprocity, as well as of demands among economic partners to codify reciprocal access for each other's nationals in the areas of business, trade, investment, or cultural exchanges. Many of these arrangements also include either explicit employment components (such as visas for about 70 professional occupations under the North American Free Trade Agreement) or allow employment that is "incidental" to the visa's primary purpose (such as when a student is allowed to work part-time during the school year and full-time when school is not in session, or when a cultural exchange visitor is allowed to teach or give lectures for a fee).

There is, however, another and more consequential reason for such convergence in practices. Competitive pressures in a globalized economy put a premium on cutting-edge technical skills and talent—wherever these may be found. With low trade barriers and with technology, like capital, recognizing neither borders nor nationality, individual initiative and talent may have become the most valuable global resource. As a result, the developed world's immigration systems are well on the way to guaranteeing access to those who have the desired attributes and are willing to put them to work for a firm—wherever that firm may be located.

Not all advanced industrial democracies draw on the global talent pool with the same intensity. It is clear, however, that the high-end immigration door is opening wider and by historical standards remarkably quickly. The EU member states, led by Germany and the United Kingdom, the latter an experienced user of highly skilled foreign nationals, are leading the way in selecting qualified workers from abroad.

This opening is likely to refuel two "old" political discourses. The first one focuses on the failure of the recipient country to adapt its own training and education systems to the requirements of the so-called new economy adequately enough to meet the needs of employers from within its own labor pool. The second discourse dwells on the effect (and propriety) of deeper and more systematic "helpings" by advanced industrial societies from the human capital pool of the developing world. With most EU member states, Japan, other advanced economies, and, increasingly, many advanced developing states poised to permit entry to highly qualified labor, the "brain drain" issue is likely to gain increasing political (and analytical) relevance in the years ahead.

Screening Foreigners Entering for Work Purposes

A state or its corporate citizens choose the foreign workers to be admitted in three principal ways. The first, emphasizing the protection of domestic workers, uses rigorous labor market tests. The second seeks to identify and rectify labor market shortages and skill/locational mismatches. The third stresses the long-term economic interests of the receiving society. In reality, of course, a combination of selection criteria is typically employed.

Most European systems emphasize domestic (and in the EU case, EU-wide) worker protection schemes—although an effort is underway to move away from that model. The United States places its primary focus on rectifying labor market shortages and mismatches—with an increasingly pronounced tendency toward simplifying the labor market tests it requires. Canada, Australia, and New Zealand have increasingly focused on long-term economic interests (what may be called, at least in their permanent systems, the "skills accretion" formula); they eschew most labor market tests.

The principal agent in each selection scheme varies accordingly. In most EU member states, the prospective employer plays an important role but is typically constrained by government predispositions to micromanage the process and deny the employer's petition. In the United States, the principal agent is almost always the prospective employer, both for the permanent and the temporary employment-based systems. In Canada and Australia, the principal agent for the permanent system is the government, with the prospective employer playing a minor role in the process. Employers, however, play a larger and increasingly independent part in the fast-expanding temporary worker admissions system.

Domestic Worker Protection Schemes

Domestic worker protection schemes differ in whether the controls are pre- or post-entry. The former is the dominant variant throughout the world; the latter is a U.S. innovation dating from 1989.

Pre-entry controls. One way to select foreign workers is to test each admission application against the availability of the eligible pool of workers for a particular job opening at a particular place and time. Under this system, the petitioner (typically the prospective employer) must demonstrate to the government's satisfaction that no domestic or other eligible workers are available for the job in question and that the employment of the foreign national will not depress the wages of such workers in similar jobs. Both requirements have proved extremely vexing both on administrative and methodological grounds.

Because of the cost and complexity of the process, an emerging consensus questions the value and efficacy of case-by-case assessments. Moreover, the approach arguably focuses on the wrong goal. It views foreign workers as offering case-by-case relief for specific job vacancies, whereas in the twenty-first century's competitive environment firms often choose workers (domestic or foreign) because small differences in the quality and specificity of skills can lead to substantial differences in performance. This argues for selecting foreign workers on the basis of their mix of skills, experience, education, and other characteristics that maximize the probability both of immediate *and* long-term labor market and economic success.

Post-entry controls: attestations. Post-entry control systems expend most regulatory and enforcement energy on the terms and conditions of the foreign worker's employment. Unlike the pre-entry test, the post-entry one is entirely a U.S. innovation. In its various forms, the attestation mechanism is the principal example of this type of control.

An attestation—a legally binding set of employer declarations about the terms and conditions under which a foreign worker will be engaged—reduces up-front barriers to the entry of needed foreign workers but still seeks to protect domestic worker interests through subsequent auditing and enforcement of the terms of the attestation. (The terms are designed to protect domestic workers from employer reliance on foreign workers to affect a union dispute, reduce wages, or make working conditions worse.)

Attestations have a number of positive features. If well conceived and implemented, attestations give employers access to needed foreign workers without harming the interests of domestic workers. They give potentially affected parties an opportunity to challenge the matters to which an employer attests. They are responsive to changing labor market conditions. They require minimal hands-on engagement by the government in an area where both data and procedures are weakest. And they can be an inducement to cooperative labor-management relations in recruitment.

Attestations, as practiced in the early twenty-first century, however, also have a number of shortcomings. Some of these are similar to the problems with the pre-entry control process. For example, the government is typically ill-equipped to determine the appropriate wage for any particular foreign worker. Furthermore, some of the documentation requirements of an attestation appear to be quite burdensome for employers and require release of what they consider proprietary information on wages. Attestations could potentially become pawns in labor–management disputes, subject to frivolous challenge by worker representatives. And the system is open to abuse by unscrupulous employers.

The Points Test

If the two main selection methods identified above are flawed—the first mostly in concept, the second in execution—what might be an alternative? Some states rely systematically on a points test for selecting large pluralities of their permanent "labor" immigrants. (New Zealand's proportion stands at three-fifths of total immigration.) Only those foreign workers whose specified personal and quantifiable attributes add up to a pre-agreed "pass mark" are allowed to immigrate permanently. (Among the characteristics currently receiving the highest point totals are education, age [comparative youthfulness], language and communication skills, and experience in a professional field.) Variants of the points system are practiced in Canada, Australia, and New Zealand. Germany has shown interest in the system.

A points system has several advantages over other selection mechanisms, at least when it is relied upon selectively and in conjunction with mechanisms that allow firms to choose directly some of the foreign workers they need. It inspires confidence as a policy instrument that applies universal, and ostensibly "hard" (i.e., quantitative and objective), selection criteria to economic-stream immigrants. Hence, it is less susceptible to the criticisms associated with the case-by-case system's "gamesmanship" between employers and bureaucrats. It can reassure key segments of the receiving society that the selection criteria for economic-stream immigrants conform to the state's economic interests. (This makes immigration politically more defensible than the alternatives discussed earlier.) And the criteria included can be altered or reweighted, or the pass mark adjusted, to respond quickly to shifting economic priorities.

A points-like system can thus shift the focus of permanent economic-stream immigration from an almost exclusive emphasis on case-by-case determination of specific job vacancies to one that takes into greater account broad economic interests. Properly conceived and implemented, and accompanied by opportunities for firms to select key workers on their own, a points-like system asks the government to do what it can be fairly good at (i.e., gauging the broad direction and needs of the economy over an intermediate- to long-range time horizon) rather than forcing it to do what it is least good at (i.e., case-by-case job matching).

Other Labor Migration Schemes

This article's focus so far has been on the formal, and individualized, selection schemes practiced most diligently by advanced industrial societies. However, the largest share of labor migration occurs through the following routes: (a) outside of formal controls; (b) through seasonal and otherwise short-term work contracts; (c) through a variety of training and similar schemes; (d) through trans-border work schemes; and (e) finally, through contracts that involve large numbers of workers, most typically tied to a particular construction or other major project.

The first form includes not only illegal migration, but also forms of migration that in many ways both predate and bypass attempts at formal regulation. Much intra-Africa migration, for instance, fits that latter characterization, as is much of the seasonal migration discussed immediately below. Both forms together amount to a total of several million persons per year.

Formal seasonal, other short-term, and industry-specific labor migration is also significant in numbers yet its size is difficult to estimate. Suffice it to say that few nationals of advanced industrial societies pick their own fruits and vegetables, tend to their agricultural holdings, staff seasonal or tourist related activities, or perform domestic and other forms of menial, difficult, and poorly-compensated work. These jobs have become the domain of foreign workers throughout the developed and, increasingly, the developing world. The workers who staff these jobs number in the low millions—probably between 2 and 3 million—and they hold a variety of legal statuses (the dominant one being an illegal status).

Training and similar schemes are notable in such countries as Japan, Germany, the U.S., and other countries that rely on them rather systematically. The numbers involved are in the lower hundreds of thousands. Such schemes are typically thinly disguised efforts to circumvent a government's prohibition of particular forms of entry, most typically directed against the importation of low-skilled workers. In most of these instances, government agencies effectively collude with employers to admit such prescribed persons.

Trans-border work schemes are typically found in neighboring countries. In their most formal expression, such schemes explicitly or implicitly allow limited employment and take the form of bilateral arrangements that often predate the strict regulation of migration. The U.S. "border-crosser" scheme has its roots in practices that go back to the early twentieth century; several hundred thousand people have a right to participate in that scheme but not all do. Germany developed similar arrangements in the 1990s with neighbors to its East, as have some other European states, more recently Italy and Greece. The total number of these additional schemes, however, generates tens of thousands of work visas.

The final form of labor migration, contract labor schemes, saw their heyday in the 1970s and 1980s. At that time, hundreds of thousands of Middle Easterners (particularly Palestinians and Egyptians), as well as East-, Southeast-, and South-Asians found contract employment in often massive projects located mostly in the Gulf states. The number of such workers in that region has fluctuated but generally numbered in the neighborhood of 2 to 3 million in the 1970s and 1980s, but has shrunk to nearly half that much in the 1990s—with South Asians having replaced most other nationalities.

See also: *Immigration, Benefits and Costs of; Immigration, Unauthorized; International Migration.*

BIBLIOGRAPHY

Bertrand, Gilles, Anna Michalski, and Lucio R. Pench. 1999. "Scenarios Europe 2010: Five Possible Futures for Europe." Working Paper. Brussels: European Commission, Forward Studies Unit.

Bilsborrow, R. E., et al. 1997. *International Migration Statistics: Guidelines for Improving Data Collection Systems.* Geneva: International Labor Office.

Brown, Michael E., and Sumit Ganguly, eds. 1997. *Government Policies and Ethnic Relations in Asia and the Pacific.* Cambridge, MA: MIT Press.

Commission for Labor Cooperation and North American Agreement on Labor Cooperation. 1997. *North American Labor Markets: A Comparative Profile.* Lanham, MD: Bernan Press.

International Labor Office. 1999. "Meeting the Challenge of Global Labor Mobility." Issues Paper. Geneva: International Labor Office.

Massey, Douglas S., et al. 1998. *Worlds in Motion: Understanding International Migration at the End of the Millennium.* New York: Oxford University Press.

McDonald, David A., ed. 2000. *On Borders: Perspectives on Cross-Border Migration in Southern Africa.* New York: St. Martin's Press.

Newland, Kathleen, and Demetrios G. Papademetriou. 1998/1999. "Managing International Migration: Tracking the Emergence of a New International Regime." *UCLA Journal of International Law and Foreign Affairs* 3(Fall/Winter 1998–99): 637–657.

Papademetriou, Demetrios G., and Stephen Yale-Loehr. 1996. *Balancing Interests: Rethinking U.S. Selection of Skilled Immigrants.* Washington, D.C.: International Migration Policy Program, Carnegie Endowment for International Peace.

Salt, John. 1998. *Current Trends in International Migration in Europe.* Council of Europe.

SOPEMI. Various years. *Trends in International Migration Annual Report.* Paris: Organization for Economic Cooperation and Development.

Stalker, Peter. 2000. *Workers Without Fronteirs: The Impact of Globalization on International Migration.* Boulder, CO: Lynne Rienner.

United Nations Department of Economic and Social Affairs. 1998. *World Population Monitoring 1997,* ST/ESA/SER.A/169. New York: United Nations.

———. 2003. *International Migration Report 2002.* New York: United Nations.

Demetrios G. Papademetriou

LANDRY, ADOLPHE

(1874–1956)

Adolphe Landry was a French man of letters, economist, demographer, and statesman. He was educated in the Ecole Normale Superieure, but as a young man he was attracted by socialist ideas and abandoned plans for a literary career in preference for studies in the social sciences. Soon he was writing and publishing papers on a wide range of economic, historical, legal, and sociological subjects. In 1907, Landry was appointed to a chair at the Ecole Pratique des Hautes Etudes. In 1910, he was elected to Parliament as a deputy from his native Corsica, and during his long political career he occupied several ministerial posts.

Landry's special interest in population was first signaled by two articles that appeared in 1909. One was on the population ideas of the eighteenth-century French economist and intellectual leader of the Physiocrats, François Quesnay; Landry's later writings also were inspired by the study of the history of economic thought. The other article presented his first formulation of demographic evolution as a sequence consisting of three stages—a primitive regime, characterized by high (uncontrolled) fertility and high mortality; an intermediate regime, such as in eighteenth- and nineteenth-century France and Britain, in which the higher standards of living that had been attained began to be protected by restriction of fertility (primarily through later marriage); and finally the contemporary regime, in which control of fertility becomes a generalized practice through contraception and abortion.

The most important contribution made by Landry to population theory was a full development of these ideas in the book *La révolution démographique* that appeared in 1934 (preceded by an eponymous article published in 1933, which later also appeared in English). "La révolution démographique"—the Demographic Revolution—denotes essentially the same process that, under the influence of the English-language literature and parallel theoretical development of the concept in the United States by demographers such as Warren Thompson, Frank Notestein, and Kingsley Davis, is primarily known as the demographic transition. Stylized presentations of the demographic transition routinely pictured the process as leading from a high-level equilibrium of birth and death rates to a low-level one: a path from a quasi-stationary state to a stationary state, with a period of more or less rapid and sustained population growth in between. In contrast, Landry's more flamboyant label signaled that he perceived the dynamics as one leading to long-term population disequilibrium. He expected birth rates to fall below death rates, first in the West and eventually spreading to the rest of the globe.

Landry was deeply concerned with what he saw as the predictable consequences of impending depopulation in France (the country farthest along toward that prospect): decadence resembling that of Venice or even extinction of civilization, exemplified by Greece and the Roman Empire. His concern was manifested in some four decades of political activism aimed at halting or reversing the process. From 1912 on, Landry took a leading role in the *Alliance nationale contre la dépopulation* and, in the interwar years, initiated a variety of legislative measures intended to improve the economic status of families with children so as to stimulate fertility. These efforts culminated in the *Code de la famille,* adopted by Parliament barely a month before the outbreak of World War II. Landry was also influential in the design of postwar French social policy, shaping social legislation with a strong pronatalist orientation; he attributed the resurgence of the birth rate in France to the effects of these policies.

Landry's 1945 book, *Traité de démographie,* written in collaboration with younger French demographers, was a then-unparalleled and up-to-date single-volume summation of the methods of demographic analysis, but it also presented a substantive description of population processes and population issues. Continuing his prominent prewar role in international scientific activities in the field of population, in 1947 Landry was elected to serve as the first president of the reconstituted International Union for the Scientific Study of Population.

See also: *Demographic Transition; Population Thought, Contemporary; Sauvy, Alfred.*

BIBLIOGRAPHY

SELECTED WORKS BY ADOLPHE LANDRY.

Landry, Adolphe. 1909. "Les idées de Quesnay sur la population." *Revue d'histoire des doctrines économiques et sociales* 2.

———. 1909. "Les trois théories de la population." *Revue Scientia.*

———. 1929. "Le maximum et l'optimum de la population." *Revue Scientia* April.

———. 1934. *La révolution démographique.* Paris: Sirey.

———. 1936. "Quelques aperçus concernant la dépopulation dans l'Antiquité gréco-romaine." *Revue Historique* January–February.

———. 1941. *La démographie française.* Paris: Presses universitaires de France.

———. 1987. "Demographic Revolution." *Population and Development Review,* 13(4): 731–740; originally published in 1933 as "La révolution démographique." In *Economic Essays in Honour of Gustav Cassel.* London: George Allen and Unwin.

Landry, Adolphe, H. Bunle, P. Depoid, M. Huber, and A. Sauvy. 1945. *Traité de démographie.* Paris: Payot.

SELECTED WORKS ABOUT ADOLPHE LANDRY.

Demartini, A. M. 1990. "Un destin bourgeois: Adolphe Landry et sa famille." *Ethnologie française* 20(1): 12–24.

Sauvy, Alfred. 1956. "Adolphe Landry." *Population* 11(4): 609–620.

JEAN-CLAUDE CHESNAIS

LAND USE

Humans use the foundation of land for dwellings, the crops of land for eating, the grass of land for grazing, and the timber of land for building. Land brings with it the minerals and fuel beneath, and it receives humanity's waste. People fight over land. Although environmental ethics strengthen human support for natural animals and plants in their competition for habitat, human dominion over the land still leaves for nature only what humanity spares from its own uses. Logically, land cover differs from land use, but it is useful to think of the covers of urban settlement, crop, grass, and forest as four classes or possibilities of land use.

A simple equation connects land use to population times average food requirement divided by food yield per unit area. The German geographer and geologist Albrecht Penck (1858–1945) wrote this equation in a journal of geopolitics in 1924. Earlier the English economist T. R. Malthus (1766–1834) phrased humanity's dependence on food from land in dynamic terms when he wrote that the slow *addition* of food from land would limit humankind's exponential *multiplication.*

Location

Before considering global land use in simple equations, the factor of location must be considered. In 1826 the Mecklenburg landowner and economist Johann von Thünen (1783–1850) published *Isolated State,* a work that introduced location into a model of a conceptually isolated land area surrounding a city. Accessibility was added to the well-known factors of soil and climate that determined land use. Von Thünen assumed, of course, that farmers would maximize their incomes by considering yield, price, and production expense. To these, however, he added the distance to market multiplied by transportation and produce-deterioration rates. The transport cost to the central city of his isolated state creates concentric zones. In the inner zone, gardening prevails but falls off in a short distance because fruit and vegetables deteriorate, and deterioration is part of transport cost. The low value of critical but bulky wood and hay restricts their production to the next zone. A dried crop containing many calories is worth many dollars per ton and does not deteriorate. Hence such crops as grain or onions grow in the third zone. Because cattle go to market on their own legs, the pastoral zone lies farthest from the city.

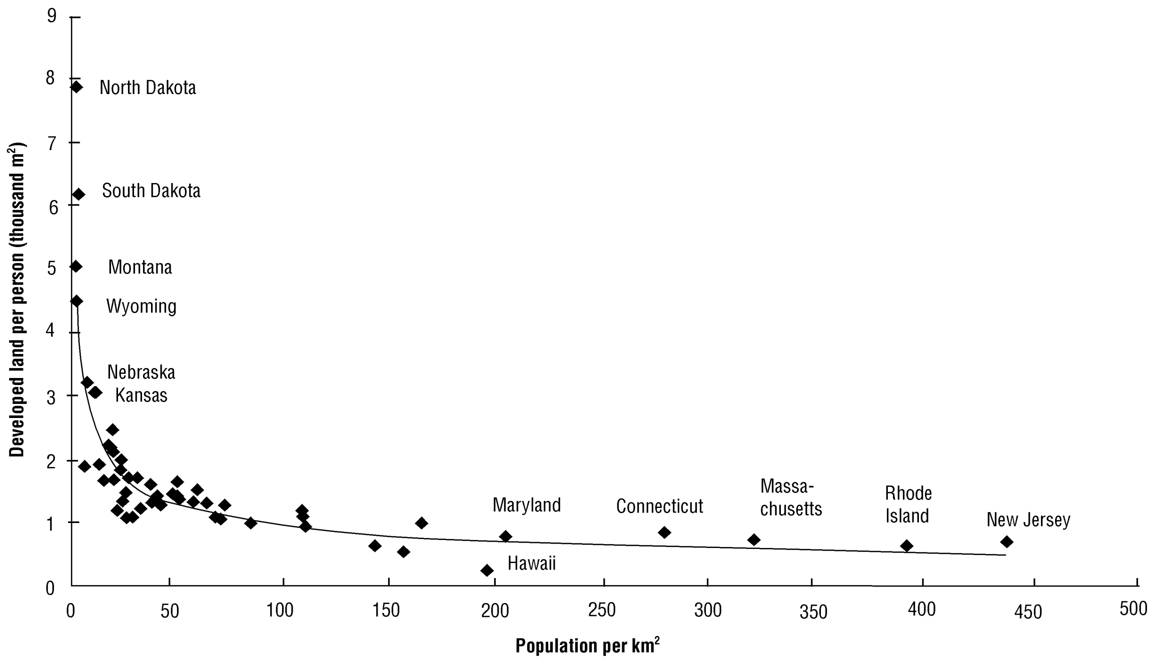
Beyond raising yields and cutting expenses, farmers soften von Thünen's law in other ways. Trains, trucks, and airplanes cheapen transport, while refrigeration slows deterioration, lowering the obstacle of distance. Nevertheless, as famine in isolated regions can still demonstrate, that the obstacle persists.

Urban Habitat

Location in the city itself imparts a value to developed or urban use that trumps other uses. An ancient city pressed upon local resources and demanded inventions in farming and transport not required by roaming hunters and fishers. A city could finance and build canals, roads, and irrigation, which scattered people could not. Urban use persists, as a ruin like a Roman road attests, whereas crops, grass, and trees can replace one another. Because urban use trumps and outlasts others, it is fortunate, as Ester Boserup argued, that paving and companions elicit

FIGURE 1

Fraction of Land Developed in 49 U.S. States as a Function of Population Density



Note: Alaska is omitted. The curve represents development as the square root of density.

SOURCE: Waggoner, Ausubel, and Wernick (1996).

more cleverness and invention than wilderness and solitude.

The intensity of urban use is indicated by the area in hectares developed or urbanized per thousand population. Assuming that the area of large cities is fully urbanized, one can calculate the area per thousand persons as less than 4 hectares in Mumbai (Bombay), India, and in Hong Kong in the 1990s. Focusing on smaller areas lowers the estimate of urban use: In 1995 the average use of land per thousand persons in New York City's five boroughs was 11 hectares; on the island of Manhattan, it was only 5 hectares. Twenty-four U.S. counties, including New York in the East and San Francisco in the West, as well as counties in Michigan and Minnesota in the North and Louisiana and Florida in the South, used fewer than 100 hectares per thousand inhabitants—that is, they had population densities of more than 1,000 persons per square kilometer.

Urban use encompasses more than dwellings. In the United States, for example, it includes industrial, commercial, and institutional land; construction and waste disposal sites; railroad yards, airports, and urban transport ways; cemeteries and golf courses; and water structures. The development of land in 49 U.S. states (omitting Alaska) demonstrates that urban use does not increase in proportion to population (see Figure 1). Thus rich as well as poor congregate and use little urban land, making city dwellers, despite their generally higher incomes, the most sparing of land.

At the same time that people congregate on one scale, however, they diffuse on another. Thus in the United States from 1920 to 1990, while the urban proportion grew, the number of persons per occupied housing unit declined from an average 4.3 to 2.7. Persistently willing to travel an hour a day in their journey to work while transport speeds increase, people spread from central cities over ever-larger metropolitan regions, building suburbs. During the 1990s, the population of metropolitan areas of 2 to 5 million people outgrew that of both more and less populous areas. From 1950 to 1990 urban land expanded at 2.8 percent per year versus total population growth of 1.2 percent, but in 1990 urban use still occupied less than 4 percent of all U.S. land. These trends are echoed in another developed nation, the Netherlands. And some slowing of the growth of urban land use can be seen in both countries.

Cropland

Of the calories and protein supporting people worldwide, 84 percent of the calories and 75 percent of the protein are from crops. Because many animals, bred for human consumption, eat crops, the dominance of crops exceeds even these high percentages. Nevertheless, such a simple proportionality as Penck envisioned between cropland and population must be modified. Dimensions prove that the forces on the right side of the following equation must be identical to the expanse of cropland:

$$\textit{Cropland} = \textit{Population} \times \textit{Income} \times \textit{Appetite} \times \textit{Yield}$$

where cropland is area in hectares, income is gross domestic product (GDP) per person, appetite is food production divided by GDP, and finally what is termed yield is cropland in hectares divided by food production. This identity implies an independence of the forces. Nevertheless, per capita food consumption rises as income increases, but not in proportion to the rise of income, causing the force of appetite (food per GDP) to fall.

Since 1960, the annual growth of the first force, global population, has slowed from above 2 percent to appreciably below 2 percent. Growth of income also slowed from more than 3 percent to below 2 percent per year. As income rose, the appetite ratio fell. The final force, cropland over food production, fell rather steadily at 2 percent per year. The net of these forces is the rate of expansion of cropland. From 1961 to 1997 cropland expansion averaged about 0.33 percent per year. The decline of the appetite and yield ratios moderated the impact on cropland area that Penck's simple equation would have predicted. The negative income elasticity of the appetite ratio tempered the effect of rising income and, in combination with farmers' improving yields, spared natural habitat from crop use. While benefiting nature, this sparing also benefited humankind, because the area of prime land suitable to be converted to crops is limited.

Grassland

The Food and Agriculture Organization (FAO) reports a category of land use called "permanent pastures," which it defines as land used permanently (five years or more) for herbaceous forage crops, either cultivated or growing wild, but apologizes that the dividing line between this category and "forests and woodland" is rather indefinite. In 1993 permanent pasture comprised 26 percent of global land, slightly more than twice the total area of cropland, slightly less than that of forests and woodlands, and slightly more than the land unaccounted for by FAO.

Demand for the protein in the meat and milk of grazing animals might seem to connect pasture to population. The change in human and animal populations, animal protein production, and the land used for pasture, however, proves that the connection is not a simple proportionality. From 1961 to 1998 humans increased at an average rate of 1.8 percent per year, but cattle increased at only 1 percent per year. The FAO-estimated 0.9 percent rise of protein added to the 1.8 percent increase of people means protein production rose fully 2.7 percent per year, outpacing cattle populations.

Equally surprising, pasture, which might have been thought to expand enough to support the extra protein production, expanded at a rate of only 0.2 percent per year. In an identity connecting population and other factors to pasture, the ratio of protein in the food supply to pasture area had to fall 2.5 percent per year. Although more animals eating feed rather than grazing lay behind some of this finding, the principal explanation must be more productive pastures and animals plus less animal product lost before it reached the table.

Forestland

Humans harvest trees for lumber for construction, pulp for paper, and wood for fuel. They clear forests for crops and pastures. Thus the expectation that rising population will shrink forests comes easily. But, contrary to that expectation, whereas forests shrank in some places, especially Africa, they expanded in Europe and the United States. French forests, for example, began expanding in the nineteenth century despite a French population that kept growing, although relatively slowly. Geographers have labeled the change from a negative to a positive connection between population and forests (from growing population and shrinking forests to expanding forests despite growing population), the forest transition. The annual 0.2 percent shrinkage of the world forest during the 1990s was made up of disparate trends, such as a 0.8 percent shrinkage in Africa but a 0.1 to 0.2 percent expansion in Europe and the United States.

Forests can be converted to farming. Whereas global forests were shrinking by 9 million hectares per year during the 1990s, pasture was expanding only about by 2 million hectares per year and cropland by less than 1 million hectare. Thus a balance of some 6 million hectares must have gone to the residual area—neither forest, cropland, nor permanent pasture—that comprises about a third of global land. Decreasing the encroachment of crops and pasture on forest further, agricultural uses can be subtracted from the residual area, and—with soil improvement and irrigation—even on formerly barren land. Expanding agricultural use by 1 hectare need not shrink forest area by 1 hectare.

Worldwide, foresters annually harvest about 0.4 percent of the 386 billion cubic meter volume of wood standing, calling the harvest "industrial roundwood." Much fuelwood fails to appear in such statistics. Because trees grow, harvesting is not a permanent subtraction from the forest. In the timberland of the United States in 1991, for example, forests grew by 2 cubic meters per hectare, exceeding the harvest by a third. Substitutes such as coal for fuelwood, concrete for poles, electronic documents for paper, and chipboard for planks, plus more efficient mills, steadily lessened the role of timber products in the U.S. economy.

High-yielding trees can spare natural habitat. Plantation trees can grow up to 20 cubic meters per hectare per year, producing the same harvest from 1 hectare as 10 hectares of the average U.S. forest. South Africa has only 4 percent of African land and 1 to 2 percent of its forest cover, but it has 19 percent of all African plantations and in 1994 cut fully 26 percent of industrial roundwood harvested on the continent. The forest area of South Africa scarcely changed from 1990 to 2000, whereas the forest of the entire continent of Africa shrank 0.8 percent annually. Intensive management can lessen the extent of logging use on natural lands.

The Residuum

After subtracting agricultural and forest land from the global supply, a residuum remains. Urban uses, mines, and oil wells occupy a few percent of it, but people leave much dry, infertile, or cold land unused. With effort, irrigation, and fertilizer, people can put some of this residuum to use.

Conclusion

Land use means land use by people. Therefore, population is the first determinant of land use, followed by the income of the population, which multiplies capability per person. Generally, however, the consumption of food and other products of land (from space for foundations to wood for fuel) does not rise in proportion to income, meaning consumption grows more slowly than population multiplied by income. Substitutes such as electronic messages for paper messages and gas fuel for wood fuel are one reason. Other technological developments such as skyscrapers and high-yield grain or trees add further leverage to modify a simple projection of land use in step with population.

See also: *Carrying Capacity; Deforestation; Density and Distribution of Population; Remote Sensing; Sustainable Development; Water and Population.*

BIBLIOGRAPHY

Alexandratos, Nikos, ed. 1995. *World Agriculture: Towards 2010. A FAO Study.* New York: Wiley.

Ausubel, Jesse H., and Cesare Marchetti. 2001. "The Evolution of Transport." *Industrial Physicist* 7(2): 20–24.

Boserup, Ester. 1981. *Population and Technological Change.* Chicago: University of Chicago Press.

Cohen, Joel E. 1995. *How Many People Can the Earth Support?* New York: Norton.

Cronon, William. 1991. *Nature's Metropolis: Chicago and the Great West.* New York: Norton.

U.S. Department of Agriculture. 1997. *Agricultural Resources and Environmental Indicators, 1996–97.* Washington, D.C.: U.S. Department of Agriculture.

Van Diepen, A. 1995. "Population, Land Use, and Housing Trends in the Netherlands, since 1950." Laxenburg, Austria: International Institute for Applied Systems Analysis.

Waggoner, Paul E., and Jesse H. Ausubel. 2001. "How Much Will Feeding More and Wealthier People Encroach on Forests?" *Population and Development Review* 27: 239–257.

Waggoner, Paul E., Jesse H. Ausubel, and Iddo K. Wernick. 1996. "Lightening the Tread of Population on the Land: American Examples." *Population and Development Review* 22: 531–545.

Young, Anthony. 1998. *Land Resources Now and for the Future.* Cambridge, Eng.: Cambridge University Press.

INTERNET RESOURCES.

Demographia. 2001. "Largest International Urban Areas: Ranked by Density." <http://www.demographia.com/db-intluadens-rank.htm>.

Food and Agriculture Organization. 2002. "FAOSTAT." <http://apps.fao.org/>.

PAUL E. WAGGONER

LANGUAGES AND SPEECH COMMUNITIES

Languages cannot be counted precisely. Each language forms an integral part of a continuum of human communication. This global continuum, which is as old as speech itself, underlies the often neglected unity of humankind. Communities seemingly separated by language are bound together by bilingual voices on one or both sides of their divide, and words, sounds, and even grammatical rules are exchanged regularly among languages that are in contact with one another.

With the worldwide spread of electronic communication, the interfaces among individual languages will become even more fluid. Multilingualism will increase. The gulf between speech and writing will narrow, as each becomes a potential electronic product of the other. More and more small speech communities will enjoy worldwide mobility through migration and through worldwide usage of telecommunication.

The growth of electronic communication inevitably favors the domination of intercommunal and international relations among a restricted number of languages dominated by English. However, electronic communication also assists in maintaining the use of more localized languages and dialects as markers of communal identity, especially when their speakers are physically separated.

Distribution of Languages by Numbers of Speakers

Populations cannot be enumerated precisely in regard to individual languages except in the case of languages spoken within small circumscribed communities. One cannot define when learners become adequate speakers: Estimates of the global population of speakers of English thus may range from less than 1 billion to almost 2 billion, depending on the definition of proficiency. However, it is possible to make useful estimates of the relative importance of languages worldwide or within specific populations.

At the beginning of the twenty-first century 27 modern "arterial languages" are accessible to 1 percent or more of humankind (i.e., each language to a population of 60 million or more) (See Table 1). Two thirds of those languages fall within a band of between 1.0 and 2.5 percent of the world's total population, ranging from Tagalog, Korean, Vietnamese, Thai with Lao, Tamil, Telugu, Italian, Persian with Tajik, Panjabi, Marathi, Wu, Cantonese, and Swahili (between 60 million and 90 million speakers each) to Javanese, Turkish with Azerbaijani, Japanese, French, and German (between 100 million and 135 million speakers each).

The remaining nine arterial languages are the giants of modern spoken and written communication, with each one being accessible to more than 3 percent of humankind. Seven of these languages are closely related to and draw an important part of their heritage from five major classical written languages (listed with the names of the modern languages in parentheses): Classical Chinese (Mandarin and its close relatives), Sanskrit (Hindi with Urdu and Bengali, along with their close relatives), Classical Arabic (Modern Arabic in its western and eastern forms), Latin (Spanish and Portuguese and their close relatives), and Church Slavonic (Russian and its close relatives).

The phrase "close relatives" conceals the basic problem of what a language is. The name "Chinese" covers a unified writing system but a great variety of spoken forms that are used largely within the same nation-state. Speakers of Spanish and Portuguese have relatively easy access to other Latin-derived ar-

TABLE 1

Major Languages of the World

Language Group	Language	Population (millions)	Main Countries or Regions
Afro-Asiatic	Arabic	250	Middle East, North Africa
Austronesian	Malay, Indonesian	200	Indonesia, Malaysia
	Javanese	100	Indonesia
	Tagalog	60	Philippines
Other Eurasian	Turkish, Azerbaijani	100	Turkey, Azerbaijan, Turkmenistan
	Japanese	130	Japan
	Korean	75	South Korea, North Korea
	Vietnamese	75	Vietnam
	Thai, Lao	90	Thailand, Laos
	Tamil	90	India, Sri Lanka
	Telugu	70	India
Indo-European	Spanish	500	Spain, Latin America
	Portuguese	200	Brazil, Portugal, Mozambique, Angola
	French	135	France, Belgium, Switzerland, Canada, Central and West Africa
	Italian	70	Italy, Switzerland
	English	1000	(countries in all continents)
	German, Dutch	135	Germany, Austria, Switzerland
	Russian, Belarussian	320	Russia, Belarus
	Persian, Tajik	60	Iran, Afghanistan, Tajikistan
	Hindi, Urdu	900	India, Pakistan
	Panjabi	85	India, Pakistan
	Bengali	250	India, Bangladesh
	Marathi	80	India
Sino-Tibetan	Chinese (Mandarin)	1000	China, Taiwan, Singapore
	Wu (Hakka, etc.)	85	China
	Cantonese	70	China
Transafrican	Swahili	90	Kenya, Tanzania, Uganda

Note: The table lists the 27 languages that reach 1 percent or more (> 60 million) of the world population as either first or second languages.

SOURCE: Adapted from the Linguasphere Register of the World's Languages and Speech Communities (Dalby, 1999– 2000). See <www.linguasphere.net>.

terial languages such as French and Italian, and vice versa, although all four of those languages developed as the languages of separate and rival nation-states. The relationship between Russian and the other Slavonic languages is somewhat similar.

Two arterial languages remain: Malay, including its modern derivative Indonesian, and English. Both owe their wide extension to maritime trade and conquest: Malay-Indonesian as a regional language now accessible to over 200 million people and English as a broadly spoken language accessible to a global population of 1 billion or more.

Is English the "most spoken language"? The answer still depends on the time of day. When the sun is over the eastern Pacific, Chinese is the world's most spoken language and Hindi with its close relatives is in the second position. When the sun is over the Atlantic and much of Asia sleeps, English is the most spoken language in the world, with Spanish in a strong second place.

Ebb and Flow of Languages

All spoken and recorded languages form part of a global continuum or "linguasphere," a shared framework for establishing personal and interpersonal thoughts, communications, and identities. The piecemeal approach to the study of individual languages belongs to the twentieth century, together with the spurious comparison of dying languages with dying species of animals and plants. The end of hunting and gathering as a viable lifestyle brought the inevitable end of a large number of minute speech communities. The heritage of those groups should be documented carefully if it is not already too late to do that. However, the natural diversity of humankind will always require and support linguistic diversity. Its extent would be better documented if population census data routinely included information on levels of multilingualism.

Future Trends

Every community that wants to preserve and promote its language should be encouraged to do so. Every child has the right to an education in her or his own language but arguably has also the right to learn a language that provides access to knowledge in all cultural and economic fields. The success or failure of globalization in all its meanings, including globalized respect for diversity and equality of opportunity, will depend on the global development of the world's languages as a shared human resource. This development will clearly benefit from the transnational use of English in the service of a multilingual and multicultural world, rather than as the vector of a dominating monolingual culture.

The most important linguistic development during the twenty-first century will be the increasing electronic empowerment of the spoken word, which is already superseding writing as the principal means of long-distance communication and also may challenge the printed word as the principal vehicle of permanent recording. English is likely to solidify its present position as the dominant vehicle for international communication, but most languages will survive within their own communities, which in several instances will be numerically larger than the population of native English speakers, as languages of cultural and localized identity.

See also: *Ethnic and National Groups; Literacy.*

BIBLIOGRAPHY

Crystal, David. 1998. *English as a Global Language.* Cambridge, Eng.: Cambridge University Press.

Dalby, Andrew. 1999. *Dictionary of Languages.* London: Bloomsbury.

Dixon, Robert M.W. 1997. *The Rise and Fall of Languages.* Cambridge, Eng.: Cambridge University Press.

Grimes, Barbara F. 2000. *Ethnologue: Languages of the World,* 14th edition, 2 vols. Dallas: Summer Institute of Linguistics.

INTERNET RESOURCE.

Dalby, David. 1999–2000. *Linguasphere Register of the World's Languages and Speech Communities.* <http://www.linguasphere.org>.

David Dalby

LASLETT, PETER

(1915–2001)

British historian and historical demographer Peter Laslett was a fellow of Trinity College Cambridge, and in 1964 he became co-founder and co-director (with E. A. Wrigley) of the Cambridge Group for the History of Population and Social Structure. Laslett was a leading historian of political thought in his early career, but from his late 40s he began to establish his reputation as a pioneering historian of the family and as a historical demographer.

The two careers were linked, since Laslett had edited Sir Robert Filmer's *Patriarcha and Other Political Works* (1949) at an early stage, and in doing so had accepted the portrayal therein of the seventeenth-century English household as structured around a dominant patriarch and enclosing a large number of kin. Laslett's later work, starting with his most famous book, *The World We Have Lost* (1965), and using listings of inhabitants that pre-dated the first official census of England and Wales (1801) by two centuries, showed that social reality bore little relation to political theory. These sources showed that pre-industrial English households on average contained four persons, who were most likely married couples with their children. Few villagers were married under age twenty; resident unmarried servants, primarily aged 15 to 30, were surprisingly prevalent; and village populations turned over rapidly from year to year as people migrated across parish boundaries.

Laslett promoted the comparative history of household structure and formation processes. In collaboration with John Hajnal of the London School of Economics, he seeded the idea of a northwest European household formation system that was founded upon late and neo-local marriage, and the circulation of adolescents away from their natal hearth as servants and apprentices for long periods after the onset of sexual maturity. These were features that pre-dated the Industrial Revolution, yet in much of the extant secondary literature were supposed to have emerged only after the shift from an agrarian economy to one in which industry and urban living predominated. Laslett, while keen to promote comparative analysis of co-resident domestic groups, was also suspicious of contrasts drawn between measures of household composition that took little account of stochastic variation. With anthropologist E. A. Hammel and mathematical demographer K. Wachter, he promoted the use of probabilistic microsimulation for the study of household structure, illustrating that many attempts to show stem-family systems in western Europe foundered on the author's failure to think probabilistically.

Laslett also pioneered work on the history of illegitimacy and, in comparative analysis, showed that illegitimacy in England was most common from the sixteenth to the early-twentieth century when marriage was early for women, and least common when it was late—though a contrary relationship held in many continental European countries.

In retirement, Laslett began to research the history of aging and the elderly, long before these subjects were fashionable. He showed that the household formation system in pre-industrial England had not created a context within which the elderly were revered, but one in which they had usually depended upon support from a wider community that extended out beyond the kin group and not infrequently entailed poor relief. Work of this kind, like so much that he published after 1965, made it necessary for social scientists to abandon many of the older certainties regarding the notion of "modernization" and its impact upon demographic processes and family forms.

See also: *Family: History; Family Reconstitution; Henry, Louis; Historical Demography; Household Composition.*

BIBLIOGRAPHY

SELECTED WORKS BY PETER LASLETT.

Laslett, Peter. 1965. *The World We Have Lost.* London: Methuen.

———. 1977. *Family Life and Illicit Love in Earlier Generations.* Cambridge, Eng.: Cambridge University Press.

———. 1996. *A Fresh Map of Life: The Emergence of the Third Age,* 2nd edition. London: Macmillan Press.

Laslett, Peter, ed. 1972. *Household and Family in Past Time.* Cambridge, Eng.: Cambridge University Press.

Laslett, Peter, and James Fishkin, eds. 1992. *Justice Between Age Groups and Generations.* New Haven, CT: Yale University Press.

Laslett, Peter, E. A. Hammel, and K. Wachter. 1978. *Statistical Studies of Historical Social Structure.* London and New York: Academic Press.

Laslett, Peter, Karla Osterveen, and Richard Smith, eds. 1980. *Bastardy and Its Comparative History.* London: Edward Arnold.

Laslett, Peter, and Richard Wall, eds. 1983. *Family Forms in Historic Europe.* Cambridge, Eng.: Cambridge University Press.

SELECTED WORKS ABOUT PETER LASLETT.

Bonfield, Lloyd, Richard Smith, and Keith Wrightson, eds. 1986. *The World We Have Gained: Histories of Population and Social Structure.* Oxford, Eng.: Basil Blackwell.

RICHARD M. SMITH

LEBENSRAUM

The term *Lebensraum*, meaning "living space," originated with the German geographer and ethnographer Friedrich Ratzel (1844–1904). He wrote on Darwinism and did research in the Americas before lecturing at Munich University, then at the University of Leipzig, and writing on the physical and cultural relations between populations and their environments. The Swedish political scientist Rudolf Kjellén (1864–1922), who coined the term "geopolitics," adopted Ratzel's concept, arguing in his major work that states are organisms that grow and decay. These ideas were avidly adopted by Nazi Germany, giving Lebensraum the sinister overtones it often carries today.

Nevertheless, all living things do need space, at some bare minimum, for their physical structure and the necessities of life: water, food, waste disposal, and so on. This requirement is manifested in the territorial behavior of the lower animals, including the forceful rejection of intruders when instinctive mechanisms (e.g., threat displays) fail to repel them. In human populations analogous behaviors may therefore be inherent, predating agriculture and even language. Wherever possible, most human population groups, however, seek to claim appreciably more living space than this bare minimum.

The Book of Genesis (12:1–9) describes a Lebensraum deficit facing Abraham and his kin, leading to conflict among their herdsmen. The ancient Greek philosopher Plato, in *The Republic,* depicts the expanding territorial needs of neighboring populations as resulting in war. In the chapter on American Indian population controls in his *Essay on the Principle of Population,* the English economist T. R. Malthus (1766–1834) wrote: "American nations are well acquainted with the rights of each community to its own dominions . . . they guard this national property with a jealous attention . . . [and] live in a perpetual state of hostility" (Malthus, p. 33).

Most societies have clear demarcations of their territory and resources. Contentious historical, political, and ethical questions often arise about definitions of and entitlements to living space. These can concern sovereignty, legitimacy, territorial boundaries, identity, belongingness, citizenship, nationality, race, ethnicity, language, religion, culture, and the need to control migration, settlement, and resource exploitation. Rival claims on the same Lebensraum are an intractable source of conflict, as in the cases of Palestine/Israel and Kosovo.

The amounts and kinds of Lebensraum needed for an acceptable quality of life vary with economic, cultural, and individual characteristics. Hunter-gatherers need a lot of space, 1 to 3 square kilometers (0.4 to 1.2 square miles) each, as do nomadic groups, which serially exhaust grazing or other resources along their traditional routes. The American folk hero, Davy Crockett, is said to have moved on when he could see smoke from a neighbor's chimney. Most contemporary humans seem reasonably content to live in dense urban areas (though they value privacy and are inclined to maximize their personal space by renting or buying as much of it as funds allow). But people are also appreciative of urban "lungs," open spaces, parks, greenbelts, and conservation and wilderness areas. At the level of the nation-state, a national security rationale is sometimes invoked to support territorial claims, seeking advantage in nondependence on other countries for essential resources such as food and raw materials. In an open-trading world, however, territorial possession as demarcated by national boundaries is at best weakly correlated with living standards.

The demand for Lebensraum may be fostered by purposeful population competition, often involving competitive breeding. The Malthus quotation, above, continued: "The very act of increasing in one tribe must be an act of aggression on its neighbours; as a larger . . . territory will be needed." Alleging overcrowding and lack of natural resources, Nazi Germany demanded the right to take extra Lebensraum by force, while simultaneously pursuing strongly pronatalist and eugenic policies domestically. Population competition is a sensitive topic of political discourse and is rarely examined even in the academic world. A few substantial treatments, however, have appeared, including works by Milica Z. Bookman, Jack Parsons, and Michael S. Teitelbaum and Jay Winter.

The spread of environmental ethics has led to pressure to protect the Lebensraum of both domestic and wild animals—and even plants—from undue human competition. A significant majority finds "battery" farming of livestock (the mass-rearing of pigs and chickens, for example, in large numbers under cover, in artificial light, and in small pens that prevent virtually all natural movement) to be deeply repugnant. Some people in affluent countries feel guilty about consuming too big a share of the world's space and resources and wish to share these with large numbers of immigrants. Countries feeling well-endowed with Lebensraum often adopt policies to occupy it more fully, either in the name of progress or for reasons of national security.

Ratzel's interests have become subsumed under a variety of disciplines: geography, geopolitics, international relations, ecology, ethology, and demography. Concepts related to Lebensraum, but lacking its historical associations, include overpopulation, physical and cultural carrying capacity, population pressure, ecological footprint, and demographic entrapment.

See also: *Carrying Capacity; Geopolitics; Land Use; National Security and Population.*

BIBLIOGRAPHY

Allan, William. 1965. *The African Husbandman.* London: Oliver and Boyd.

Bookman, Milica Z. 1997. *The Demographic Struggle for Power: The Political Economy of Demographic Engineering in the Modern World.* London and Portland, OR: Frank Cass.

Hitler, Adolf. 1939. *Mein Kampf* (1925), trans. James Murphy. London: Hurst and Blackett.

Kjellén, Johan Rudolf. 1916. *Staten som lifsform.* 3 vols. Stockholm: Hugo Gaber.

Malthus, T. R. [1798] 1958. *Essay on the Principle of Population* London: Dent.

Parsons, Jack. 1971. *Population versus Liberty.* London: Pemberton.

———. 2002. *Population Competition for Security or Attack: A Study of the Perilous Pursuit of Power through Weight of Numbers* [CD-ROM]. Llantrisant, Wales: Population Policy Press.

Ratzel, Friedrich. 1882. *Anthropogeographie.* 2 vols. Stuttgart: J. Engelhorn.

———. 1885–1888. *Völkerkunde.* 3 vols. Leipzig: Bibliographisches Institut.

Sack, Robert David. 1986. *Human Territoriality: Its Theory and History.* Cambridge, Eng.: Cambridge University Press.

Teitelbaum, Michael S., and Jay Winter. 1998. *A Question of Numbers: High Migration, Low Fertility, and the Politics of National Identity.* New York: Hill and Wang.

Wackernagel, Mathis, and William E. Rees. 1996. *Our Ecological Footprint.* Gabriola Island, BC, Canada: New Society Publishers.

Jack Parsons

LEIBENSTEIN, HARVEY

(1922–1994)

Harvey Leibenstein was an American economist and economic demographer. Born in Yanishpol, Russia (now Ukraine), educated in Canada and the United States (Ph.D. from Princeton University, 1951), he served on the faculties of the University of California, Berkeley (1951–1967) and Harvard University (1967–1992). A disabling automobile accident in 1987 forced his retirement. Leibenstein's early work focused on demographic determinants in economic development; later his attention turned to extra-rational calculations in human decision-making.

Influenced by Frank Notestein (an empiricist) and Oskar Morgenstern (by contrast a theorist), Leibenstein's 1954 book, *A Theory of Economic-Demographic Development,* an outgrowth of his dissertation, explains in the then-emerging algebraic abstraction how economic development worked to destabilize Malthusian population equilibria. Besides a conventional presentation (economic statics), he developed the topic according to several types of dynamics—as found in Samuelson's *Foundations of Economic Analysis* (1947). These involved interactions at critical time-points among such variables as the composition of the initial population, varying injections of new capital, and fortuitous changes in personal income (consumption)—involving different socioeconomic sectors.

Leibenstein's second book, *Economic Backwardness and Economic Growth* (1963), introduces his "critical minimum effort thesis" and further details the breakdown of Malthusian equilibria in developing nations. Again the language is often algebraic, but there are important data insertions: Leibenstein pioneered using nutritional inputs as a cause and a consequence of economic growth—indeed, Leibenstein increasingly employed the term growth to refer to higher average incomes rather than capital inputs.

As his career developed, Leibenstein's skepticism about using rational maximization as the explanation of economic behavior grew (he had Herbert Simon, the theorist of bounded rationality, as a quondam colleague). This skepticism, appearing in a 1974 article, "An Interpretation of the economic theory of fertility: Promising path or blind alley?," took issue with Gary Becker's view that couples would (or even could) actually calculate their preference functions before deciding to conceive an additional child.

Instead, Leibenstein turned to insights found in behavioral psychology and worked throughout his remaining career to develop a 'micro-micro' system in which individual workers operated within the framework of three, successively smaller, output levels: what they could produce, what was required to hold their jobs, and what they would have preferred. He used the term "X-efficiency" to describe the increment of the highest over the lowest. Of course, the critical area involves not only the attitudes of single workers but also how groups of workers, each capable of making his or her own choices and reacting to the difference between the three identified levels of output, will influence the stint. Leibenstein handled this set of interactions as illustrative of the well-known Prisoners' Dilemma problem.

Although X-efficiency underlay the reasoning in *Beyond Economic Man* (1976), the idea, after being ridiculed by the economist George J. Stigler in a 1976 article (to which Leibenstein replied in kind: "X-Inefficiency Xists: Reply to an Xorcist"), was further elaborated and fortified in *General X-Efficiency Theory and Economic Development* (1978), and in *Inflation, Income Distribution, and X-Efficiency* (1980). It culminated with *Inside the Firm* (1987).

See also: *Economic-Demographic Models; Microeconomics of Demographic Behavior.*

BIBLIOGRAPHY

SELECTED WORKS BY HARVEY LEIBENSTEIN.

Leibenstein, Harvey. 1954. *A Theory of Economic-Demographic Development.* Princeton, NJ: Princeton University Press.

———. 1963. *Economic Backwardness and Economic Growth: Studies in the Theory of Economic Development.* New York: John Wiley.

———. 1974. "An Interpretation of the Economic Theory of Fertility: Promising Path or Blind Alley?" *Journal of Economic Literature* 12: 457–479.

———. 1976. *Beyond Economic Man.* Cambridge, MA: Harvard University Press.

———. 1978. *General X-Efficiency Theory and Economic Development.* New York: Oxford University Press.

———. 1978. "X-Inefficiency Xists: Reply to an Xorcist." *American Economic Review* 68: 203–211.

———. 1979. "A Branch of Economics is Missing: Micro-Micro Theory." *Journal of Economic Literature* 17: 477–502.

———. 1981. "Economic Decision Theory and Human Fertility Behavior: A Speculative Essay." *Population and Development Review* 7: 381–400.

———. 1987. *Inside the Firm.* Cambridge, MA: Harvard University Press.

SELECTED WORKS ABOUT HARVEY LEIBENSTEIN.

Stigler, George J. 1976. "The Xistence of X-Efficiency." *American Economic Review* 66: 213–16.

Mark Perlman

LEXIS DIAGRAM

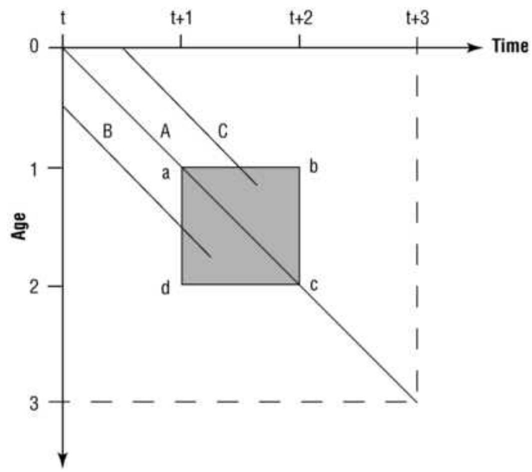
Lexis diagrams play a valuable role in demographic analysis by providing a highly effective visual language for conveying information about the sets of persons and events that are the basis of all population statistics. The diagrams complement verbal descriptions of these sets, which are often clumsy and hard to grasp. The diagrams are named after the German statistician and actuary Wilhelm Lexis (1837–1914).

There are four principles of Lexis diagram representation. *First,* a demographic event may be represented by a point on a coordinate plane whose coordinates are the time at which the event occurred and the age of the person to whom the event occurred. *Second,* each two dimensional set in the coordinate plane represents the set of events whose representing points fall within its boundaries. *Third,* a person may be represented by the straight line, called a "life line," connecting the points representing this person's birth and death. *Fourth,* each line in the coordinate plane represents the set of persons whose life lines intersect this line.

Figure 1 illustrates each of these principles. Line A is the life line of a person who was born at time t and died, at exact age 3, at time $t+3$. Lines B and C both represent persons who died during year $t+1$ at 1 completed year of age (i.e., at an exact age ≥1 and <2). Square *abcd* represents the set of all such deaths, which divide into two parts: deaths of persons who were age 1 in completed years at the beginning of year $t+1$, represented by triangle *acd,* and

FIGURE 1

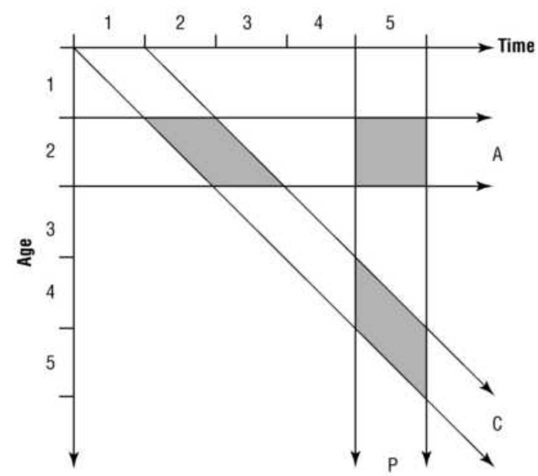
Lexis Diagram 1



SOURCE: Author.

FIGURE 2

Lexis Diagram 2



SOURCE: Author.

deaths of persons who reached exact age 1 during that year, represented by triangle *abc.* The set of persons who reached exact age 1 (celebrated their first birthday) during year $t+1$ is represented by line *ab.* The set of persons who were age 1 in completed years at the beginning of year $t+1$ is represented by line *ad.*

The drawing and interpretation of Lexis diagrams is facilitated by two general methods. The "method of extremes" consists of identifying extreme cases, drawing lines or plotting points representing these cases, and connecting these points or lines to obtain the desired representation. Referring to Figure 1, for example, consider the set of persons who reach exact age 1 during year $t+1$. The extreme cases here are reaching exact age 1 at time $t+1$ and reaching exact age 1 at time $t+2$, corresponding to points *a* and *b,* respectively. The line *ab* connecting these points is the desired representation.

The "method of intersections," which applies only to sets of events, consists of identifying an age group, time period, and/or birth cohort, drawing the representations of the groups so identified, and taking the intersection of these representations. Three examples of practical importance are illustrated in Figure 2, in which age groups and time periods of equal length have been marked off.

Deaths occurring during the 5th time period to persons in the 2nd age group are represented by the square, which is the intersection of the horizontal strip *A* corresponding to the age group and the vertical strip *P* corresponding to the time period. Numbers of deaths in such sets are the numerators of age-specific death rates.

Deaths of persons in the cohort born in the 1st period that occur when these persons are in the 2nd age group are represented by the parallelogram with sides parallel to the time axis, which is the intersection of the horizontal strip *A* representing the age group and the diagonal strip *C* representing the cohort. Numbers of deaths in such sets are the numerators of life table probabilities of death.

Deaths of persons in the cohort born during the 1st period that occur during the 5th period are represented by the parallelogram with sides parallel to the age axis, which is the intersection of the diagonal cohort strip *C* and the vertical time period strip *P*. Numbers of deaths in such sets figure in population projection calculations.

The age axis in the Lexis diagram may be replaced by an axis representing time elapsed since any event, such as marriage, divorce, or first birth, providing for description of a wider variety of sets of persons and events. The time axis most often represents calendar time, but diagrams for sample survey data may express time as months or years prior to interview. As the metric of age is elapsed time, units of time and age are represented by the same distance on the two axes. It follows that life lines form a 45-degree angle to the axes.

Lexis diagram representations apply to events of all kinds, including births regarded as events occurring to the mother, marriages, and divorces. The diagrams themselves do not indicate what kind of event is represented, however. This information must be supplied by context. The point representing any event occurring to a person necessarily lies on the life line representing this person. This obvious but important fact serves to identify persons experiencing particular events as members of various groups, for example, as members of a particular birth cohort.

Life lines may be generalized to represent a person's membership in a particular population by removing from the line those points corresponding to periods when the person was not a member of the population. These generalized life lines may be used, for example, to represent persons in populations that experience migration.

Different orientations of the Lexis diagram axes may be used for different purposes. The orientation shown above is most generally useful because it corresponds to the way tables of births and deaths are arranged, with rows for events occurring at older ages placed below rows for events occurring at younger ages.

See also: *Demography, History of.*

BIBLIOGRAPHY

Lexis, Wilhelm. 1880. "La représentation graphique de la mortalité au moyen des points mortuaires," *Annales de démographie internationale* Tome IV: 297–324.

INTERNET RESOURCE.

Vandeschrick, Christophe. 2001. "The Lexis diagram, a misnomer," *Demographic Research* Volume 4, Article 3 <http://www.demographic-research.org>

GRIFFITH FEENEY

LIFE COURSE ANALYSIS

The life course approach is an interdisciplinary program of study, under development since the mid-1970s, which has been increasingly influential in demographic research. It is concerned with explaining how and when events such as leaving the parental home, starting or dissolving a union, having a child, migration, job entry and exit, and retirement are experienced. Life course analysis entails the collection of life course data together with the (statistical) analysis of the *timing* of events (when do they happen?), their *sequencing* (in which order do they happen?), and their *quantum* (how many events happen?). The focus of this article is on quantitative methods, although qualitative life course analysis has also been influential and is sometimes integrated with quantitative research.

In their 1998 review of methods of life course research, Janet Giele and Glen Elder identify the chief elements that shape individual lives and that are crucial for the analysis of life courses. These are: individual development; history and culture (location in time and place); and social relations (linked lives). Parallel and potentially interdependent trajectories of individual lives are the main units of analysis, with the trajectories marked by events. These elements have natural counterparts at the macro level: individual development lies behind the use of age as the primary time axis; location in time and the idea of linked lives suggest using a cohort approach to the study of social change; history and culture emphasize the importance of period and location.

Collection of Life Course Data

Quantitative life course data may be collected in surveys, using either question lists or so-called event history calendars. Retrospective collection of the timing of events has become a standard feature of most demographic surveys. Life course data can also be obtained from panel surveys or other follow-up surveys and from civil registration data.

In surveys, the timing of events is usually asked within a roster of questions for each trajectory separately and following a particular order. For instance, the timing of events concerned with the relationships within the family of origin would be asked before the timing of events on union formation and dissolution. The quantum of events is collected in the same context, while the sequencing of events is derived indirectly from the information on timing. This way of collecting life course data has been widely advocated and used in life course research. In the 1990s it was implemented in surveys such as the Demographic and Health Surveys.

Studies employing event history calendars start by collecting data on the timing of so-called landmark events through a question list. Information on the timing of other events, and on the state the individual occupied in each time unit over the reference period, is then collected by use of a graphical display of the trajectory of primary interest (either on paper or on a computer screen). The complexity of the calendar depends on the length of the reference period and on the time unit used—typically one month. Event history calendars are extensively applied in panel surveys such as the U.S. Panel Study of Income Dynamics.

Robert F. Belli, William L. Shay, and Frank P. Stafford compared the two types of data collection in 2001; their results indicate that event history calendars generally yield more accurate reports, although sometimes with increased overreporting of events.

Statistical Analysis of Life Courses

Two approaches have been followed in the statistical analysis of life course data. Event history analysis focuses on time-to-event as the key dependent variable. Sequence analysis focuses on life courses or segments of the life course as a conceptual unit.

Event history analysis. This statistical method has found major application in demography since the 1980s. Applied to individual life course data, the approach uses life table nonparametric techniques to compare the timing of life course events across space (including international comparisons) and time (mostly using the cohort as the preferred time dimension). This is the individual-level equivalent of period and cohort analysis in traditional demography.

The regression models of event history analysis contribute to the explanation of life course dynamics by linking the time-to-event variable with explanatory variables (covariates). Covariates can be external to a trajectory (as is the case for macro-level variables, comprising period effects), or internal to a trajectory (as is the case for other trajectories of the life course that are potentially influencing the time-to-event). External covariates can be of three kinds: those that are fixed during a life course or from a particular point of time (birth cohort, age-at-marriage when studying time-to-divorce); covariates whose temporal dynamics cannot be influenced by the events in the trajectory of interest (age of an individual in the case of time-to-divorce); and those located at an aggregate level of social dynamics (time period, regional economic indicators, policy indicators). Multilevel event history models, developed in the 1990s, allow accurate treatment of the case of individuals aggregated into household or regional clusters, therefore taking into account the "time and place" dimensions of life courses.

Internal covariates usually refer to other trajectories of the life course of the same individual or of linked individuals, and their use allows researchers to study complex interdependencies between trajectories. Event history analysis may take into account unobserved factors underlying these interdependencies, such as value orientations or attitudes. The relevance of time-constant unobserved factors for the analysis of parallel and potentially interdependent trajectories has been debated in the literature. The so-called causal approach of Hans-Peter Blossfeld and Götz Rohwer assumes that all factors that are relevant to the simultaneous analysis of several trajectories are observed and included in the past history of the trajectories. Other modeling approaches allow for the effects of time-constant unobserved factors. The most general applied approach is the multilevel and multiprocess modeling of life courses developed by Lee A. Lillard and Constantijn W.A. Panis.

Sequence analysis. Older life course concepts like that of the family life cycle were holistic and made more or less explicit reference to biological structures. The recent life course literature has been more analytic. Nevertheless, by focusing on specific events researchers may achieve a unitary, holistic perspective on trajectories of the life course. The most-used analytical technique for the holistic analysis of life courses is known as sequence analysis, introduced into the social sciences during the 1990s by Andrew Abbott.

In sequence analysis, each life course or trajectory in the life course is represented as a string of characters (states). This representation is analogous to the one used to code DNA molecules in the biological sciences. Indeed, one method used to analyze sequence-type data, optimal matching analysis

(OMA), was originally created for the alignment of DNA sequences. The goal of OMA is to compute a matrix of dissimilarities between pairs of sequences, starting from a definition of distance between states, and of "costs" of inserting and deleting states in a sequence. The dissimilarity matrix can be used as the input for statistical techniques based on dissimilarity, such as cluster analysis or multidimensional scaling. The method has been applied to the sociology of occupations. A demographic application—to the analysis of the transition to adulthood—is discussed in Francesco C. Billari's 2001 article.

Alternative approaches to the analysis of life courses as a conceptual unit have also been explored, although they have not surfaced extensively in the literature as of the early twenty-first century. These include the use of correspondence analysis and datamining techniques.

See also: *Cohort Analysis; Event History Analysis; Family Demography; Family Life Cycle.*

BIBLIOGRAPHY

Abbott, Andrew, and Angela Tsay. 2000. "Sequence Analysis and Optimal Matching Methods in Sociology." *Sociological Methods and Research* 29: 3–33.

Belli, Robert F., William L. Shay, and Frank P. Stafford. 2001. "Event History Calendars and Question List Surveys: A Direct Comparison of Interviewing Methods." *Public Opinion Quarterly* 65: 45–74.

Billari, Francesco C. 2001. "The Analysis of Early Life Courses: Complex Descriptions of the Transition to Adulthood." *Journal of Population Research* 18: 119–142.

Blossfeld, Hans-Peter, and Götz Rohwer. 2002. *Techniques of Event History Modeling.* Mahwah, NJ: Erlbaum.

Dykstra, Pearl A., and Leo J. G. van Wissen. 1999. "Introduction: The Life Course Approach as an Interdisciplinary Framework for Population Studies." In *Population Issues: An Interdisciplinary Focus,* ed. Leo J. G. van Wissen and Pearl A. Dykstra. New York: Kluwer Academic/Plenum Publishers.

Freedman, Deborah, Arland Thornton, Donald Camburn, Duane Alwin, and Linda Young-DeMarco. 1988. "The Life History Calendar: A Technique for Collecting Retrospective Data." *Sociological Methodology* 18: 37–68.

Giele, Janet Z., and Glen H. Elder Jr., eds. 1998. *Methods of Life Course Research: Qualitative and Quantitative Approaches.* Thousand Oaks, CA: Sage.

Lillard, Lee A., and Constantijn W. A. Panis. 2000. *AML Multilevel Multiprocess Statistical Software, Release 1.0.* Los Angeles: EconWare.

Mayer, Karl Ulrich, and Nancy B. Tuma, eds. 1990. *Event History Analysis in Life Course Research.* Madison: University of Wisconsin Press.

Wu, Lawrence L. 2000. "Some Comments on Sequence Analysis and Optimal Matching Methods in Sociology: Review and Prospect." *Sociological Methods and Research* 29: 41–64.

Francesco C. Billari

LIFE SPAN

Life span, a characteristic of life history that is the product of evolution, refers to the duration of an organism's entire life course. Application of the concept is straightforward at both the individual and cohort levels. At the individual level, it is the period between birth and death; at the cohort level (including both real and synthetic cohorts), it is the average length of life or life expectancy at birth. Life span applied to a population or a species, however, requires a modifier to avoid ambiguity. Maximum observed life span is the highest verified age at death, possibly limited to a particular population or time period. The overall highest verified age for a species is also called its record life span. The theoretical highest attainable age is known as maximum potential life span, maximum theoretical life span, or species-specific life span. Depending on context, maximum life span can refer to either the observed or the potential maximum.

Maximum observed life spans (i.e., longevity records) are not synonymous with theoretical maximums for at least two reasons. First, maximum longevity is not an appropriate general concept because an animal dies before the age of infinity not because it cannot pass some boundary age but because the probability of its riding out the ever-present risk of death for that long is infinitesimally small. In other words, there is no identifiable age for each species to which some select individuals can survive but none can live beyond. Second, the number of individuals observed heavily influences the record age of a species. That is, the longevity records for species in which the life spans of large numbers of individuals have been observed will be significantly greater than the corresponding figure for a species that has the same longevity but is represented by a few dozen individuals. For the vast majority of longevity records by species, the population at risk, and therefore the denominator, is unknown.

Conceptual Aspects of Life Span

The life span concept is relevant only to species in which an individual exits—to entities circumscribed by distinct birth and death processes. Thus the concept does not apply to bacteria, which reproduce by binary fission, to plant species that reproduce by cloning, or to modular organisms with iterated growth such as coral or honeybee colonies. When a single reproductive event occurs at the end of the life course that results in the death of the individual, then life span is linked deterministically to the species' natural history. This occurs with the seed set of annual plants (e.g., grasses), in drone (male) honeybees as a consequence of the physical damage caused by mating, in many mayfly species when a female's abdomen ruptures to release her eggs after she drops into a lake or stream, and in anadromous (river-spawning) salmon that die shortly after spawning. Life span can be considered indeterminate for species (including humans) that are capable of repeated (iteroparous) reproduction. That life span is indeterminate in many species is consistent with what is known about the lack of cutoff points in biology—all evidence suggests that species do not have an internal clock for terminating life.

Changes that occur in organisms that enter resting states such as dormancy, hibernation, and estivation (a state of resting that occurs in summer) reduce mortality rates and thus increase longevity. This also occurs when individuals are subjected to caloric restriction or when their reproductive efforts are reduced. A species' life course may consist of many phases such as infant, juvenile, and pre- and postreproductive periods; therefore, a change in overall life span will correspond to a commensurate change in the duration of one or more of these stages. When environmental conditions are greatly improved, such as for animals kept in zoos or laboratories or under the conditions experienced by contemporary humans, mortality rates usually decrease and thus longevity increases. Whereas earlier stages, such as the prereproductive period, are evolved life history traits, the added segment(s) arising at the end of the life course are byproducts of selection for robustness or durability at earlier stages and are thus not evolved traits. Rather, these additional life segments are due to "ecological release" and are referred to as "post-Darwinian" age classes.

Life span can be thought of as the sum total of the duration of each phase of the life course, either potential or realized. Thus implicit in life span extension (shortening) is an increase (decrease) in one or more of the phases of the life course. Because it is not possible to change one segment of the life course without affecting all other segments, life span extension (and shortening) will affect either directly or indirectly the timing and rhythm of all life events, from maturation and parental care to reproduction and grandparenting.

Life Span as an Adaptation

In evolutionary biology an adaptation is a characteristic of organisms whose properties are the result of selection in a particular functional context. Different bird beaks are adaptations for exploiting different niches that have had to be balanced with other traits such as body size and flight propensity. In the same way, the longevity of an animal is an adaptation that has had to be balanced with other traits, particularly with reproduction. The variations in the relationship between reproduction and longevity can only make sense when placed within the context of such factors as duration of the infantile period, number of young, and the species' ecological niche—the organism's overall life history strategy. Indeed, the longevity potential of a species is not an arbitrary or random outcome of evolutionary forces but rather an adaptive one that must fit into the broader life history of the species. In as much as life spans differ by 5,000-fold in insects (2 days for mayflies to 30 years for termite queens), by 50-fold in mammals (2 years for mice to 122 years for humans), and by 15-fold in birds (4 years for songbirds to 60 years for the albatross), it is clear that life span is a life history adaptation that is part of the grand life history design for each species.

A Life Span Classification Scheme

The literature on aging and longevity contains descriptions of only a small number of life span correlates, including the well-known relationship between longevity and both body mass and relative brain size and the observation that animals that possess armor (e.g., beetles, turtles) or capability of flight (e.g., birds, bats) are often long-lived. But major inconsistencies exist within even this small set of correlates. For example, there are several exceptions to the relationship of extended longevity and large body size (e.g., bats are generally small but most bat species are long-lived), and this positive relationship may be either absent or reversed within certain orders—including a negative correlation within the Pinnipeds (seals and walruses) and no correlation within the Chiroptera (bats). Likewise, the observation that flight ability and extended longevity are correlated does not provide any insight into why within-group differences in life span (e.g., among birds) exist, nor does it account for the variation in longevity in insects where adults of the majority of species can fly.

A classification system for the life span determinants of species with extended longevity that applies to a wide range of invertebrate and vertebrate species consists of the following two categories: (1) environmentally selected life spans and (2) socially selected life spans (see Table 1). The first category includes animals whose life histories evolved under conditions in which food is scarce and where resource availability is uncertain or environmental conditions are predictably adverse part of the time. Some of the longest-lived small and medium-sized mammals (e.g., rodents, foxes, small equines, ungulates) live in deserts where rainfall and, thus reproduction, is episodic and unpredictable. Examples include gerbils, rock hyrax, and feral asses. The extended longevity of animals in this category evolved through natural selection. The second category, socially selected life spans, includes species that exhibit extensive parental investment, extensive parental care, and eusociality (the social strategy characteristic of ants, bees, wasps, and termites, featuring overlapping generations, cooperative care of young, and a reproductive division of labor). It includes all of the social primates including humans. The extended longevity of animals in this category results from natural, sexual, and kin selection.

This classification system places the relationship between life span and two conventional correlates, relative brain size and flight capability, in the context of life history. That is, brain size is related to the size of the social group and the degree of sociality, which is, in turn, linked to extended life span. And intensive parental care is linked to flight capability in birds and bats, which, in turn, is also linked to extended life span. For example, most bird species are monogamous, with both sexes helping in the rearing (e.g., one protecting the nest while the other collects food). The reproductive strategy of the majority of bat species is to produce only a single altricial (naked and helpless), relatively large offspring at a time—flight preempts the possibility of the female foraging for food while gestating multiple young. Thus bat parental investment in a single offspring is substantial.

Life Span Patterns: Humans as Primates

Estimates based on regressions of longevity against brain and body mass for anthropoid primate subfamilies or limited to extant (currently living) apes indicate a major increase in longevity between *Homo habilis* (52 to 56 years) and *H. erectus* (60 to 63 years), occurring roughly 1.7 to 2 million years ago (see Table 2). The predicted life span for small-bodied *H. sapiens* is 66 to 72 years. From a catarrhine (Old World monkeys and apes) comparison group, when contemporary human data are excluded from the predictive equation, a life span of 91 years for humans is predicted. For early hominids, to live as long as predicted was probably extremely rare; the important point is that the basic Old World primate design resulted in an organism with the potential to survive long beyond a contemporary mother's ability to give birth. This suggests that postmenopausal survival is not an artifact of modern lifestyle but may have originated between 1 and 2 million years ago, coincident with the radiation of hominids out of Africa.

The general regression equation expresses the relationship of longevity to body and brain mass when 20 Old World anthropoid primate genera are the comparison group. Ninety-one years is the predicted longevity for a 50-kilogram (110-pound) primate with a brain mass of 1,250 grams (44 ounces; conservative values for humans) when a case-deletion regression method is employed (that is, the prediction is generated from the equation excluding the species in question) and 72 when humans are included within the predictive equation. When six genera of apes are used as the comparison group, the regression equation is:

$$\log_{10} LS = 1.104 + 0.072\ (\log_{10} Mass) + 0.193\ (\log_{10} Brain)$$

yielding a predicted human longevity of 82.3 years. Thus, a typical Old World primate with the body size and brain size of *Homo sapiens* can be expected to live between 72 and 91 years with good nutrition and protection from predation.

The contemporary maximum human life span of over 120 years based on the highest recorded age at death consists of two segments: (1) the Darwinian or "evolved" segment of 72 to 90 years; and (2) the post-Darwinian segment, which is the artifactual component that emerged because of the improved living conditions of modern society. Therefore the arguments that the maximum human life span has not changed in 100,000 years can be considered substantially correct when the "evolved" maximum life span is considered. It is clear, however, that this is not correct when the nonevolved segment of the human life span is considered: There is evidence from Swedish death records that the record age in humans (the maximum observed life span) has been increasing for well over a century.

Life Span Extension in Humans Is Self-Reinforcing

Improved health and increased longevity in societies may set in motion a self-perpetuating system of longevity extension. Increased survival from birth to sexual maturity reduces the number of children desired by parents. Because of the reduced drain of childbearing and rearing, parents with fewer children remain healthier longer and raise healthier children with higher survival rates, which, in turn, fosters yet further reductions in fertility. Greater longevity of parents also increases the likelihood that they can contribute as grandparents to the fitness of both their children and grandchildren. This self-reinforcing cycle, a positive feedback relationship, may be one reason why the average human life span has been continuing to increase.

The decline in mortality rates during the early stages of industrialization in countries such as the United States was probably one of the forces behind the expansion of educational effort and the growing mobility of people across space and between occupations. Whereas previous conditions of high mortality and crippling morbidity (disease) effectively reduced the prospective rewards to investment in education during the preindustrial period, expectancy for a prolonged working life span must have made people more ready to accept the risks and costs of seeking their fortunes in distant places and in new occupations. The positive feedback of gains in longevity on future gains involves a complex interaction among the various stages of the life cycle, with long-term societal implications in terms of the investment in human capital, intergenerational relations, and the synergism between technological and physiological improvements. In other words, long-term investment in science and education provides the tools for extending longevity, which, in turn, makes more attractive further long-term investments in individual education. Thus humans gain progressively greater control over their environment, their health, and their overall quality of life.

The positive correlation between health and income per capita is well known in international development studies, usually interpreted with income as the determining factor. But the correlation is partly explained by a causal link running the other way—from health to income. In other words, productivity, education, investment in physical capital, and the "demographic dividend" (advantageous changes in birth and death rates) are all self-reinforcing—these factors contribute to health, and better health (and greater longevity) contributes to their improvement.

TABLE 1

The Two General Categories of Factors That Favor the Evolution of Extended Life Span and Examples of Species within Each

Category	Examples
Environmentally selected	Tortoises, sea turtles, deep-water tube worms, tuatara; birds, beetles, *Heliconius;* butterflies, tree-hole mosquitoes
Socially selected	Elephants, killer whales, dolphins, most primates (including humans), naked mole rats, micro-bats (brown bat, vampire), parrots, hornbills, albatross, termite, ant and bee queens, tsetse flies

SOURCE: Modified from Carey and Judge (2001).

TABLE 2

Estimates of Longevity for Fossil Hominids

Hominid Species	Life Span (years)	Incremental Change
Australopithicus afarensus	46.6	
Homo habilis	55.0	8.4
H. erectus	62.0	7.0
H. sapiens (pre-historical)	72.9	10.9
H. sapiens (contemporary)	122.0	49.1

Note: Estimates based on hominoid body size range from 42–44 years for *Australopithecus* to 50 years for *Homo erectus*. Incorporation of brain mass increased estimates for *Homo habilis* from 43 years to 52–56 years and for *Homo erectus* from 50 years to 60–63 years.

SOURCE: Carey and Judge (2001).

See also: *Aging and Longevity, Biology of; Evolutionary Demography.*

BIBLIOGRAPHY

Carey, James R., and D. S. Judge. 2001. "Life Span Extension in Humans Is Self-Reinforcing: A General Theory of Longevity." *Population and Development Review* 27: 411–436.

Goldwasser, L. 2001. "The Biodemography of Life Span: Resources, Allocation, and Metabolism." *Trends in Ecology and Evolution* 16: 536–538.

Judge, D. S., and J. R. Carey. 2000. "Post-reproductive Life Predicted by Primate Patterns." *Journal of Gerontology: Biological Sciences* 55A: B201–B209.

Wilmoth, J. R., L. J. Deegan, H. Lundstrom, and S. Horiuchi. 2000. "Increase of Maximum Life-Span in Sweden, 1861–1999." *Science* 289: 2366–2368.

JAMES R. CAREY

LIFE TABLES

The life table is a device that describes a cohort's or a population's mortality experience. The life table, sometimes called table of mortality (*table de mortalité* in French, and similarly labeled in most languages other than English) is one of the oldest and probably the single most valuable tool in demography. It has many applications that range well beyond mortality analysis. It is called a table, because in its classical presentation it is made of a number of numerical columns representing various indicators of mortality, but the information it contains can be also conveyed in graphical form.

The concept of a life table comes from a cohort perspective. If one could follow a birth cohort of 100,000 individuals through time in a closed population (a population without in- and outmigration), the number of survivors at various ages would correspond to the "number left alive at age x," in the life table its l_x column. The difference between survivors at two consecutive ages, x and $x+n$, would correspond to the number of deaths between x and $x+n$, in the life table denoted by ${}_nd_x$. The ratio of ${}_nd_x$ to l_x produces another column of the life table, the probability of dying between age x and $x+n$, denoted by ${}_nq_x$. Thus, data on cohort survival can be readily converted into a life table.

In its classical form, the life table includes the following columns:

x = exact age

l_x = number still alive at age x

${}_nd_x$ = number dying between ages x and $x+n$ = $l_x - l_{x+n}$

${}_nq_x$ = probability of dying between ages x and $x+n$, conditional on survival to age x = ${}_nd_x / l_x$

${}_np_x$ = probability of surviving from age x to age $x+n$, conditional on survival to age x $= l_{x+n} / l_x$

${}_na_x$ = average number of person-years lived in the interval between age x and $x+n$ by those dying in the interval

${}_nL_x$ = number of person-years lived between ages x and $x+n$ $=nl_x + {}_na_x \cdot {}_nd_x$

${}_nm_x$ = death rate between ages x and $x+n$ $= {}_nd_x / {}_nL_x$

T_x = person-years lived above age x (sum of ${}_nL_x$ for ages x and higher)

$\mathring{e}_x$ = expectation of life at age $x = T_x / l_x$

Traditionally, a life table where $n = 1$ is called an "unabridged" or a "single-year" life table, and the left subscript can be omitted. A common alternative is to use 5-year age groups starting with age 5, and to present information for the age group 0–4 (that is, below exact age 5) in two groups: age 0 (i.e., less than age 1) and ages 1–4. In this case, the life table is called "abridged." It formerly was common practice to end a life table with an open-ended age interval starting at age 85. With the large proportions of survivors to age 85 in many low-mortality populations, though, the preferred practice is to present more detailed information above age 85, carrying it up to age 100 and concluding with an open-ended interval above that age. Because of the distinctive mortality differences between the sexes, life tables are commonly also presented separately for males and for females.

Although the life table is in principle a cohort concept, it is not commonly used in this fashion. The reason for this is both practical and substantive. Exhaustive cohort mortality data are rarely available, because that would require systematic death registration for a period spanning 100 years or more. In other words, it would be necessary to wait for a cohort to be extinct or near extinct to be able to construct a full cohort life table and obtain an accurate estimate of its life expectancy at birth. Accuracy would be compromised if the population was not closed—that is, if it were depleted not only by death but also outmigration—and if death registration included deaths of immigrants. A further and more substantive drawback of cohort life tables is that they refer to a period stretching over a century, during which mortality conditions are likely to have changed. For descriptive and policy purposes, typically less heterogenous and more timely information is necessary.

The limitations of cohort life tables have led demographers to design period life tables, based on the concept of "synthetic" cohorts. A synthetic cohort is a hypothetical cohort of persons subject through their life to the age-specific mortality rates of one specific period. This contrasts with a real cohort where each age-specific rate pertains to a different year. The theoretical construct of synthetic cohorts allows one to construct period life tables and compute life-cycle indexes (such as the life expectancy at birth) on the basis of observations relating to, and hence reflecting the mortality conditions for, a well-defined and relatively short time period. In practice, the period chosen is most often a single calendar year, or a two-year period bracketing a census count, or a quinquennium.

Life Table Construction

The construction of a period life table is not as straightforward as for a cohort, because many of the life table functions, including survivors at various ages, are not directly observable. One related life table function that can be estimated from actual data is ${}_nM_x$, the set of age-specific death rates in the population. This is commonly calculated as ${}_nD_x$ / ${}_nN_x$, where ${}_nD_x$ is the number of deaths between age x and x+n observed in a population during a specific period, and ${}_nN_x$ is the population aged x to x+n at the middle of that period. The basic step in constructing a period life table is to estimate death probabilities, ${}_nq_x$, for the synthetic cohort, from ${}_nM_x$, the age-specific death rates observed in a population for a particular period.

Strictly speaking, ${}_nM_x$ is not exactly equivalent to ${}_nm_x$, the mortality rate observed in the corresponding synthetic cohort. This is because in a cohort (real or synthetic), ${}_nm_x$ results from ${}_nd_x$ and ${}_nL_x$, both of which are entirely produced by mortality conditions. That is, in a cohort, the number of survivors at various ages (and thus the corresponding person-years lived) is fully a product of underlying mortality conditions. Similarly, the number of deaths in the age-interval is also the product of mortality conditions applied to the number of survivors. Thus ${}_nm_x$ is an unbiased mortality measure. By contrast, ${}_nM_x$ is the product of specific mortality conditions applied to the population in the corresponding age-group, ${}_nN_x$. Unlike ${}_nL_x$, ${}_nN_x$ is not entirely produced by the mortality conditions to which the synthetic cohort is subject. It is also affected by the age distribution of the actual population within that age group, which is itself the product of past fluctuations in the number of births, past variations in mortality, and past migration. Thus ${}_nM_x$ and ${}_nm_x$ can differ. For most purposes, however, the difference is not large enough to produce significant differences in life table indexes such as life expectancy at birth. In life table construction, it is common to assume that ${}_nM_x$ = ${}_nm_x$; there are, however, more involved methods of construction that do not require this simplifying assumption.

The second operation in constructing a period life table involves converting the set of ${}_nm_x$ to ${}_nq_x$. This is done by using the following exact equation, derived from the equation for ${}_nL_x$ specified earlier:

$$_nq_x = \frac{n\ _nm_x}{1 + (n - {_na_x})\ _nm_x}.$$

This equation relates an age-specific mortality rate in a cohort (real or synthetic) to the corresponding probability of dying in the age interval x to $x+n$. After this operation, one can readily calculate the number of survivors at various ages in the synthetic cohort and the remaining columns of the life table.

This equation shows, however, that $_nm_x$ is not the only input for the $_nm_x$ to $_nq_x$ conversion. The conversion also involves $_na_x$, the average number of person-years lived between x and $x+n$ by persons dying during the age interval. These values are usually not readily available in a population. When dealing with an unabridged life table, it is not consequential to make the assumption that life table deaths occur on average at the middle of the single-year interval ($_1a_x = 0.5$).

When dealing with five-year age groups, there are a number of methods for estimating $_na_x$ in a population. One method involves graduation techniques that yield reliable results but that are not easy to implement. Another strategy consists of borrowing $_na_x$ from another population with comparable mortality levels and patterns and for which $_na_x$ values have been accurately estimated. The assumption that $_na_x = n/2$ is also used sometimes in abridged life tables. For the first two age groups (for ages 0 and 1–4), however, this assumption is seriously inadequate because mortality risks decrease rapidly within this age range, and thus deaths are more concentrated toward the beginning of the age interval rather than equally distributed. At these ages, it is possible to use estimation equations based on empirical populations at various mortality levels. These equations permit the estimation of $_1a_0$ and $_4a_1$ from the recorded level of $_1m_0$. Similar adjustments may be necessary in very old age groups, in which the reverse phenomenon occurs: deaths are more concentrated toward the upper end of the age interval.

With $_nN_x$, $_nD_x$, and $_na_x$ in hand, all life table columns can be derived. It is also necessary to choose an arbitrary value for l_0, called the *radix* of the life table, to which the columns l_x, $_nd_x$, $_nL_x$, and T_x are proportional. It is common to choose 100,000 as the value for l_0. At the other end of the life table, for an open-ended age interval starting at age x^*, it is usually assumed that $_\infty L_{x^*} = l_{x^*} / {_\infty M_{x^*}}$.

An abridged period life table for the female population of Austria in 1992 is presented in Table 1. In its first two columns, this table also shows the empirical data—population numbers by age, derived from census statistics and numbers of deaths by age, derived from vital statistics—from which the life table was calculated.

The functions of the life table describe the level and age-pattern of mortality of a population. The $_nq_x$ and $_nm_x$ columns are two related ways of showing how the risk of mortality varies by age, conditional on survival to age x. The $_nd_x$ column, if divided by l_0, can be viewed as the probability for a newborn to die in a particular age group. The l_x column, divided again by l_0, corresponds to the probability of surviving from birth to age x. More generally, l_y / l_x (with $y > x$) corresponds to the probability of surviving from age x to age y, conditional on survival to age x, and $1 - l_y / l_x$ is the probability that a person who survived to age x will die between age x and y. Furthermore, $(l_x - l_y) / l_0$ is the probability that a newborn will die between ages x and y, and $(T_x - T_y) / l_0$ is the number of years that a newborn can expect to live between ages x and y. Figure 1 shows l_x, $_1q_x$, and $_1d_x$ functions for the female population of Sweden. These data, presented for four different years during the twentieth century, illustrate how the age-pattern of life table functions varies as a country experiences mortality decline.

Perhaps the most widely-reported life table measure is $\mathring{e}_0$, the life expectancy at birth. In a period life table, it corresponds to the average number of years that a newborn cohort would live if subjected through the life course to the age-specific mortality rates of the particular period to which the life table pertains. By extension, this number can be said to represent the length of life an average individual can expect at birth under the given mortality conditions. In a life table pertaining to an actual cohort that is now extinct, $\mathring{e}_0$ corresponds to the observed mean age at death for that particular cohort. Life expectancy, as was indicated above, is also calculated for ages other than zero. For age x, $\mathring{e}_x$ can be interpreted as the number of years that an individual can expect to live above age x, conditional on survival to age x.

Life Table Applications

The life table has many applications beyond the measurement of mortality. One of these applications

TABLE 1

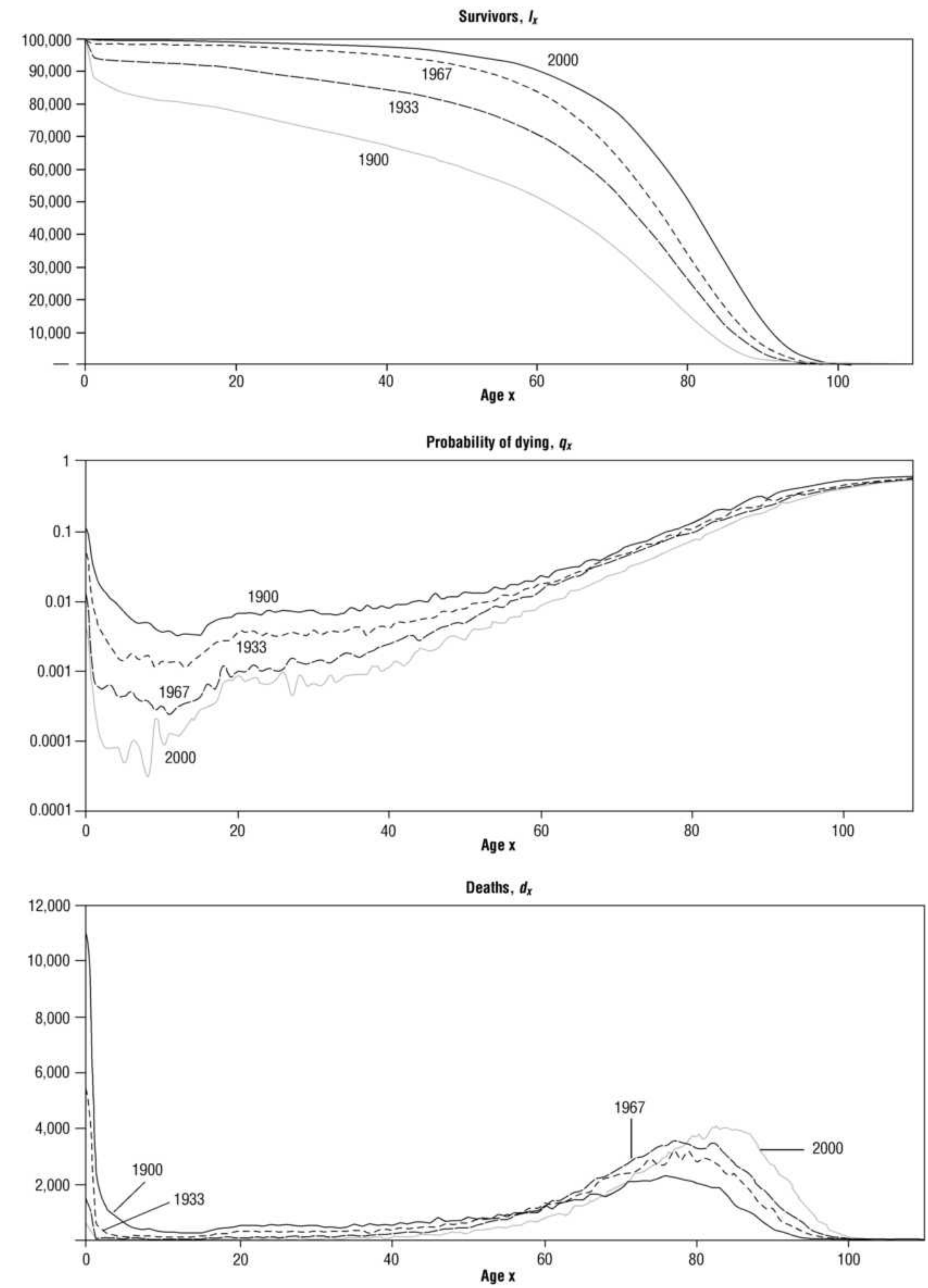
Abridged Life Table, Austria 1992, Females

Exact age x	Mid-year population in age interval x to $x+n$ ${}_nN_x$	Deaths between ages x and $x+n$ during the year ${}_nD_x$	Death rate between ages x and $x+n$ ${}_nm_x$	Average person-years lived in the interval by those dying in the interval ${}_na_x$	Probability of dying between ages x and $x+n$ ${}_nq_x$	Probability of surviving from age x to $x+n$ ${}_np_x$	Number surviving at age x l_x	Number dying between ages x and $x+n$ ${}_nd_x$	Person-years lived between ages x and $x+n$ ${}_nL_x$	Person-years lived above age x T_x	Expectation of life at age x $\mathring{e}_x$
0	47,925	419	0.008743	0.068	0.008672	0.991328	100,000	867	99,192	7,288,901	72.889
1	189,127	70	0.000370	1.626	0.001479	0.998521	99,133	147	396,183	7,189,709	72.526
5	234,793	36	0.000153	2.500	0.000766	0.999234	98,986	76	494,741	6,793,526	68.631
10	238,790	46	0.000193	3.143	0.000963	0.999037	98,910	95	494,375	6,298,785	63.682
15	254,996	249	0.000976	2.724	0.004872	0.995128	98,815	481	492,980	5,804,410	58.740
20	326,831	420	0.001285	2.520	0.006405	0.993595	98,334	630	490,106	5,311,431	54.014
25	355,086	403	0.001135	2.481	0.005659	0.994341	97,704	553	487,127	4,821,324	49.346
30	324,222	441	0.001360	2.601	0.006779	0.993221	97,151	659	484,175	4,334,198	44.613
35	269,963	508	0.001882	2.701	0.009368	0.990632	96,492	904	480,384	3,850,023	39.900
40	261,971	769	0.002935	2.663	0.014577	0.985423	95,588	1,393	474,686	3,369,639	35.252
45	238,011	1,154	0.004849	2.698	0.023975	0.976025	94,195	2,258	465,777	2,894,953	30.734
50	261,612	1,866	0.007133	2.676	0.035082	0.964918	91,937	3,225	452,188	2,429,176	26.422
55	181,385	2,043	0.011263	2.645	0.054861	0.945139	88,711	4,867	432,096	1,976,988	22.286
60	187,962	3,496	0.018600	2.624	0.089062	0.910938	83,845	7,467	401,480	1,544,893	18.426
65	153,832	4,366	0.028382	2.619	0.132925	0.867075	76,377	10,152	357,713	1,143,412	14.971
70	105,169	4,337	0.041238	2.593	0.187573	0.812427	66,225	12,422	301,224	785,699	11.864
75	73,694	5,279	0.071634	2.518	0.304102	0.695898	53,803	16,362	228,404	484,475	9.005
80	57,512	6,460	0.112324	2.423	0.435548	0.564452	37,441	16,307	145,182	256,070	6.839
85	32,248	6,146	0.190585	5.247	1.000000	0.000000	21,134	21,134	110,889	110,889	5.247

SOURCE: United Nations (1994).

FIGURE 1

Graphical Representation of Unabridged Life Tables for Females, Sweden 1900, 1933, 1967, and 2000



SOURCE: Human Mortality Database <www.mortality.org>.

concerns the relationship between the mortality level of a population and its age structure. In particular, a life table can be conceived as a stationary population, which is a population closed to migration, where the annual number of births (B) and mortality conditions (embodied in the life table) are constant over time. If these conditions apply, the population will have an age distribution, ${}_nN_x$, that is proportional by a factor B/l_0 to the ${}_nL_x$ column of the life table, and a total population size, $P = B\ \mathring{e}_0$. The annual number of deaths in this population will equal the annual number of births, and the crude death and birth rates will have the value of $1/\mathring{e}_0$. In this population all demographic parameters, including total population size, are constant over time. The growth rate of this population is zero—hence the designation "stationary."

It follows that if a population can be assumed to be stationary, population parameters can be directly translated into life table parameters. For example, in a stationary population, $\mathring{e}_0 = P\ /\ B$, and ${}_nL_x = {}_nN_x\, .\ l_0\ /\ B$. Also, in a stationary population, the observed distribution of deaths, ${}_nD_x$, is proportional to the distribution of deaths in the life table, ${}_nd_x$. Thus, the observed mean age at death equals $\mathring{e}_0$, which is not the case in non-stationary populations. These equalities are useful for estimating mortality or other single-decrement processes in any population or sub-population that can be assumed to be stationary.

The life table can also be used to project a population in the future. If a particular life table can be assumed to represent mortality conditions of a specific population between time t and t+5, and if there is no migration between t and t+5, the population aged x to x+5 at time t, ${}_5N_x(t)$ can be projected to time t+5 using the ${}_5L_x$ column of the life table and the following equation:

$${}_5N_{x+5}\ (t+5) = {}_5N_x(t)\ \frac{{}_5L_{x+5}}{{}_5L_x}$$

This equation rests on the assumption that the population is stationary between age x and x+5, an assumption that is not very problematic for this purpose. The births that occurred between t and t+5 can also be projected to time t+5 to calculate the population under age 5 at time t+5 using the following equation:

$${}_5N_0\ (t+5) = B[t,\ t+5]\ \frac{{}_5\mathrm{L}_0}{5\ l_0}$$

Naturally, an important component of population projections involves making assumptions about the future course of mortality and the construction of corresponding life tables. The above equations describe the mechanical use of life tables for projection purposes, once life tables for future time periods have been estimated.

Mortality Models

Comparison of life tables in various populations has led demographers to observe regularities of age-patterns of mortality. In particular, across populations and time periods, age-specific mortality risks tend to follow a U-shape curve, with higher mortality risks at younger and older ages, with the lowest risks in the neighborhood of age 10 (see Figure 1). Another observation is that mortality rates are highly intercorrelated within a population. When mortality rates are higher at particular ages, they also tend to be higher at other ages. Although with a given level of mortality—as indexed, for example, by the value of the expectation of life at birth—somewhat different age-specific mortality rates may be associated in different populations, this variability is within relatively narrow bounds.

These observations have led demographers to search for parsimonious representations of mortality patterns, or mortality "models." The purpose of mortality models is the representation of complex age/level variations in life table columns with a small number of parameters. Mortality models can permit the estimation of mortality indicators in settings where the data ideally required for life table construction (an accurate census count of the population and accurate death registration for years fairly close to the time of the census, or corresponding statistics derived from an accurate population register) are absent. In such situations it may be still possible to estimate a limited number of population parameters, which, along with a model, can be useful for estimating a full life table.

Mathematical mortality models are the oldest parsimonious representations of mortality patterns. The purpose of such models is to present a functional form relating mortality risks to age, with a small number of parameters adjusting for varying levels and patterns across populations. Mathematical mortality models have not been very successful because the shape of the mortality curve is too complex to be easily summarized in a functional form. An important contribution of mathematical representations of mortality, however, is the Gompertz "law" of mortality, according to which the logarithm of the death rate is a linear function of age. The Gompertz equation is frequently used to represent or estimate mortality rates past middle adult ages, although it tends to overestimate mortality rates at older ages.

The most widely-used mortality models are model life tables. In their classical form, model life tables are a set of life tables indexed along two dimensions, *family* and *level.* A family is a group of model life tables with similar age patterns of mortality, often based on the experience of populations that are geographically close. Within a family, tables are indexed by level, from low to high life expectancy at birth. These model life tables are estimated by grouping high-quality empirical life tables with similar age patterns of mortality, and by observing how age-specific mortality rates typically vary as the overall mortality level changes. Regression equations are then used to construct model life tables for various families and mortality levels.

The most commonly used sets of model life tables were developed by A. J. Coale and P. Demeny and by the United Nations. Coale and Demeny model life tables are mostly based on the experience of European populations during the first half of the twentieth century, whereas United Nations tables are based on the experience of developing countries during the second half the twentieth century.

Model life tables are convenient to use, because within a family, a unique life table can be selected on the basis of only one life table indicator. The use of model life tables thus can flexibly accommodate various data configurations of the populations under study. However, the choice of the family of life tables appropriate for application to actual populations is not always straightforward, and the full range of age variations in actual mortality experience may not be fully represented in the currently available model life tables.

Another category of mortality models is the relational model, to which the *logit* model developed by William Brass belongs. Brass (1971) observed that any two life tables can be related to each other in a linear way after performing a "logit" transformation of $q(x)$, the probability of dying before age x. The logit system is thus a system in which a "standard" life table can be adjusted for varying levels and age-patterns of mortality across populations after solving for the two linear parameters relating empirical life table values to the standard. The Brass logit system is often used to smooth an empirical life table or to complete a life table with missing values.

Multiple-Decrements

Although life tables were originally developed to study mortality, the same logic can be used to study many other processes. The only requirement is that the process must be a single-decrement process, which means that there is only one mode of exiting a defined state of interest with no possible return to that state. When studying mortality, the state of interest is being alive, and the only way to leave that state, with no return permitted, is through death. The same logic can be applied, for example, to first marriages, in which case the state of interest is being never married and the event of interest is first marriage. Other single-decrement processes include first migration from place of birth, marital survival, or entry to the labor force.

In reality, single-decrement processes are rare. For a real cohort, mortality is in fact the only true single-decrement process. Other states such as "being never married" can be left not only by marriage, but also by death. Mortality always operates in addition to other processes, and thus multiple-decrement processes are far more common than single-decrement processes. Nonetheless, single-decrement life table logic can be applied to multiple decrements if the different sources of exits can be merged into one combined source of decrement, or if sources of decrements other than the one of interest can be ignored because they are very infrequent during the age-range under study. Also, if information is available only for individuals who did not experience other sources of decrement, the process of interest can be studied as a single-decrement process. For example, data on first marriages reported by individuals aged 85 can be used to reconstruct a life table in the single state where first marriage is the only source of decrement. Such strategy will provide an unbiased single-decrement life table if survivors had the same risks of experiencing a first marriage as those who did not survive (independence of probabilities).

In a multiple-decrement environment, it is sometimes useful to present information on the various modes of exits. Such analysis is commonly performed in a multiple-decrement life table, which is a life table where several sources of decrement affect the number of people still alive, and where each source of decrement is specified in various columns. For example, in a cause-specific life table, there are as many ${}_nd_x{}^i$ columns as there are causes of death *i*. The sum of ${}_nd_x{}^i$ in an age group is equal to ${}_nd_x$, the number of deaths from all causes in the corresponding single-decrement life table.

There are also methods that permit construction of a single-decrement life table in the absence of, or net of, other sources of decrement. Such life tables are sometimes called "associated single-decrement life tables" or "cause-deleted life tables." This approach involves information on a population subject to various sources of decrement, but it models the process of interest by reconstructing a hypothetical cohort where that process would be the only possible source of attrition. For example, if various causes of death are taken to be different modes of exiting the cohort, an associated single-decrement life table would permit estimation of the survival of a cohort in the absence of a particular cause (or group of causes).

Life table analysis is a powerful tool that has regained interest in the social sciences with recent developments in statistical techniques. If data on cohort survival is available at the individual level and includes covariates, it is possible to use a set of techniques termed "survival analysis" or "event-history analysis." The main purpose of these techniques is to estimate the influence of individual-level characteristics on the age-specific risk of attrition, the so-called "hazard rate." Because of their roots in classical life-table analysis, some of these procedures have been termed "life tables with covariates."

As noted earlier, the underlying assumption of single- and multiple-decrement life tables is that once the event of interest is experienced, individuals can never return to their original state. In reality, there are many processes where individuals can experience reverse flows. For example, if the state of interest is being "currently married," there are return flows as individuals who experience divorce or widowhood remarry and become "currently married" again.

Such processes can be analyzed through increment-decrement life tables, sometimes called multistate life tables. In an increment-decrement life table, there are as many l_x columns as there are states (excluding "being dead"), and these l_x columns can increase or decrease depending on the observed rates of transition from one state to the other. Among other uses, increment-decrement life tables allow estimation of the expected number of years in a particular state. For example, they can permit the estimation of the number of years that a newborn can expect to live in the "currently married" state, which could not be done using classical, single-decrement life tables.

Historical Note

The concept of life tables was first created in 1662 by John Graunt (1620–1674) in his *Natural and political observations made upon the bills of mortality* (1662). Further developments were made by the Huygens brothers and Gottfried Leibniz (1646–1716). The first systematic construction of a life table is credited to the astronomer Edmund Halley (1656–1742) in 1693. During the seventeenth century, life table construction was significantly improved due to the work of Willem Kersseboom (1691–1771), Nicolaas Struyck (1686–1769), and Antoine Deparcieux (1703–1768). However, these scientists lacked the two necessary data sources for the construction of a period life table—deaths and population by age. Therefore, early life tables were accurate only if the population under study was a closed cohort or a stationary population, and thus they had limited applicability. Taking advantage of the exhaustive Swedish data, Pehr Wargentin (1717–1783) constructed the first scientifically correct period life table in 1766.

Before the seventeenth century, death was believed to be either a magical or sacred phenomenon that could not and should not be quantified. The invention of life tables was thus an important scientific breakthrough, not only because of the technical aspects of life table construction, but also because of the concept of mortality as a measurable phenomenon following observable regularities.

See also: *Actuarial Analysis; Brass, William; Demography, History of; Event-History Analysis; Farr, William; Gompertz, Benjamin; Graunt, John; Mortality, Age Patterns of; Multistate Demography; Renewal Theory and Stable Population Model; Stochastic Population Theory.*

BIBLIOGRAPHY

Brass, William. 1971. "On the Scale of Mortality." In *Biological Aspects of Demography,* ed. W. Brass. London: Taylor and Francis Ltd.

Coale, Ansley J., and Paul Demeny. 1983. *Regional Model Life Tables and Stable Populations.* New York: Academic Press. (First edition 1965, Princeton: Princeton University Press.)

Dupâquier, Jacques. 1996. *L'invention de la table de mortalité: de Graunt à Wargentin: 1662–1766.* Paris: P.U.F.

Keyfitz, Nathan. 1985. *Applied Mathematical Demography,* 2nd edition. New York: Wiley.

Keyfitz, Nathan, and Wilhelm Flieger. 1990. *World Population Growth and Aging: Demographic Trends in the Late Twentieth Century.* Chicago and London: University of Chicago Press.

Pressat, Roland. 1972. *Demographic Analysis: Methods, Results, Applications.* Chicago: Aldine-Atherton.

Preston, Samuel H., Patrick Heuveline, and Michel Guillot. 2001. *Demography: Measuring and Modeling Population Processes.* London: Blackwell Publishers.

Schoen, Robert. 1988. *Modeling Multigroup Populations.* New York: Plenum Press.

United Nations. 1982. *Model Life Tables for Developing Countries.* New York: United Nations Population Studies, no. 77.

Michel Guillot

LIMITS TO GROWTH

For demographers, limits to growth is an old subject, at least as it relates to population growth, harking back to political economist T. R. Malthus (1766–1834) or even earlier writers. Since the 1972 publication of the Club of Rome study *Limits to Growth* the term has come to refer to both population and economic growth—that is, growth in population and growth in per capita resource use, the product of which gives the growth rate of total resource use. This total resource use is a flow from nature's sources (mines, wells, forests, fisheries, grasslands), through the transformations of production and consumption within the economy, and back as wastes to nature's sinks (atmosphere, oceans, a neighbor's back yard). Just as an animal lives from its metabolic flow, beginning with food from the environment, and ending with the return of wastes to its environment, so the economy lives from its metabolic flow, or "throughput." The throughput, like the metabolic flow, is entropic and irreversible. That is not to say that most waste materials are not recycled by biogeochemical processes powered by the sun. It is only to point out that such recycling is external to the animal or economy—whose life therefore depends on these natural services provided by its environment.

Two Kinds of Dissipative Structures

In physical terms human bodies are dissipative structures, which is to say that their natural tendency is to decay, die, and fall apart. The same is true for artifacts that we accumulate as wealth. A car, a house, or a shirt is a dissipative structure that requires a throughput to be maintained and replaced. A population of inanimate objects (e.g., shirts) inevitably wears out and depreciates over time, requiring new production to make up for the loss, as well as maintenance expenditures (replacing buttons) to slow down the rate of depreciation to a minimum. For demographers it is easy to think in terms of two populations of dissipative structures, one consisting of human bodies, the other of artifacts—basically extensions of human bodies. Each population, if it is to remain in a steady state, has both short-term maintenance requirements and long term reproduction requirements, each supplied by the entropic throughput from and back to nature. If these two steady-state populations are so large that the throughput necessary to maintain them requires inputs from nature's sources and outputs to nature's sinks at rates beyond nature's replenishing and absorptive capacities, then the throughput flow becomes ecologically unsustainable, and so do the two populations.

Definition of Limits to Growth

The limits to growth, in twenty-first century usage, refers to the limits of the ecosystem to absorb wastes and replenish raw materials in order to sustain the economy (the two populations of dissipative structures). The economy is a subsystem of the larger ecosystem, and the latter is finite, non-growing, and, in terms of materials, closed. Although the ecosystem is open with respect to solar energy, that solar flow is also nongrowing. Therefore in a biophysical sense there are clearly limits to growth of the subsystem. The difficulty in perceiving this is that these limits are not experienced as a rigid barrier, like an unyielding brick wall hit by a car. Instead, they are like the limits imposed by a budget that allows borrowing against the future or deferral of maintenance and replacement costs. Although limits to growth are ultimately physical and biological in their origin, society feels their effects economically long before they experience any absolute physical crash. The challenge for policy making is to express these limits in economic terms, and institutionalize them in decision making. Society needs to know not only what scale of economy and throughput will terminally disrupt the ecosystem, but also when the extra ecosystem disruptions required by a growing throughput begin to cost more in terms of sacrificed ecosystem services than they benefit others in terms of extra production. In other words, one must think in terms of the optimum *scale* of the economic subsystem (the two populations) relative to the total ecosystem. Beyond this optimal point further growth becomes in an ultimate sense uneconomic.

Harmful Effects of Economic Growth

The term "uneconomic growth" will not be found in the index of any textbook in macroeconomics. All growth (typically as measured by Gross Domestic Product [GDP]) is considered economic growth. Yet the concept of the optimum is central to economics, and nothing could be clearer than that growth beyond the optimum must be uneconomic—in the strict sense that it increases costs by more than benefits, thus making society collectively poorer, not richer. Politically it would be extremely inconvenient to discover that society has exceeded the optimal scale and that growth was now uneconomic. How could one fight poverty without growth? Society might have to redistribute existing wealth. How can one trust the demographic transition to automatically limit births as incomes increase, if growth no longer makes society richer? Society might have to purposefully limit births. How can society clean up the environment without growth to make people richer so that one can afford the costs of cleaning up? Society might have to pay those costs out of a lower income. The radical nature of these responses suggests that a world without growth has become politically unthinkable. Is it any wonder that there is a relentless intellectual effort devoted to debunking the notion of limits to growth or minimizing its relevance?

It is true of course that GDP growth can be made less material-intensive. (The analogous adjustment of making people less material-intensive—smaller—in order to allow for a larger population might meet more resistance.) But the scope for this substitution is itself limited, and appeal to it only serves to highlight the extent to which growth is the dominant value around which modern societies are organized. The reasoning in support of the ultimate reality of limits is unaffected.

The Future of Economic Growth

In the early twenty-first century it seems that society is witnessing the conflict between a physical impossibility (continual growth) and a political impossibility (limiting growth). But in the long run the physically impossible is more binding than the merely politically impossible. The hope is that growth will not prove politically impossible to limit, once society accepts that growth can be uneconomic. But society may have to suffer a bit before that becomes clear.

See also: *Carrying Capacity; Ecological Perspectives on Population; Sustainable Development; World Population Growth.*

BIBLIOGRAPHY

Daly, Herman E. 1996. *Beyond Growth: The Economics of Sustainable Development.* Boston: Beacon Press.

Meadows, Daniela H. 1992. *Beyond the Limits: Confronting Global Collapse, Envisioning a Sustainable Future.* Post Mills, VT: Chelsea Green.

Meadows, Daniela H., et al. [1972] 1992. *The Limits to Growth* (1972). New York: Universe Books.

Herman E. Daly

LITERACY

Literacy can be defined as the ability to read simple passages of printed text and sign one's name. The expansion of literacy is both a marker of and a contributory factor to economic development. It also may play a role in the mortality and fertility declines of the demographic transition.

Collection of Literacy Data

In developing countries literacy data are collected routinely in national censuses for the population above a specified age. For historical studies the data problems are much greater. One of the few sources that can be mined for historical Europe are parish records from the mid-sixteenth century to the mid-nineteenth century.

After the mid-eighteenth century in England marriage registration required that a couple and their witnesses sign (or mark) the parish register. Because people were taught to read before learning to write, the ability to sign one's name can be used as an indicator of literacy. In a society in which nearly all people married, information on historical levels of and trends in literacy therefore can be drawn from marriage records.

Findings from the Past

These snapshots from earlier periods made it clear that the acquisition of functional literacy was a dramatically stratified cultural resource. Men were more than twice as likely as women to be able to sign their names; the higher up the social scale one moved, the more likely it was that one could sign; the more urbanized one was, the less likely one was to identify oneself with a mark; and so on.

In the middle of the eighteenth century essentially one in two English men could sign his name and thus presumably could read. In economic terms those people who were active in a capitalist economy were likely to be readers who were able to keep ledgers and write letters to partners, customers, and others. In social and cultural terms those with leisure time were able to enjoy the burgeoning output of the presses; novels and newspapers were significantly new developments at that time. In demographic terms, however, it is not clear whether one can determine the characteristics that distinguished the literate from the illiterate. Readers (and signers) were not more "modern" than their illiterate families, neighbors, and friends; all belonged to a demographic culture marked by Malthusian prudential marriage and a fertility regime that was not so much "natural" as it was culturally constructed. There was little difference in fertility profiles between the literate and the illiterate.

TABLE 1

Illiterate Population (Age 15 Years and Over) and Proportion Illiterate, by Sex, in Major World Regions, 1995

Region	Illiterate population (millions)	Illiteracy rates (percent)		
		Men	Women	Both sexes
Sub-Saharan Africa	140.5	33.4	52.7	43.2
Arab States	65.5	31.6	55.8	43.4
Latin America and Caribbean	42.9	12.3	14.5	13.4
Eastern Asia/Oceania	209.9	9.4	23.7	17.4
Southern Asia	415.5	37.1	63.4	49.8

SOURCE: UNESCO (1998); University of Pennsylvania/ Graduate School of Education (1999).

During the classical Industrial Revolution (1770–1850) it seems that living in one of the northern English towns was no more likely to lead to the acquisition of literacy than it was to improve one's children's life expectancy. Early industrial society neither privileged literacy nor promoted it. Although functional literacy remained fairly constant, there was a significant demographic change: Marriages took place earlier in both town and country, illegitimacy rates skyrocketed, marital fertility became more duration-sensitive (higher levels in the first years of marriage, which might only reflect bridal pregnancy, but also higher levels in the later years), and mortality levels dropped in the countryside but rose dramatically in the inner cities.

The truly significant shift in popular functional literacy came about in the second half of the nineteenth century and coincided with the onset of the demographic transition and the fertility decline. In part this was a reflection of the declining value of children's labor; in part it was a reflection of the incursions of state-sponsored schools, which became compulsory only in the 1870s and were plagued with truancy for another generation; and in part it was a reflection of the reconfiguration of popular culture in the age of the Penny Post, the postcard, the penny newspaper, the train schedule, and a series of changes that made the acquisition and maintenance of literacy more relevant to the entire population. One could function as an illiterate in the pre-1850 oral culture, but this became less true afterward.

Even if most people never were required to sign their names on any occasion other than the marriage ceremony, illiteracy became a cultural disadvantage that discriminated against nonreaders.

The Contemporary Situation

Illiteracy remains a problem in much of the world. The statistics assembled by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and published in that organization's *World Education Report* estimated that worldwide in 1995 there were 885 million illiterates among the population 15 years old and over, 64 percent of whom were women. The corresponding rate of adult illiteracy was given as 22.6 percent (16.4 percent for men and 28.8 percent for women). The illiteracy data for developing countries as of 1995, grouped into UNESCO's five regions, are given in Table 1.

The connection between "modernizing" literacy and the demographic transition cannot be determined. Micro-level research that would analyze the demographic implications of literacy directly remains to be done.

See also: *Education; Historical Demography.*

BIBLIOGRAPHY

Goody, Jack. 1986. *The Logic of Writing and the Organization of Society.* Cambridge, Eng.: Cambridge University Press.

———. 2000. *The Power of the Written Tradition.* Washington, D.C.: Smithsonian Institution Press.

Goody, Jack, ed. 1968. *Literacy in Traditional Societies.* Cambridge, Eng.: Cambridge University Press.

Laqueur, Thomas. 1976. "The Cultural Origins of Popular Literacy in England 1500–1850." *Oxford Review of Education* 2: 255–275.

Levine, David. 1979. "Education and Family Life in Early Industrial England." *Journal of Family History* 4: 368–380.

———. 1980. "Illiteracy and Family Life during the First Industrial Revolution." *Journal of Social History* 14: 25–44.

———. 1984. "Parson Malthus, Professor Huzel, and the Pelican Inn Protocol: A Comment." *Historical Methods Newsletter* 17: 21–24.

Sanderson, Michael. 1974. "Literacy and Social Mobility in the Industrial Revolution in England." *Past and Present* 56: 75–104.

Schofield, R. S. 1973. "Dimensions of Illiteracy." *Explorations in Economic History,* 2nd series. 10: 437–454.

Spufford, Margaret. 1979. "First Steps in Literacy: The Reading and Writing Experiences of the Humblest Seventeenth-Century Spiritual Autobiographers." *Social History* 4: 407–435.

United Nations Educational, Scientific, and Cultural Organization. 1998. *World Development Report 1998: Teachers and Teaching in a Changing World.* Paris: UNESCO.

Vincent, David. 1981. *Bread, Knowledge and Freedom: A Study of Nineteenth-Century Autobiography.* London: Methuen.

———. 1989. *Literacy and Popular Culture. England, 1750–1914.* New York: Cambridge University Press, 1989.

———. 2000. *The Rise of Mass Literacy: Reading and Writing in Modern Europe.* Cambridge, Eng.: Polity Press.

INTERNET RESOURCE.

University of Pennsylvania/Graduate School of Education. 1999. International Literacy Explorer. <http://www.literacyonline.org/explorer/regsworld.html>.

DAVID LEVINE

LITERATURE, POPULATION IN

"Adam and Eve," wrote George Bernard Shaw in his ambitious play *Back to Methuselah,* "were hung up on two frightful possibilities. One was the extinction of mankind by their accidental death. The other was the prospect of living forever. They could bear neither. Consequently, they had to invent natural birth and natural death, which are, after all, only modes of perpetuating life without putting on any single creature the terrible burden of immortality." Thus not only the human race, but the science of demography was born.

Yet in demographic terms, for over a century Westerners have seemed unable to decide what they fear most. The precipitous drop in European fertility rates has produced anxiety about numerical dwindling, latterly echoed even in the United States. Yet the six-fold increase in worldwide population since the early 1800s has prompted a contrary fear of crushing biological overload. Given the emotive nature of these opposing horrors—*We are about to disappear! vs. We are being overrun!*—it is less surprising that population issues have filtered into the Western literary canon than that their direct treatment in mainstream literature is so rare.

Predictably, what Anton Kuijsten termed "demografiction" divides between the twin terrors of population decline and population excess. Less obvious is a third category: fear of population professionals.

Fear of Population Decline

When fertility fell earlier in France than in the rest of Europe, alarm spread that low birth rates would doom the French to obscurity. Horrified by Malthusianism, so at odds with the perceived French predicament, in 1899 Emile Zola published the pronatalist novel *Fécondité* in order to demonstrate that capitalism promotes poverty, while "fruitfulness" is the moral and economic strength of the working class.

Mathieu and Marianne Froment begin poor but happy, and heedlessly beget some dozen children, to the despair of their more prosperous betters, who promote Malthusian woe. By the time this gothic tale is through, the effete capitalists have paid for their venal shortsightedness with murder, suicide, and madness, their lines truncated when single sons fall prey to depravity or consumption. By contrast, Mathieu and Marianne's 158 progeny of three generations gather for their seventieth wedding anniversary on their thriving farm.

Zola's arguments retain remarkable resonance in the early twenty-first century. "Had not every civilization, every progress, been due to the impulse of numbers?," Mathieu asks, presaging Julian Simon. Warnings about "that terrible swarming of Asiatic barbarians" bound to "sweep down on our Europe, ravage it, and people it afresh" anticipate Pat Buchanan. And Mathieu's declaration that population equilibrium will only arrive "when the earth, being entirely inhabited, cleared, and utilized, shall at last have accomplished its destiny" would hearten Wall Street globalists as much as it would sicken wilderness advocates.

Fécondité's present-day foil, *Headbirths, or The Germans Are Dying Out* by Günter Grass is a short, droll novel whose protagonists constitute the fecund Froments' demographic antithesis. The childless Harm and Dörte Peters take a sociologically edifying holiday tour of Asia while debating the torturous "Yes-to-baby No-to-baby" question. Counterintuitively for the field, economics barely enter in; instead the Peterses agonize about Third World poverty and nuclear radiation. Yet amidst the liberal pieties, the couple airs concerns that ring more true. Would this very holiday be possible with an infant? Encumberment could put their "sacred right to self-realization in danger." Finally, Dörte warms to a child, but Harm has gone off the idea, and on return they put pregnancy on hold pending the outcome of the German election.

The Peters's very method of decision making has predetermined its outcome. Harm shouts, "If I make a child, I want to do it consciously. Do you hear? Not the Hindu way!" But conscious reasoning will always come up with an excuse to forestall the inconvenience of Yes-to-baby, while the unthinking "Hindu way" will continue to people the planet.

Harm and Dörte embody the teleological revolution of the West's second demographic transition, whereby meaning has come to dwell inordinately in the present at the expense of the future. Yet P. D. James's *The Children of Men* hauntingly illustrates that the present's sense of fulfillment—not to mention its economy—is contingent on progenitors. The human race having become universally infertile post-1995, James's world of 2021 is a grim, senescent place, as the last, spoilt generation runs rampant and the burdensome elderly organize mass suicides to avoid being the last to turn out the light. Even more conceptually clever is Amin Maalouf's kindred novel, *The First Century After Beatrice,* whose instruction to the patriarchal Third World might run: Be careful what you wish for. A pill marketed as guaranteeing the birth of sons does just what it says; in Maalouf's future Third World there are plenty of people—for the time being—but hardly any girls.

Prospective human extinction has inspired a raft of commercial fiction. As a rule, thrillers like Michael Crichton's *The Andromeda Strain* are satisfied with sacrificing a handful of cautionary unfortunates before catastrophe is averted, while science fiction gleefully smites millions of walk-ons with no guarantee of a happy ending.

The nature of the catastrophe often expresses the prevailing angst of the era. E. M. Forster's story "The Machine Stops" reflects anxieties about automation: A machine that tends to every human need creates a race of biological incompetents, like domesticated pets; when the machine breaks down and no one understands how it works, the species is finished. Subsequent science-fiction authors have also demonized dependence on technologies, extrapolating social disaster when metal, electricity, or plastic cease to function. Novels like John Christopher's *No Blade of Grass* and J. G. Ballard's *The Burning World* convey concerns about food and water supply, others like Christopher's *The Long Winter* about global temperature shift. But fictional apocalypse comes in a festival of more inventive guises: volcanic gas, planetary collision, infectious insanity, and extraterrestrial wasps. Arthur C. Clarke, however, designs extinction with a more cheerful slant. When a computer prints out "The Nine Billion Names of God" in his eponymous short story, the stars wink out quietly one by one; in *Childhood's End,* the last generation of men watches helplessly as its children evolve into incomprehensibly superior beings.

Otherwise, most doomsday novels feature war or disease. During the Cold War, of course, the most common threat to the human race in bookstores was bellicosity. The specter of nuclear holocaust gave rise not only to death-ray shoot-outs in outer space, but to realistic accounts like Neville Shute's mournful *On the Beach* (humanity's last remnants in Australia await an approaching cloud of nuclear fall-out), as well as to witty satires like Kurt Vonnegut's *Cat's Cradle* (all water crystallizes into "ice-nine").

With fears of the Bomb receding and AIDS in ascendance, plague novels have become more the vogue. In a seminal work of this subgenre, George R. Stewart's *Earth Abides,* a young man in California recovers from a snakebite to find most of the human race dead from a new virus. As the handful of immune survivors form an ad hoc community, depopulation has some kid-in-a-candy-store appeal; houses, groceries, and liquor are free and abundant. But as Stewart tracks three post-plague generations, he vividly demonstrates that numbers maintain advanced civilization. Reduce the race to the size of a small town, and how many residents will remember how to make plastic? The last Americans plunder canned goods (with little respect for sell-by dates), and literacy atrophies; electrical and water systems break down. At length, the community reverts to its hunter-gatherer forebears.

As demonstrated by T. C. Boyle's *After the Plague* of 2001, whose title story also deploys Stewart's premise, the emergence of HIV, the threat of biological weapons, and the multiplication of disease vectors via globalization make epidemiology more than physics the black art of the age. At least on paper, expect more plague.

Fear of Population Excess

In the literature of population decline, peril makes people seem precious. The same cannot be said of the literature of population excess, in which two may be company but 30 billion is a crowd.

In *Back to Methuselah,* George Bernard Shaw commends an ideal lifespan of at least 300 years, lest "mere human mushrooms . . . decay and die when they are just beginning to have a glimmer of the wisdom." Yet Kurt Vonnegut's playful story "Tomorrow and Tomorrow and Tomorrow" extrapolates what life might be like if "anti-gerasone" keeps folks alive for as long as they care to stick around. In a world of 12 billion, families of several generations live on top of one another, and the irritable 172-year-old Gramps tyrannizes his relatives with threats of disinheritance should he ever kick his own bucket. Taxed to penury to finance pensions, the youthful 112-year-old protagonist wails to his wife, "I don't think we're ever going to get a room to ourselves or an egg or anything."

With average Western lifespans climbing, its elderly cohorts swelling, and genetic research into the arrest of aging making headway, Vonnegut's premise becomes less fanciful. Likewise Simone de Beauvoir's novel, *All Men Are Mortal,* in which a fourteenth-century Italian takes a drug to induce immortality, only to discover that by the twentieth century his existence is boring, lusterless, and oppressive. While medical science still cannot offer eternal life, de Beauvoir's thesis—that brevity is one key to life's sweetness—suggests that great efforts lavished on longevity might be misspent.

Mainstream treatments of population excess are few. True, for those who argue that many poor countries are already too populous, the novels and travel books of V. S. Naipaul might qualify, and it is indeed sobering to come across in *The Overcrowded Barracoon* of 1972, "To be one of 439 million Indians is terrifying," when a slight three decades later Indians number over one billion. But for the most part authors define an "overpopulated" world as one more crowded than their own. Thus put off to the future, the issue has been primarily the purview of genre writers.

One exception is Colin Macpherson's *The Tide Turners,* set in his present of six billion people and credibly deploying available technology. Determined to give the earth a "rest" from human depredation, a group of young Australian eco-idealists design a virus that will leave humans sterile. Their aim is to disseminate the virus worldwide and shrink population to two billion over 40 years, though there's one unaddressed fly in the ointment: Total success would leave the species not reduced but extinct. Little matter, since the plot is foiled by a murderous cabal of anti-environmental capitalists.

As literature, *The Tide Turners* is pretty crude; the characters often speak like Sierra Club pamphlets. Moreover, the amateur virologists are portrayed as perfectly noble; proclaims the project's founder to his flock, "You're all heroes." Yet given that these do-gooders plan to expose the entire species to a contagious foreign virus after testing it for a few months on 150 subjects, *The Tide Turners* might better belong in the third category posited here.

Perhaps the most prestigious modern writer to take on population excess is Anthony Burgess, whose amusing social satire *The Wanting Seed* exemplifies how overdoing "fruitfulness" leads to biological perversity and moral inversion. In his antinatalist Britain of the near future, homosexuality confers prestige ("It's sapiens to be homo"); parenthood, shame. While in George Orwell's *1984* sham wars create social cohesion, here they are staged as a means of population control. When iron state control breaks down, wholesale cannibalism ensues.

Though aspiring to realism, George Turner's *The Sea and Summer* is set in mid-twenty-first century Australia—where, along with California, a disproportionate number of dystopic novels take place. (Perhaps a paradisiacal reputation helps set the stage for paradise lost.) Here multiple catastrophes intersect—global-warming floods, monetary collapse, food shortage, and mass unemployment—each exacerbated by population growth. In Turner's strict class structure, the middle-class "Sweet" live in constant terror of slipping to the "Swill," the dirty, teeming ruck living in tower blocks on meager state handouts.

Turner's book and Harry Harrison's entertaining *Make Room, Make Room*—set in a New York City of 35 million, and the basis of 1973's cannibalistic cult film *Soylent Green*—are two better representatives of a whole class of population pulp novels that took off in the 1960s, powered by Ehrlich-style alarmism. Overabundance in these books reliably cheapens humanity into chaff; in fact, cannibalism is a running theme. In swarming dystopias, civil liberties erode, and small, protected elites often control the seething horde through fascistic or mechanistic means. Drab, mass-produced garments portray a loss of individuality, as the one is lost in a sea of the many. Quality of life plummets: The food runs to tasteless seaweed pellets. Drink may be available, but only rotgut; writers seem especially distressed by the prospect of no longer being able to get a decent bottle of wine. Living space is at a premium, domestic architecture dismal, often vast banks of the bleak Bauhaus high-rises typical of 1960s public housing.

Yet by and large these high-density nightmares are uncomplicated by race, which lends them a certain innocence. The same cannot be said of Jean Raspail's *The Camp of the Saints,* a novel both prescient and appalling.

It is the year 2000, and Raspail's population projection of seven billion worldwide turned out to be close. Resentful and wretched, 800,000 residents of Calcutta swarm onto a fleet of ships and steer the convoy toward the coast of France. As the rutting, reeking, hate-driven throng approaches, liberal, multicultural France prepares to greet her "visitors" with open arms. Meantime, resident immigrants, despising their menial jobs, constitute a waiting fifth column. By the time the ships run ashore—and the first landing party is a tide of bloated corpses thrown overboard—similar sea-jackings have occurred elsewhere, and the full-scale invasion of the First World by the Third has begun.

Certainly *The Camp of the Saints* is racist. While Turner personalizes the "Swill," Raspail's stinking "river of sperm" floating toward France is dehumanized, its mascot at the prow a speechless deformed dwarf. Yet it's a tough call whether Raspail is more disgusted by "the sweating, starving mass, stewing in urine and noxious gases" or by his own countrymen, who are too paralyzed with self-contempt to defend their borders: "Cowardice toward the weak is cowardice at its most subtle, and indeed, its most deadly." And to give the novel its due, it is written with tremendous verbal energy and passion.

Raspail gives bilious voice to an emotion whose statement is increasingly taboo in the West, but that can grow even more virulent when suppressed: the fierce resentment felt by majority populations when that status seems threatened. And the Third World migration pressures that Raspail foresaw have been brought to bear on the early twenty-first century, as squalid human trafficking proliferates and hundreds of asylum seekers nightly storm the Channel Tunnel at Calais, often bringing rail service to a halt. In their even-handed work, *Fear of Population Decline,* even Michael Teitelbaum and Jay M. Winter concede, "It seems doubtful . . . whether large-scale immigration can ever serve as a politically viable response to declining population." If *The Camp of the Saints* contains a lesson, it is that nativist concerns about immigration need fair airing, for such primitive anxiety is too potent to be consigned solely to the far right.

Fear of Population Professionals

All of these works radically diverge on which human aggregate constitutes the intolerable, and which the ideal. Not only Raspail but also John Brunner (*Stand on Zanzibar*) presents a millennial total of seven billion as horrific; Vonnegut cites an alarming 12 billion. Zola counter-claims that the earth could readily support "ten times" his own time's population of 1.5 billion, while Olaf Stapledon's blissful, stable utopia in *Last and First Men* contains only 100 million people. Yet demographers no more agree on optimal and catastrophic numbers than do the amateurs—which has helped to foster a whole literature demonizing not a population problem itself, but the folks who think they know how to fix it.

One such specimen is this writer's *Game Control,* whose irascible protagonist Calvin Piper has been fired as head of USAID's population division for his unacceptable promotion of higher infant mortality in the Third World. But his retirement in Nairobi is hardly idle: Calvin is researching a pathogen that would neatly decimate a third of the world's population overnight. Despite its outlandish premise, *Game Control* is closer to social satire than science fiction, and focuses as firmly on demographers as on their subject. Luminaries in the field like Julian Simon, John Bongaarts, Ben Wattenberg, and Garrett Hardin all make textual appearances, and Calvin's shy, worthy girlfriend Eleanor Merritt works for the Pathfinder Fund.

Calvin's fomenting about the dire consequences of inaction is sometimes convincing, but his motivation is suspect. He's resentful about having been fired. Though not strictly a bigot—dismisses Eleanor, "Calvin's not a racist. He hates everybody"—he is certainly a misanthrope. (In fact, Calvin finally comes to recognize the illogic of going to so much trouble to save a race he detests.) When, having uncovered his ludicrous scheme, Eleanor sets out to prove that AIDS alone will "cure" population growth, Calvin refuses to believe that the disease is up to the job. His attachment is not to humanity's salvation, but to his pet project, and most of all: to being right.

Zola also peopled *Fécondité* with glib demographic know-it-alls, and in Thomas Love Peacock's *Melincourt,* Malthus himself (as Mr. Fax) gives fatuous advice: "The world is overstocked with featherless bipeds. . . . It is better that the world should have a small number of peaceable inhabitants . . . than the disproportionate mass of fools, slaves, coxcombs, thieves, rascals, liars, and cutthroats with which it is at present encumbered." Peacock leaves little doubt that Malthus is an ass.

For Peacock, Malthusianism is class-driven: "It seems . . . peculiarly hard that all the blessings of life should be confined to the rich. If you banish the smiles of love from the cottage of poverty, what remains to cheer its dreariness?" Thus, the wealthy get all the land, the fine food, the wines, and the status, and now they want a monopoly on sex as well.

An array of commercial fiction, too, engenders a healthy suspicion of population snake oil. The plague in Chelsea Quinn Yarbro's *The Time of the Fourth Horseman* is caused by population control gone wrong. In the medical thriller *Benefits,* by Zoe Fairbairns, a contraceptive in the water supply gives rise to dreadful mutations, while both Turner's *The Sea and Summer* and Blanche d'Alpuget's *White Eye* put a more nefarious slant than *The Tide Turners* on a sterilization virus.

More serious writers have raised the alarm about social control of reproduction, notably Aldous Huxley in his *Brave New World* of fascistic eugenics.

Like Burgess, Huxley turns "family values" ingeniously on their head: with raising test-tube children the business of the state, promiscuity is lauded; love, monogamy, and childbirth are obscene. The principles of Henry Ford—from whose birthday all dates are marked, à la "the year of our Ford 600"—are applied to churn out identical editions of people, bred to be contented with their place. Margaret Atwood's *The Handmaid's Tale* has a gloomier texture, and there's no missing the feminist message: After environmental degradation has rendered much of the population sterile, fertile women are forced into sexual slavery to bear children for wealthy barren couples. Huxley is more fun.

The gentlest poke at the population pro would be R. K. Narayan's charming *The Painter of Signs.* During Indira Gandhi's aggressive vasectomy drive, a young artisan is smitten with a zealous family planning worker, who breaks his heart. Then, no woman who views children as "defeat for her cause" and is "obsessed with the sexual activities of others" could possibly have made a good wife.

Demography, Life, and Literature

Demography is a lightning rod for literary reservations about humanity itself, which can appear repulsive in sufficient quantity, or even seem to deserve its fate when having brought extinction upon itself. Alternatively, "demografiction" can animate the humanitarian truism that biologically people all sink or swim together. This collective existential ambivalence helps to express the dichotomy that other people are at once resource and rival: individuals need social cooperation to survive, yet the fiercest competition for that survival comes from our own kind. Because beneath the field's dry statistical surface there teems an irresistible Pandora's box of paranoia, nationalism, racism, rivalrous ambition, misanthropy, and apocalyptic dread, demography is sure to tempt more fiction-writing dabblers to prize open the lid.

See also: *Population Thought, History of.*

BIBLIOGRAPHY

FEAR OF POPULATION DECLINE.

Ballard, J. G. 1964. *The Burning World (An Earth Without Water).* New York: Berkley Medallion.

Boyle, T. Coraghessan. 2001. *After the Plague.* New York: Viking Press.

Christopher, John. 1956. *No Blade of Grass.* New York: Simon and Schuster.

———. 1962. *The Long Winter.* New York: Simon and Schuster.

Clarke, Arthur C. 1953. *Childhood's End.* New York: Ballantine Publishing Group.

———. 1967. *The Nine Billion Names of God: The Best Short Stories of Arthur C. Clarke.* New York: Harcourt, Brace, and World, Inc.

Crichton, Michael. 1969. *The Andromeda Strain.* New York: Alfred A. Knopf.

Forster, E. M. 1911. *The Machine Stops and Other Stories.* Cambridge, Eng.: Provost and Scholars of King's College.

Grass, Günter. 1982. *Headbirths, or The Germans are Dying Out,* trans. Ralph Manheim. New York: Harcourt Brace Jovanovich.

James, P. D. 1994. *The Children of Men.* New York: Warner Books.

Maalouf, Anton. 1994. *The First Century After Beatrice.* London: Abacus.

Shaw, George Bernard. 1921. *Back to Methuselah.* London: Constable and Co.

Shute, Neville. 1957. *On the Beach.* New York: Morrow.

Stewart, George R. 1949. *Earth Abides.* New York: Ballantine Books.

Vonnegut, Kurt. 1963. *Cat's Cradle.* New York: Delacorte Press.

Zola, Emile. 1899. *Fécondité,* trans. E. Vizetelly. 1900. London: Chatto and Windus.

FEAR OF POPULATION EXCESS.

Ballard, J. G. 1967. "Billenium." In *Cities of Wonder,* ed. Damon Knight. New York: McFadden-Bartell.

Blish, James, and Norman L. Knight. 1967. *A Torrent of Faces.* New York: Doubleday.

Brunner, John. 1968. *Stand on Zanzibar.* New York: Doubleday.

Burgess, Anthony. 1962. *The Wanting Seed.* New York: Norton.

de Beauvoir, Simone. 1955. *All Men Are Mortal.* Cleveland, OH: World Publishing Co.

Ehrlich, Max. 1971. *The Edict.* New York: Doubleday.

Goldberg, Marshall, and Kenneth Lay. 1980. *Disposable People.* New York: Tower.

Harrison, Harry. 1967. *Make Room, Make Room.* New York: Berkley Medallion.

Macpherson, Colin. 1999. *The Tide Turners.* Queensland, Australia: Mopoke Publishing.

Moorcock, Michael. 1975. *The Distant Suns.* New York: Unicorn. Anthologized in *Sailing to Utopia.* 1996. New York: Orion Publishing Group.

Naipaul, V. S. 1972. *The Overcrowded Barracoon.* London: André Deutsch.

Oliver, Chad. 1985. *Shadows in the Sun.* New York: Crown.

Pendleton, Don. 1970. *Population Doomsday.* New York: Pinnacle Books.

Raspail, Jean. 1975. *The Camp of the Saints,* trans. Norman Shapiro. New York: Charles Scribner's Sons.

Turner, George. 1987. *The Sea and Summer.* London: Faber and Faber.

Vonnegut, Kurt. 1968. "Tomorrow and Tomorrow and Tomorrow." In *Welcome to the Monkeyhouse.* New York: Delacorte Press.

FEAR OF POPULATION PROFESSIONALS.

Atwood, Margaret. 1986. *The Handmaid's Tale.* Boston: Houghton Mifflin.

d'Alpuget, Blanche. 1986. *White Eye.* New York: Simon and Schuster.

Fairbairns, Zoe. 1979. *Benefits.* New York: Virago.

Huxley, Aldous. 1932. *Brave New World.* London: Chatto and Windus.

Narayan, R. K. 1976. *The Painter of Signs.* London: William Heinemann.

Peacock, Thomas Love. [1817] 1948. *Melincourt.* In *The Novels of Thomas Love Peacock.* London: Rupert Hart-Davis.

Shriver, Lionel. 1994. *Game Control.* London: Faber and Faber.

Stapledon, Olaf. 1968. *Last and First Men.* New York: Dover Publications.

Yarbro, Chelsea Quinn. 1976. *The Time of the Fourth Horseman.* New York: Doubleday.

OTHER REFERENCES.

Kuijsten, Anton. 1999. "Demografiction." In *The Joy of Demography and Other Disciplines: Essays in Honour of Dirk van de Kaa,* ed. Anton Kuijsten, Henk de Gans, and Henk de Feijter. Amsterdam: Nethurd Publications, Amsterdam.

Teitelbaum, Michael S., and Jay M. Winter. 1985. *Fear of Population Decline.* San Diego: Academic Press.

LIONEL SHRIVER

LONGITUDINAL DEMOGRAPHIC SURVEYS

Longitudinal surveys are surveys that involve repeated data collection from individuals over time. They are of two types: specific-purpose surveys and panel surveys. Specific-purpose surveys collect information on a topic-specific basis at successive times from comparable populations but *not* the same individuals. These kinds of surveys may generically be termed *longitudinal surveys,* and have historically represented the dominant form of longitudinal data collection. They are most appropriate for comparing, for example, changes in demographic, socioeconomic, social-psychological, or health behaviors or attitudes in populations or subgroups of populations over time. *Panel surveys* involve the repeated interviewing, over time, of the *same* individuals. Surveys of this type permit examination of transitions in individual behaviors, attributes, or attitudes over time, and of linkages over time at the individual level. Analytically, these two forms of data collection can often complement each other, and they each have distinctive strengths and weaknesses. The surveys discussed in this article—selected longitudinal surveys with substantial demographic content undertaken in the United States—are of both types.

In addition to the brief appended bibliography, on-line addresses are provided that give access to more detailed accounts of the surveys described.

Health- and Fertility-Related Surveys

National Health Interview Survey (NHIS). The NHIS, the main longitudinal health data collection activity in the United States, is a continuing cross-sectional (non-panel) national survey of the civilian, non institutional population. The survey, entailing personal interviews, is conducted by the Bureau of the Census for the National Institutes of Health. Information is collected annually from about 40,000 households and over 100,000 individuals on basic demographics, illnesses, injuries, impairments, chronic conditions, activity limitations, utilization of health services, and other health topics. The survey has been conducted annually since 1957, although it has undergone several major changes. Since 1995, black and Hispanic households have been over-sampled. That is, they are over-represented in the survey compared to their actual representation in the population, in order to ensure sufficient numbers for statistically reliable group comparisons. A core questionnaire is completed each year including information of the type noted above; periodically, modules on selected topics such as disease prevention or cancer are added. The core questionnaire includes a basic family questionnaire, an adult questionnaire, a child questionnaire (information is collected from an adult), and a child immunization questionnaire.

The National Survey of Family Growth (NSFG). The NSFG collects detailed information about family relationships and fertility-related experiences from a representative national sample of adults of childbearing age. Five rounds were held from 1973 to 1995, covering only female respondents. Beginning with the sixth round in (2002), the sample (some 19,000 respondents) includes males. The sampling frame is the same as for the NHIS. Public user files for past rounds of the survey are available.

The National Health and Nutrition Examination Survey (NHANES). In contrast with the NHIS survey, NHANES focuses more directly on the collection of health measurement statistics. This survey has gone through several cycles. From 1960 through 1970, three National Health Examination Surveys (the name that it was known by prior to 1999) were conducted, covering (sequentially) chronic adult diseases, early and later childhood growth and development. Beginning in 1970, a new emphasis on health and nutrition was introduced, and increasing attention was given to over-sampling of minority groups in the population. Since 1999, NHANES has been an annual survey in which about 5,000 respondents are interviewed in each round. It entails detailed household interviews, physical examinations, and health and dietary interviews. Its data can be linked to related surveys such as the NHIS.

National Longitudinal Study of Adolescent Health (Add Health). Add Health is a panel survey of the health-related behaviors of adolescents who were in grades 7 through 12 as of the first survey wave (1994–1995). It is a fully representative national survey that focuses on adolescent sexuality, its social, psychological, and physiological correlates, and to some degree its determinants. Its premise is that families, friends, schools, and communities can encourage healthy or unhealthy behaviors among adolescents. In wave one, data were collected directly from about 90,000 youths in randomly selected schools in 80 U.S. communities. Three follow-up waves focused on a sub-sample of 20,000, who were interviewed at home—the last of them in 2001 to 2002, when the respondents were 18 to 25 years of age. Additional follow-up surveys are planned. Supplementary data collection from parents, school personnel, and siblings was also conducted. The sample includes a substantial number of minority youth. Public-use Add Health data are distributed by the Sociometrics Corporation on its web site.

Employment- and Income-Focused Surveys

The Current Population Survey (CPS). The CPS is a nationwide survey of about 50,000 to 60,000 civilian non-institutional households conducted monthly for the U.S. Bureau of Labor Statistics (BLS) by the Bureau of the Census. Dating from the 1940s, the CPS provides a continuous profile of the changing American population and is the primary source of information on the employment characteristics of the population. In addition to the core monthly employment and unemployment data, this survey also collects extensive demographic, social, and economic data. Recent CPS outputs of general interest include an annual demographic supplement that includes statistics on work experience over the year, income, migration, and household composition, and periodical supplements on race and ethnicity (in 1995 and 2000), marital history (1995), fertility (2000), and school enrollment (annually in October). Special topics vary from year to year, depending on current issues of interest to government agencies. While the CPS is usually thought of as a continuing cross-sectional survey, it also has some short-term panel qualities. Households selected for inclusion remain in the survey for four months, are skipped for eight months, and then return for an additional four months; hence, a relatively large sample is available for short-term panel analyses.

The Panel Study of Income Dynamics (PSID). The PSID, begun in 1968, is essentially a longitudinal survey of a representative national sample of United States population, and the households in which they reside. The study is conducted by the Survey Research Center at the University of Michigan. It emphasizes the dynamic aspects of economic and demographic behavior, but its content includes explanatory and outcome measures drawn from several disciplines. PSID has sought to maintain continuity over time in the collection of basic data items, especially on the source and amount of income, family structure and demographic behavior, labor market activity, housing, and geographic mobility. Occasional survey supplements have covered such topics as wealth accumulation, neighborhood characteristics, health care, and child development.

The sampling methodology for the PSID is complex. For example, adults who form their own families become respondent units in subsequent rounds. Largely as a result of this, the sample size grew from 4,800 families in 1968 to over 7,000 by 2001. Since 1997, the survey has been conducted biennially.

The child development study, begun in 1997, involves a sub-sample of about 3,500 children, providing detailed information on care-giving, within-family time use of children, and selected measures of children's cognitive, emotional, and behavioral development—all of which can be readily linked with the main PSID data file. PSID data are available to public users on the Internet.

The National Longitudinal Surveys (NLS). NLS is a generic term that encompasses a set of longitudinal panel surveys that have been conducted since 1966. Data were still being collected regarding four cohorts in 2002: (1) women who were 14 to 24 when first interviewed in 1968 or 30 to 44 in 1967—about 5,300 women; (2) men and women 14 to 21 in 1978—about 8,000 persons; (3) younger and older children of the NLSY79 female respondents—about 8,000 subjects; and (4) men and women ages 12 to 16 when first interviewed in 1997—about 8,000 subjects. Other than the child data collected in the NLSY97 survey, all these surveys focused on labor market dynamics. Their data also cover a wide range of complementary behavioral and attitudinal data on education, training, and family and household structure, enabling researchers to explore linkages between dimensions of employment and other factors. The 1979 survey's child data included in-depth information on psychometrics and other dimensions of child development. Information and data for these surveys are available from the Center for Human Resource Research at Ohio State University on its website.

Survey of Income and Program Participation (SIPP). SIPP is a continuing series of national panel surveys undertaken by the Bureau of the Census, designed to collect data on income, labor force, participation in government transfer programs, and general demographic conditions. Sample sizes range from 14,000 to 36,000 households. The survey is built around a core of labor force, program participation, and income questions. At its outset in 1984, SIPP was intended to measure the effectiveness of transfer programs; over time, it has evolved to become more of an omnibus survey that meets a wide range of research objectives. Topical modules have included personal histories, childcare and support, and school enrollment. Public use data for selected waves of the survey are available, and additional information may be found on the Internet.

An add-on to SIPP is the Survey of Program Dynamics (SPD), conducted from 1997 through 2002 with a sample of 18,000 households. The SPD survey includes an extensive set of questions regarding the children of the interviewed adult—questions on schooling, health, and child-focused activities—and a self-report from adolescent children about a wide range of their activities and behaviors.

Education Surveys

NLS–72/HS&B/NELS:88. Three longitudinal studies of youth, essentially covering the years since 1972, are panel surveys that follow a series of high school cohorts over time. These surveys are: (1) The High School Class of 1972 (NLS–72), a national sample of about 19,000 high school students followed from when they were seniors through 1986; (2) The High School and Beyond survey (HS&B), a sample from the class of 1980 initially comprising about 30,000 sophomores (followed to 1992) and 12,000 seniors (followed to 1986); and (3) The National Education Longitudinal Survey, 1988 (NELS:88) that followed about 18,500 8th graders from 1988 to 2000. These surveys collected detailed information about school progression and transitions to the work force, and a variety of demographic and family information.

Early Childhood Longitudinal Study (ECLS). The aim of these two panel surveys is to provide data on child development from infancy to the beginning of adolescence. The *kindergarten* component follows a nationally representative sample of about 22,000 children who attended kindergarten from 1998 to 1999 through the fifth grade; the *birth cohort* component follows 13,500 children born in 2001 from nine months of age through first grade. Both surveys examine the effects of family, school, community, and individual characteristics on a child's development. The samples include significant minority representation.

Aging Surveys/Family Processes Surveys

The Longitudinal Study of Aging. This panel survey was initiated in 1984 as a supplement on aging (SOA) to the NHIS. It included about 7,500 persons aged 70 and over, and reinterviews were conducted with most respondents in 1986, 1988, and 1990. The primary objective was to obtain data to (1) describe the continuum of movement from functional independence through dependence, including institutionalization and death; and (2) provide morbidity and mortality statistics by various demographic characteristics. These individual interview data have been linked with various other data files from the NHIS, and other forms of available records. The data are available on CD ROM.

Health and Retirement Study (HRS)/Study of Assets and Health Dynamics Among the Oldest Old (AHEAD). The HRS, a panel survey, was initiated by the National Institute on Aging in 1990. The first data collection wave in 1992 included over 12,600 persons in 7,600 households who were members of the 1931 to 1941 birth cohort. The sample includes an over-representation of minority respondents. The core sample has been reinterviewed at two-year intervals. The interviews cover health, retirement behavior and plans, family structure, income and employment, and related topics. The data can be linked with several administrative data sets including social security earnings data and the national death index.

Beginning in 1993, a parallel survey of 7,447 respondents (and spouses) aged 70 and over, the AHEAD study, was initiated. Additional birth cohorts have been added to this data set since its inception, and in 1998 the AHEAD and HRS samples were merged. The data are collected by the Survey Research Center at the University of Michigan.

National Survey of Families and Households (NSFH). This panel survey represents a first attempt to comprehensively interview a large nationally representative sample of the population about behaviors, attributes, and attitudes regarding a full range of family-linked activities for a wide variety of family types. Personal interview waves were conducted in 1987 to 1988, 1992 to 1993, and 2001 to 2002. The first wave includes 13,007 respondents in 9,637 households, with an over-representation of minority household units, single-parent families, families with step-children, cohabiting couples, and recently married persons, as well as selected *focal children* in the household. The second wave followed up on a large proportion of the original respondents, current and past spouses, partners and other core family members. The third wave consists of telephone interviews with a subset of the second wave respondents. The large sample size for family units undergoing transitions, in conjunction with the depth of behavioral and attitudinal detail, permit comprehensive examination of family processes and transitions.

See also: *Census; Databases, Demographic; Demographic Surveys, History and Methodology of.*

BIBLIOGRAPHY

Bureau of Labor Statistics, U.S. Department of Labor. 2002. *The National Longitudinal Surveys Handbook.* Columbus: Center for Human Resource Research, Ohio State University.

Carley, M. L., K. L. Muller, E. A. McKean, and E. L. Lang. 1997. *National Survey of Family Growth: Cycle V, 1995: A User's Guide to the Machine-Readable Files and Documentation.* (Data Set N8–O5). Los Altos, CA: Sociometrics Corporation, Data Archive on Adolescent Pregnancy and Pregnancy Prevention.

Curtain, T. R., S. J. Ingels, S. Wu, and R. Heuer. 2002. *National Education Longitudinal Study of 1988, Base Year to Fourth Follow-Up Data File User's Manua* (NCES 2002–323). U.S. Department of Education. Washington, D.C.: National Center for Education Statistics. Retrieved from

National Education Longitudinal Study: 1988–2000 Data Files and Electronic Codebook System—Base Year through Fourth Follow Up ECB/CD-ROM, Public Use.

Hill, Martha S. 1992. *The Panel Study of Income Dynamics: A User's Guide.* Newbury Park, CA: Sage Publications.

Kelley, M. S., and J. L. Peterson. 1997. *The National Longitudinal Study of Adolescent Health (Add Health), Waves I and II, 1994-1996: A User's Guide to the Machine-Readable Files and Documentation* (Data Sets 48–50, 98, A1–A3). Los Altos, CA: Sociometrics Corporation, American Family Data Archive.

U.S. Department of Education, National Center for Education Statistics. 2000. *National Education Longitudinal Study: 1988–2000 Data Files and Electronic Codebook System—Base Year through Fourth Follow-Up ECB/CD-ROM, Public Use.* [NCES 2002–322 CD-ROM]. Washington, D.C.: U.S. Department of Education, National Center for Education Statistics.

Westat. 2001. *Survey of Income and Program Participation Users' Guide Third Edition.* Washington, D.C.: Mathematica Policy Research.

Zill, Nicholas, and Margaret Daly, eds. 1993. *Researching the Family: A Guide to Survey and Statistical Data on U.S. Families.* Washington, D.C.: Child Trends.

INTERNET RESOURCES.

Child Development Supplement to the Panel Study of Income Dynamics. Sponsor: National Institute of Child Health and Human Development. <http://www.isr.umich.edu/src/child-development/home.html/>.

Current Population Survey. Bureau of Labor Statistics and Bureau of the Census. <http://www.bls.census.gov/cps//>.

Early Childhood Longitudinal Study. National Center for Educational Statistics. <http://www.nces.ed.gov/ecls/>.

Health and Retirement Study: A Longitudinal Study of Health, Retirement, and Aging Sponsored by the National Institute of Aging. Institute for Social Research, University of Michigan. <http://www.umich.edu/~hrswww>.

High School and Beyond: Overview. National Center for Education Statistics. <http://nces.ed.gov/surveys/hsb//>.

National Center for Health Statistics: Monitoring the Nations Health. Centers for Disease Control and Prevention (CDC). <http://www.cdc.gov/nchs/nhis.htm/>.

National Center for Health Statistics: Monitoring the Nations Health. Centers for Disease Control and Prevention (CDC). <http://www.cdc.gov/nchs/about/major/nsfg/nsfgback.htm/>.

National Center for Health Statistics: Monitoring the Nations Health. Centers for Disease Control and Prevention (CDC). <http://www.cdc.gov/nchs/nhanes.htm/>.

National Education Longitudinal Study of 1988: NELS 88 Overview. National Center for Education Statistics. <http://nces.ed.gov/surveys/nels88//>.

National Longitudinal Survey of the High School Class of 1972: Overview. National Center for Education Statistics. <http://nces.ed.gov/surveys/nls72//>.

National Survey of Families and Households. NICHD and NIA. <http://www.ssc.wisc.edu/nsfh/>.

Ohio State University Center for Human Resource Research. Ohio State University. <http://www.chrr.ohio-state.edu//>.

Overview of the Panel Study of Income Dynamics. National Science Foundation. <http://www.isr.umich.edu/src/psid/overview.html/>.

Research Design, Facts at a Glance. AddHealth. <http://www.cpc.unc.edu/addhealth/facts.html/>.

Research Practice Feedback. Sociometrics Corporation. <http://www.socio.com/>.

United States Census Bureau. <http://www.sipp.census.gov/sipp/>.

FRANK MOTT
THOMAS GRYN

LÖSCH, AUGUST

(1906–1945)

German economist and pioneer of locational analysis, August Lösch grew up in Heidenheim, Württemberg, Germany. He studied economics in Freiburg with Walter Eucken, and in Bonn, and later at Harvard, with Joseph Schumpeter. From 1940 to 1945 he served as a research director at the Kiel Institute for Global Economics. Some of Lösch's early research was concerned with the interaction of demographic and economic change, in particular, the effect of population on the business cycle. The work for which he is best known, however, is *The Economics of Location* (1940, American edition 1954), which applies general equilibrium theory to a spatially distributed economy.

Lösch used modern theoretical and statistical approaches to explore the impact of population change on economic cycles. Initially he believed that falling birth rates were disadvantageous to economic growth, as did most of his contemporaries. But his empirical investigations seemed to prove the contrary: population growth resulted in high costs to the national economy, while reduced population growth rates would potentially save capital for further investments. He buttressed his arguments by elaborate empirical investigations of demographic and economic growth in nineteenth-century Germany. One conclusion he reached, again contrary to general judgement, was that population change was more a cause than a consequence of business cycles. He propounded his findings in numerous articles, and in a 1936 lecture in Chicago, published the following year in the *Quarterly Journal of Economics,* where he also attacked the views of Raymond Pearl (1879–1940) and Corrado Gini (1884–1965) on population growth.

In his analyses Lösch started with as few assumptions as possible, establishing in theoretical terms in the manner of the classic pioneer of locational modelling, Johann Heinrich von Thünen (1783–1850), how characteristics of production and trade would give rise to spatial patterns of settlement. He concluded that this pattern must exhibit a hexagonal and hierarchical structure, which turned out to coincide with observed patterns. The study became one of the starting points of the field of Regional Science in the 1960s. Lösch's work on locational systems can be seen as a formal counterpart to that of the geographer Walter Christaller (1893–1969).

Historians have investigated how various aspects of Nazi policy were influenced by scientific knowledge, including findings from demography and economics. Lösch's work is sometimes mentioned in this context: his theoretical concepts were used in planning the intended settlement structure in Eastern Europe. But Lösch himself was strongly opposed to Nazi policies, even refusing to embark on a university career because he believed German universities had been corrupted by the regime. Unfortunately he did not live to participate in their restoration.

See also: *Central Place Theory.*

BIBLIOGRAPHY

SELECTED WORKS BY AUGUST LÖSCH.

Lösch, August. 1932. *Was ist vom Geburtenrückgang zu halten?* Dissertation, Bonn University.

———. 1937. "Population Cycles as a Cause of Business Cycles." *Quarterly Journal of Economics* 51: 649–662.

———. 1940. *Die räumliche Ordnung der Wirtschaft.* Jena: G. Fischer. English translation (of the 2nd rev. ed.): *The Economics of Location.* New Haven: Yale University Press, 1954.

SELECTED WORKS ABOUT AUGUST LÖSCH.

Christaller, Walter. 1933. *Die zentralen Orte in Süddeutschland.* Jena: Gustav Fischer. (Partial English translation: 1966. *Central Places in Southern Germany.* Prentice Hall).

———. 1941. "Raumtheorie und Raumordnung." *Archiv für Wirtschaftsplanung.* Vol. I. 116–3.

Felderer, Bernhard. 1990. "A Theory Explaining Lösch-Cycles," In *Infrastructure and the Space-Economy – in Honour of Rolf Funck,* ed. Karin Peschel. Berlin: Springer.

Funck, Rolf, and J. B. Parr, eds. 1978. *The Analysis of Regional Structure: Essays in Honour of August Lösch.* London: Pion. (Karlsruhe Papers in Regional Science, Vol. 2.)

Funck, Rolf H., and Antoni Kuklinski, eds. 1986. *Space-Structure-Economy: A Tribute to August Lösch.* Karlsruhe: von Loeper. (Karlsruhe Papers in Economic Policy Research, Vol. 3.)

Mackensen, Rainer. 1990."August Lösch as a Population Analyst," In *Infrastructure and the Space-Economy—in Honour of Rolf Funck,* ed. Karin Peschel. Berlin: Springer.

Preston, R. E. 1985. "Christaller's Neglected Contribution to the Study of the Evolution of Central Places," *Progress in Human Geography* 9: 177–193.

Stolper, Wolfgang F. 1954. "August Lösch in memoriam," Preface to the American edition of *The Economics of Location.* New Haven: Yale University Press.

Valavanis, Stefan. 1955. "Lösch on Location." *American Economic Review* 45: 637–644.

RAINER MACKENSEN

LOTKA, ALFRED J.

(1880–1949)

Alfred James Lotka was born in Galicia, in a city that was then part of the Austrian empire known as Lemberg, and which is now known as L'viv in Ukraine. Lotka's parents, Jacques and Marie (Doebely) Lotka, were U.S. citizens. He grew up in France and studied chemistry, physics and mathematics at Birmingham University in England, the University of Leipzig in Germany, and Cornell University in the United States, earning a D.Sc. from Birmingham in 1912. In 1902, he moved to the United States, where he spent most of the rest of his life. After working as an industrial chemist and at various other jobs, he held a temporary research appointment from 1922 to 1924 in American biometrician and eugenist Raymond Pearl's group at Johns Hopkins University. Lotka worked for the Metropolitian Life Insurance Company in New York City from 1924 until his retirement in 1948. Two months before his 55th birthday he married Romola Beattie; they had no children. He was president of the Population Association of America (1938–1939) and of the American Statistical Association (1943).

Lotka's concept of population embraced molecules, equipment, rotifers, Drosophila, humans, interacting species, interacting genotypes, and publications. He developed a powerful mathematical armamentarium for analyzing populations. He remains the population scientist nonpareil, whose five books and more than 100 papers not only shaped demography, the core population-science discipline, but also advanced ecology, evolutionary biology, epidemiology, economics, operations research, and chemistry among other subjects. Although the clarity and charm of his writings make them highly accessible to the reader, their range and profundity demand careful study. Most of the mathematical theory of population developed subsequently by other scientists is still best described as footnotes to Lotka's work.

While at Johns Hopkins University, Lotka completed his multifaceted book, *Elements of Physical Biology* (1925). Lotka's use of systems of differential equations, his emphasis on comparative statics and his focus on maximal principles and the stability of equilibria led to penetrating insights and opened new analytical perspectives.

A second book, *Théorie Analytique des Associations Biologiques,* was published in two parts (1934 and 1939). The second part focuses on demographic analysis with special application to humans. It lays out the three basic equations of Lotka's theory of stable populations:

$$b = 1 / \int_0^\omega e^{-ra}\, p(a)da,$$

$$c(a) = be^{-ra}\, p(a),$$

and

$$1 = \int_0^\omega e^{-ra}\, p(a)m(a)da,$$

as well as the general renewal equation:

$$B(t) = \int_0^\omega B(t–a)p(a)m(a)da,$$

where the population is closed to migration and consists of "a large number of essentially similar units" (e.g., human females) and where a is age, b is the birth rate, r is the population growth rate, $c(a)$

is the proportion of the population at age *a*, $p(a)$ is the probability of survival from birth to age *a*, $m(a)$ is the maternity rate or rate of reproduction at age *a*, and $B(t)$ is the number of births at time *t*, and ω is an upper limit on age. These equations have been of fundamental importance to demographic theory and application. Lotka's research on the renewal equation began in 1908 at Cornell University in collaboration with Professor F. R. Sharpe.

Lotka devoted much thought to cyclical processes, from simple predator-prey interactions to global physico-chemical-biological systems. His research on the former led to the Lotka-Volterra equations used in ecology; his thinking about the latter anticipates current concerns about environmental stability.

The range of Lotka's interests is suggested by his study of the number of authors with *n* publications in lengthy bibliographies, such as Chemical Abstracts. He found that the probability of *n* is approximately $6/(\pi n)^2$, which implies that three-fifths of the authors listed contribute one article, 15 percent contribute two articles, and only a one-quarter contribute more than two.

See also: *Biology, Population; Demography, History of; Renewal Theory and the Stable Population Model.*

BIBLIOGRAPHY

SELECTED WORKS BY ALFRED LOTKA.

Lotka, Alfred J. [1906] 1977. "Relation Between Birth Rates and Death Rates." In *Mathematical Demography: Selected Papers,* ed. D. Smith and Nathan Keyfitz. Berlin: Springer-Verlag.

———. [1922] 1977. "The Stability of the Normal Age Distribution." In *Mathematical Demography: Selected Papers,* ed. D. Smith and Nathan Keyfitz. Berlin: Springer-Verlag.

———. 1925. *Elements of Physical Biology.* Baltimore: Williams & Wilkins. Reprinted as *Elements of Mathematical Biology* (1956). New York: Dover Publications.

———. 1926. "The Frequency Distribution of Scientific Productivity." *Journal of the Washington Academy of Sciences* 16: 317–323.

———. 1934, 1939. *Théorie Analytique des Associations Biologiques.* Paris: Hermann et Cie.

———. 1998. *Analytical Theory of Biological Populations,* (Théorie Analytique des Associations Biologiques) trans. David P. Smith and Helene Rossert (New York: Plenum Press.).

Sharpe, F. R., and Alfred J. Lotka. [1911] 1977. "A Problem in Age-Distribution." In *Mathematical Demography: Selected Papers,* ed. D. Smith and Nathan Keyfitz. Berlin: Springer-Verlag.

SELECTED WORKS ABOUT ALFRED LOTKA.

Arthur, W. Brian, and James W. Vaupel. 1984. "Some General Relationships in Population Dynamics." *Population Index* 50(2): 214–226.

Samuelson, Paul A. 1977. "Resolving a Historical Confusion in Population Analysis." In *Mathematical Demography: Selected Papers,* ed. David Smith and Nathan Keyfitz. Berlin: Springer-Verlag.

Simon, Herbert A. 1959. "Review of Elements of Mathematical Biology by Alfred J. Lotka." *Econometrica* 27(3): 493–495.

James W. Vaupel

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MALTHUS, THOMAS ROBERT

(1766–1834)

Thomas Robert Malthus was a demographer, political economist, and Christian moral scientist. He was educated privately up to the age of 16 and then sent to a dissenting academy prior to entry into Cambridge, where, from 1784 to 1788, he undertook the course of studies designed to prepare him as a clergyman in the Church of England. These studies centered on theology, history, and mathematics, including Newtonian mechanics. Malthus first became a curate near the family home in Surrey, later adding a living in Lincolnshire. He retained these livings when he was appointed to a professorship at the East India College, Haileybury, in 1805, the post he held for the rest of his life.

It was during his initial period as a rural clergyman that Malthus composed his first published work: *An Essay on the Principle of Population as it affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Godwin, M. Condorcet, and other Writers,* published in 1798. This anonymous work was originally intended to cast doubt on the doctrine of human perfectibility. By invoking a well-established principle, that population always expands in response to improvements in the supply of subsistence goods, Malthus showed that any attempt to create an ideal society in which altruism and common property rights prevailed would be undermined by its inability to cope with the resulting population pressure. In a context dominated by the hopes aroused by the French Revolution, this amounted to an assertion of the greater power of bioeconomic factors over human agency.

Malthus gave mathematical form to the principle by contrasting a maximum potential rate of population increase, the geometric ratio, with a posited arithmetic rate of increase in subsistence. But this deductive framework had an empirical foundation. Malthus employed Benjamin Franklin's figures for the increase in American population, under conditions in which subsistence posed no limits, to demonstrate that doubling was possible within 25 years. By contrast with his opponents he believed that his conclusions were the result of following a Newtonian procedure of arguing from observed effects to possible causes, rather than by speculating about the possible effects of known causes.

At this stage, Malthus had not yet reached the level of analysis that would later lead him to be called the founding father of modern demography. Indeed, his estimates of the rate of increase in the British population, like those of most of his contemporaries, were wide of the mark. He believed that it was doubling every 200 years, when it became clear, after the first census evidence collected from 1801 onwards, that it was doing so every 55 years. Thus, although Malthus was an acute observer of rural poverty, he was not, initially at least, reacting to the rapid population increase researchers now know to have been taking place. The special quality of his findings can be found in his contention that population pressure on living standards was "imminent and immediate." His opponents had maintained that while agriculture was in its present underdeveloped state there was no population problem. Although population pressure might threaten living standards at some distant point in the future, it would then be possible to remedy this by improvements in technology and recourse to birth control. Malthus, by contrast, held that the living standards of those who lived by labor had always been, and would remain, under pressure; that positive checks affecting mortality rates were still in operation in most parts of the world; and that preventive checks affecting marriage habits and birth rates were currently in operation in Western Europe and North America.

It followed from the immediacy of the population principle that attention needed to be focused on the way in which these checks operated to maintain the balance between population and available subsistence. In the polemical first edition of his *Essay,* Malthus treated all forms of check as varieties of "misery and vice." In the second much larger and more thoroughly empirical version published in 1803, commonly called the *Second Essay,* he introduced the idea of a virtuous check—moral restraint. This entailed postponement of marriage together with strict sexual continence during the waiting period. The second essay bore a new subtitle that signaled Malthus's endorsement of more positive solutions, partly via encouragements to individual prudence, partly via changes in social and political institutions. It became *An Essay on the Principle of Population; or a View of Its Past and Present Effects on Human Happiness; with an Inquiry into our Prospects respecting the Future Removal or Mitigation of the Evils which It Occasions.*

As a Christian moralist, Malthus thought it was his task to propose checks and institutional reforms that would reduce the harmful effect of population pressure on morals and happiness, even where this involved choosing the lesser of two evils. Since Malthus regarded birth control within marriage as a vicious practice, he cannot be described as a neo-Malthusian, the position adopted by many of his secular-minded followers. Prudishness plays no part here: he was opposed to birth control on the grounds that such "unnatural" expedients ran contrary to God's beneficent design in placing humankind under the right degree of pressure to ensure its development. It follows that use of the term "Malthusian devil" (as some have characterized what they consider the pessimistic aspects of Malthus's theories) is peculiarly inappropriate as a description of Malthus's own way of thinking. There had to be a reason why a beneficent Providence had endowed humanity with the sexual passion. It was to provide a spur to advance civilization by finding those means of living with its consequences that were consonant with human kind's long-term happiness. It also follows that Malthus was not an anti-populationist (that is, he did not oppose an increase in population or advocate a decrease) but rather, was a theorist of optimal population growth, inquiring into that relationship between the various physical and moral variables that would produce the best result. For this reason it is not entirely anachronistic to describe him as an early theorist of sustainable development.

Although Malthus was accused of propounding a form of bioeconomic determinism that ignored cultural variables, his mature procedure belies this charge. Once possessed of a fundamental natural law, inquiry could be centered on the surrounding circumstances—social, economic, and cultural—that determined how the law operated in any given setting. By appealing to the evidence provided by historians of the ancient world, and anthropological findings based on travel literature, as well as the new census material and other inquiries into the condition of the poor, Malthus established himself as a demographer in the modern vein: someone committed not merely to an examination of the relationship between births, deaths, and marriages, but to the cultural factors brought to light by other evidence on modes of life.

Studies of the response of population to wages and prices entailed lags that could generate cycles or fluctuations, during which there would be periods of maladjustment and market disequilibrium. Malthus was more impressed by these "irregular movements" than his friend and rival economist, David Ricardo: hence many of the disagreements over the causes of economic growth and the reasons for post-war depression that feature in their correspondence and in Malthus's attempt to provide an alternative to Ricardian economics in his *Principles of Political Economy* of 1820. This also explains J. M. Keynes's interest in Malthus in the 1920s and 1930s when he was formulating his own attack on economic orthodoxy.

Historical demographers have added greatly to our understanding by stressing the agrarian or essentially pre-industrial nature of Malthus's analysis of population problems. His arithmetic ratio became the basis for the law of diminishing returns, a proposition that dominated political economy up to John Stuart Mill, and has made a reappearance in the works of ecologists concerned with the global limits to growth. Malthus was one of the first to recognize the significance of what became known as the Western European marriage system of delayed marriage and hence lower birth rates. He also came to recognize one of the main features of the demographic transition. Higher incomes might lead not to more children, but to more goods and leisure. Comforts and luxuries could bring with them a desire to protect high and rising standards of living.

See also: *Condorcet, Marquis de; Demography, History of; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY THOMAS ROBERT MALTHUS.

Malthus, Thomas Robert. [1803] 1989. *An Essay on the Principle of Population* (with the variora of 1806, 1807, 1817, 1826), ed. Patricia James. Cambridge, Eng.: Cambridge University Press.

———. [1820] 1989. *Principles of Political Economy,* ed. John Pullen. Cambridge, Eng.: Cambridge University Press.

SELECTED WORKS ABOUT THOMAS ROBERT MALTHUS.

Coleman, David, and Roger Schofield, eds. 1986. *The State of Population Theory; Forward from Malthus.* Oxford: Blackwell.

James, Patricia. 1979. *Population Malthus; His Life and Times.* London: Routledge and Kegan Paul.

Petersen, William. 1999. *Malthus: Founder of Modern Demography.* New Brunswick, NJ: Transaction Publishers. (Originally published by Harvard University Press, 1979.)

Winch, Donald. 1987. *Malthus.* Oxford: Oxford University Press.

Wrigley, E. A., and David Souden, eds. 1986. *The Works of Thomas Robert Malthus* (8 volumes). London: William Pickering.

Donald Winch

MARRIAGE

Marriage is a legal contract between two individuals to form a sexual, productive, and reproductive union. Through the marriage, this union is recognized by family, society, religious institutions, and the legal system. Marriage defines the relationship of the two individuals to each other, to any children they might have, to their extended families, and to society generally. It also defines the relationship of others, including social institutions, toward the married couple. Fundamental features of marriage include: a legally-binding, long-term contract; sexual exclusivity; coresidence; shared resources; and joint production. Spouses acquire rights and responsibilities with marriage, enforceable through both the legal system and through social expectations and social pressure.

Legal Aspects of Marriage

Marriage differs from other less formal relationships primarily in its legal status. Marriage is a legally-binding contract. Historically, both secular and religious law generally viewed marriage vows as binding and permanent. The contract could be broken only if one spouse violated the most basic obligations to the other and could be judged "at fault" in the breakdown of the marriage. Social changes lead, however, to shifts in the legal underpinning of marriage and, in turn, the legal treatment of marriage shapes the institution.

Changes in family law in many high-income countries appear to have made marriage less stable, as exemplified in the U.S. experience. Beginning in the mid-1960s, state governments in the United States substantially liberalized and simplified their divorce laws. One important feature of these changes was a shift from divorce based on fault or mutual consent to unilateral divorce, which required the willingness of only one spouse to end the marriage. Most states also adopted some form of "no-fault" divorce, which eliminated the need for one spouse to demonstrate a violation of the marriage contract by the other. The shift to unilateral or no-fault divorce laws in the United States was accompanied by a surge in divorce rates. The scholar Leora Friedberg has found that at least some of the increase in divorce rates resulted directly from the shift in the legal environment in which couples marry and decide to divorce or remain married. The link between divorce rates and laws that permit unilateral divorce has led several states to develop alternative, more binding, marriage contracts, such as "covenant marriage."

Fundamental Features of the Institution

According to Linda J. Waite and Maggie Gallagher, permanence, joint production, coresidence, and the social recognition of a sexual and childrearing union are the most important characteristics of the institution of marriage. These features lead to some of the other defining characteristics of marriage. Because two adults make a legally-binding promise to live and work together for their joint well-being, and to do so, ideally, for the rest of their lives, married couples tend to *specialize,* dividing between them the labor required to maintain the family. The coresidence and resource sharing of married couples have substantial economies of scale; at any standard of living, it costs much less for people to live together than it would if they lived separately. Both these economies of scale and the specialization of spouses increase the economic well-being of family members living together.

The institution of marriage assumes the sharing of economic and social resources and *co-insurance.* Spouses act as a small insurance pool against life's uncertainties, reducing their need to act individually to protect themselves against unexpected events. Marriage also connects spouses and family members to a larger network of help, support, and obligation through their extended family, friends, and others. The insurance function of marriage increases the economic well-being of family members. The support function of marriage improves married people's emotional well-being.

The institution of marriage also builds on and fosters trust. Since spouses share social and economic resources, and expect to do so over the long term, both partners gain when the family unit gains. This reduces the need for family members to monitor the behavior of other members, increasing efficiency.

Benefits of Marriage

The specialization, economies of scale, and insurance functions of marriage typically yield a substantial increase in the economic well-being of family members. Joseph Lupton and James P. Smith noted in their 2003 article that married people generally produce more and accumulate more assets than unmarried people. Married people also tend to have better physical and emotional health than single people. This is at least in part because they are married: the social support provided by a spouse, combined with the economic resources produced by the marriage, facilitates both the production and maintenance of health.

In most societies, sexual relationships largely take place within marriage. Edward O. Laumann, John H. Gagnon, Robert T. Michael, and Stuart Michaels provide an analysis of data from the United States that indicates that almost all married men and women are sexually active, and almost all have only one sex partner—their spouse. Unmarried men and women have much lower levels of sexual activity than the married, in part because a substantial minority have no sex partner (survey data indicate that just under a quarter of unmarried men and a third of unmarried women who were not cohabiting had no sex partner in the year preceding the survey). Men and women who are cohabiting are at least as sexually active as those who are married, but are less likely to be sexually exclusive.

One central function of marriage is the bearing and raising of children. The institution of marriage directs the resources of the spouses and their extended families toward the couple's children, increasing child well-being.

Age at Marriage

In the United States and much of Europe age at marriage generally declined in the first half of the twentieth century, but then rose strongly, reaching levels not seen earlier in the century. Jason Fields and Lynne Casper noted in their 2001 study that between 1970 and 2000 the median age of first marriage for women in the United States increased by almost five years, from 20.8 to 25.1, and for men the median age increased by almost four years, from 23.2 to 26.8. In this same time period, the proportion of women who had never been married increased from 36 percent to 73 percent among those 20 to 24 years old and from 6 percent to 22 percent among those 30 to 34 years old. Similar increases occurred for men.

The delay in first marriage was especially striking for African Americans, as highlighted in a 2000 study by Catherine A. Fitch and Stephen Ruggles. Among African Americans, the median age at first marriage in 2000 was 28.6 for men and 27.3 for women, a rise of six and seven years, respectively, since the 1960s. Among those African Americans 30 to 34 years old in 2000, 44 percent of women and 46 percent of men had never married.

Trends in age at marriage in Europe have been broadly similar, although marriage patterns differ substantially by country. Sweden, Denmark and Iceland show the highest average ages at marriage for women (around age 29); the Eastern European countries of Bulgaria, the Czech Republic, Hungary, and Poland show the lowest (around age 22). Since societies with relatively high age at marriage also tend to be those in which many people never marry, this diversity suggests that marriage is a more salient component of family in some European countries than others.

Marriage typically takes place at younger ages in the developing countries of Africa, Asia, and Latin America. The average mean age at marriage in these regions is 25 for men and 21 for women, compared to almost 28 for men and 25 for women in the developed countries. Everywhere men tend to marry at older ages than women, but the gap in average age at marriage between spouses varies both within and between regions. According to United Nations data, this gap tends to be largest where women marry relatively early.

Union Formation

Declines in marriage are closely linked to increases in cohabitation, although it is difficult to untangle the nature of the association. In the United States cohabitation has become an increasingly common step in the courtship process. R. Kelly Raley noted that while only 7 percent of the women born in the late 1940s cohabited before age 25, 55 percent of those born in the late 1960s had cohabited by that age. Most couples begin their intimate life together by cohabiting rather than by marrying: the form of union has changed, but unions remain the norm. But even considering marriage and cohabitation together, in the early-twenty-first century young adults are less likely to be in a union than those of earlier cohorts. Among women born in the late 1960s, about a third had not formed a union by age 25, compared to a quarter of those born in the early 1950s.

Kathleen Kiernan has documented rising cohabitation in Europe, but with large variation among countries. It is strikingly common in Denmark, Sweden, and Finland; France too shows fairly high levels, with about 30 percent of the women ages 25 to 29 in cohabiting unions. A group of countries that includes the Netherlands, Belgium, Great Britain, Germany, and Austria shows moderate levels of cohabitation—from 8 to 16 percent of women from 25 to 29 involved in this type of union. In the Southern European countries and Ireland cohabitation remains rare: less than 3 percent of women ages 25 to 29 cohabit with a partner.

In many European countries, the majority of women are in cohabitational or marital unions by their mid- to late twenties. In the Nordic countries and France, about a third of women ages 25 to 29 are cohabiting, a third are married, and a third are single. However, over 60 percent of women in Italy, 50 percent in Spain, and over 30 percent in Portugal and Greece are neither cohabiting nor married at these ages.

Proportion Married

A consequence of the trends discussed above is that a larger proportion of adults is unmarried in the early twenty-first century compared to the past. In the United States in 1970, unmarried people made up 28 percent of the adult population. In 2000, that proportion was 46 percent. (The shift away from marriage has been even more pronounced among African Americans.) In Europe, marriage is most common in Greece and Portugal, where over 60 percent of women ages 25 to 29 are married, and least common in the Nordic countries, Italy, and Spain, where a third or less are married.

Nevertheless, the vast majority of adults still marry at some time in their lives. In the United States, the proportion of people ever married by age 50 is more than 95 percent for both men and women. Relatively high proportions of men and women have not married by their late 40s in the Nordic countries and in Caribbean countries such as Jamaica and Barbados, with a long history of visiting relationships that include sexual relationships but not cohabitation. In Sweden, for example, 76 percent of men and 84 percent of women in their late forties had ever married, whereas in Jamaica, only 52 percent of men and 54 percent of women had ever married by these ages.

Marital Disruption and Union Dissolution

A substantial proportion of all marriages end in divorce or separation due to marital discord. The divorce rate, which reflects the number of divorces in a year relative to the number of married people, rose continuously for more than a century in the United States and many other industrialized countries, then leveled off at a fairly high rate in about 1980. In the

United States, around half of all marriages end in divorce. According to Waite and Lillard and scholars Teresa Castro Martin and Larry L. Bumpass, the marriages most at risk are those with no children, those with children from a previous union or older children, those begun at a young age, and those between partners with relatively low levels of education.

Although high divorce rates make marriages seem unstable, other types of unions are much more likely to dissolve. Cohabitational unions show quite high chances of disruption, with a quarter ending in separation within three to four years compared to only five percent of marriages, according to one 1995 study by Zheng Wu and T.R. Balakrishnan. Many cohabitations become marriages, but these show lower stability than marriages not preceded by cohabitation.

Alternative Family Structures

The married, two-parent family has been the most common family form in the United States and other industrialized countries for some centuries. But even when this form was most prevalent, many people lived in other types of families, typically because of the death of one member of the couple before all the children were grown. With high mortality, frequently one partner in a marriage would die relatively early, so remarriage and stepfamilies were common as were single-parent families. The rise of cohabitation and non-marital childbearing have meant that unmarried-couple families and never-married-mother families have become common alternative family forms.

One alternative family form consists of two adults of the same sex, sometimes raising children. In the United States, about 2.4 percent of men and 1.3 percent of women identify themselves as homosexual or bisexual and have same-gender partners. According to one estimate by Dan Black, Gary Gates, Seth Sanders, and Lowell Taylor, in 1990 about 1 percent of adult men lived with a male partner and about the same percentage of adult women lived with a female partner, though these may be underestimates since some of those living in a gay or lesbian union do not identify as such in surveys. Legal and social recognition of these unions as "marriages" is generally not available in the United States, although France has enacted national registered partnerships, Denmark extended child custody rights to same-sex couples, and in 2000 the Netherlands became the first country to grant same-sex couples full and equal rights to marriage.

See also: *Cohabitation; Divorce; Family: Future; Family Policy; Fertility, Proximate Determinants of; Partner Choice; Sexuality, Human.*

BIBLIOGRAPHY

Black, Dan, Gary Gates, Seth Sanders, and Lowell Taylor. 2000. "Demographics of the Gay and Lesbian Population in the United States: Evidence from Available Systematic Data Sources." *Demography* 37: 139–154.

Fields, Jason, and Lynne Casper. 2001. "America's Families and Living Arrangements: March 2000." *U.S. Census Bureau Current Population Reports,* 20–537.

Fitch, Catherine A., and Steven Ruggles. 2000. "Historical Trends in Marriage Formation: the United States 1850–1990." In *Ties that Bind: Perspectives on Marriage and Cohabitation,* ed. L. Waite, C. Bachrach, M. Hindin, E. Thomson, and A. Thornton. New York: Aldine de Gruyter.

Friedberg, Leora. 1998. "Did Unilateral Divorce Raise Divorce Rates? Evidence from Panel Data." *American Economic Review* 88: 608–627.

Kiernan, Kathleen. 2000. "European Perspectives on Union Formation." In *Ties that Bind: Perspectives on Marriage and Cohabitation,* ed. L. Waite, C. Bachrach, M. Hindin, E. Thomson, and A. Thornton. New York: Aldine de Gruyter.

Laumann, Edward O., John H. Gagnon, Robert T. Michael, and Stuart Michaels. 1994. *The Social Organization of Sexuality.* Chicago: University of Chicago.

Lupton, Joseph, and James P. Smith. 2003. "Marriage, Assets, and Savings." In *Marriage and the Economy,* ed. S. Grossbard-Shechtman. Cambridge, Eng.: Cambridge University Press.

Martin, Teresa Castro, and Larry L. Bumpass. 1989. "Recent Trends in Marital Disruption." *Demography* 32: 509–520.

Raley, R. Kelly. 2000. "Recent Trends in Marriage and Cohabitation." In *Ties that Bind: Perspectives on Marriage and Cohabitation,* ed. L. Waite, C. Bachrach, M. Hindin, E. Thomson, and A. Thornton. New York: Aldine de Gruyter.

United Nations. 2000. *Wall Chart on Marriage Patterns 2000.* New York: United Nations Department of Economic and Social Affairs, Population Division.

Waite, Linda J., and Lee A. Lillard. 1991. "Children and Marital Disruption." *American Journal of Sociology* 96: 930–953.

Waite, Linda J., and Maggie Gallagher. 2000. *The Case for Marriage: Why Married People are Happier, Healthier, and Better Off Financially.* New York: Doubleday.

Wu, Zheng, and T.R. Balakrishnan. 1995. "Dissolution of Premarital Cohabitation in Canada." *Demography* 32(4): 521–532.

LINDA J. WAITE

MARX, KARL

(1818–1883)

Karl Marx was born in Trier, Germany. He studied law in Bonn and Berlin and received his doctorate in 1841 at the University of Jena. Marx then devoted himself to the fields of classical philosophy and political economics. He earned his living as editor of the *Rheinische Zeitung* and as the author of various books and articles in which he analyzed the origins of industrial capitalism and its effects on the living conditions of the working classes. His scholarly studies were soon combined also with political activism, both often in collaboration with his life-long friend and supporter Frederic [Friedrich] Engels. Their most famous joint writing (albeit thought to be primarily Marx's), the *Communist Manifesto,* appeared in 1848, offering a summary of the Marxian theory of history as well as a political program statement. The first section of the *Manifesto* contains a compelling description of what today is called globalization—as a consequence of expanding capitalist markets. It also displays the literary verve characteristic of many of Marx's writings:

> The bourgeoisie has subjected the country to the rule of the towns. It has created enormous cities, has greatly increased the urban population as compared with the rural, and has thus rescued a considerable part of the population from the idiocy of rural life. . . . The bourgeoisie keeps more and more doing away with the scattered state of the population, of the means of production, and of property. It has agglomerated population, centralized means of production, and has concentrated property in a few hands. The necessary consequence of this was political centralization. Independent, or but loosely connected provinces, with separate interests, laws, governments and systems of taxation, became lumped together in one nation, with one government, one code of laws, one national class-interest, one frontier and one customs-tariff. The bourgeoisie, during its rule of scarce one hundred years, has created more massive and more colossal productive forces than have all preceding generations together. Subjection of Nature's forces to man, machinery. . . whole populations conjured out of the ground — what earlier century had even a presentiment that such productive forces slumbered in the lap of social labour?

Marx moved to London in 1849 working on his magnum opus, *Das Kapital,* the first volume of which appeared in 1867 and was soon translated into many languages, serving as an ideological rallying point for political action. The main passages in that work that specifically address population questions are in Chapter XXV, Section 3. They set out the thesis that capitalism generates and is dependent upon a constantly renewed surplus population—an industrial reserve army that leads to unemployment and immiseration—and present a critique of Malthusian population theory.

> The labouring population. . .produces, along with the accumulation of capital produced by it, the means by which itself is made relatively superfluous, is turned into a relative surplus-population; and it does this to an always increasing extent. This is a law of population peculiar to the capitalist mode of production; and in fact every special historic mode of production has its own special laws of population, historically valid within its limits alone.

The attack on Malthus is developed more elaborately in Section F of the *Foundations [Grundrisse]* *of the Critique of Political Economy,* a compilation of Marx's 1857–1859 notebooks, published more than half a century after his death. Marx recognizes Malthus's work as significant in two respects: "(1) because he gives brutal expression to the brutal viewpoint of capital; (2) because he *asserted* the fact of overpopulation in all forms of society." But he vehemently rejects the Malthusian theoretical construct, in terms spiked with unrelenting invective: "clerical fanaticism," "motley compilations from historians and travellers' descriptions," "a conception [that] is altogether false and childish."

Marx's own interpretation of the population law of capitalism, a topic to which he returned in passages of his *Critique of the Gotha Program* (1875), fueled much theoretical discourse. Among Marx's critics were Paul Mombert (1876–1938) and Georg Adler (1863–1908); they pointed out flaws in his use and interpretation of statistical surveys. Above all, they accused Marx of failing to take sufficiently into account changes in population dynamics and wages. And where capitalism flourished, history itself refuted the notion of the immiseration thesis, along with conception of the mechanisms, including population dynamics, that were supposedly leading to that state.

See also: *Communism, Population Aspects of; Social Reproduction.*

BIBLIOGRAPHY

SELECTED WORKS BY KARL MARX.

Marx, Karl. 1993 [1857–1858]. *Grundrisse: Foundations of the Critique of Political Economy.* Penguin Classics.

———. 1992 [1867]. *Capital: A Critique of Political Economy.* Penguin Classics.

———. 1933 [1875]. *Critique of the Gotha Program.* New York: International Publishers.

SELECTED WORKS ABOUT KARL MARX.

Adler, Georg. 1968. *Die Grundlagen der Karl Marxschen Kritik der bestehenden Volkswirtschaft. Kritische und ökonomisch-literarische Studien.* Hildesheim: Olms.

McLellan, David, ed. 2000. *Karl Marx: Selected Writings.* New York: Oxford University Press.

Meek, Ronald L. 1971 [1953]. *Marx and Engels on the Population Bomb.* Berkeley, CA: Ramparts Press.

Mombert, Paul. 1929. *Bevölkerungslehre. Grundrisse zum Studium der Nationalökonomie.* ed. Karl Diehl und Paul Mombert. Bd. 15, Jena: Fischer.

Petersen, William. 1988. "Marxisms and the Population Question: Theory and Practice." In *Population and Resources in Western Intellectual Traditions,* ed. M. S. Teitelbaum and J. Winter. Supplement to Vol. 14 of *Population and Development Review,* pp. 77–101.

Tucker, Robert C., ed. 1978. *The Marx-Engels Reader,* 2nd edition. New York: W. W. Norton & Co.

Jochen Fleischhacker

MASCULINITY RATIO

See *Sex Ratio*

MASS MEDIA AND DEMOGRAPHIC BEHAVIOR

In the decades following World War II, radio and television broadcasting expanded rapidly throughout the developing world, and by the end of the century a substantial proportion of the world's population had routine access to them and to the information and entertainment they purvey. Plausibly, the spread of broadcast media, and mass media in general, in a society has some influence on both values and behaviors. This article is concerned with possible media influences in the areas of health and fertility.

According to International Telecommunication Union figures, among the population of low and middle income countries, in the year 2000 there were 265 radios and 185 television sets per 1,000 population. Television sets were more widely distributed in the countries of Europe and Central Asia (448 per 1,000), Latin America and the Caribbean (269 per 1,000), and East Asia and the Pacific (252 per 1,000) than in the countries of the Middle East and North Africa (172 per 1,000), South Asia (75 per 1.000), and Sub-Saharan Africa (59 per 1,000).

Intended and Unintended Effects

In thinking about the ways that the mass media may have influenced fertility and health, it is useful to distinguish between intended and unintended effects. Television, radio, and print media have frequently been mobilized to promote family planning, immunization, and a number of other services and behaviors ranging from safe sex to quitting smoking. These efforts have included both short-term and long-term information, education, and communication (IEC) campaigns, social marketing, as well as entertainment-cum-education programs that have used the appeal of entertainment in an attempt to show individuals how they can live safer, healthier, and happier lives. However, there is also reason to believe that the reception of regular commercial or public programming may have an unintended influence on ideas, values, and behaviors. The unintended effects of television viewing on fertility might include an influence on consumption aspirations as well as on norms and values regarding family life, sexuality and reproduction, and on the efficacy of modern medicine. The eventual influence is likely to be the result of continued, repetitive exposure over a long period of time.

Researchers, from both the communications field and the demography field, face difficult conceptual and methodological issues in identifying media effects. With respect to the general, unintended effects of mass media on demographic behavior, there is the familiar gap between empirical association and causal interpretation. Television ownership is highly correlated with many relevant indicators such as income, electrification, and other types of infrastructure. Those that choose to purchase televisions may have views that are different from those who do not. At higher levels of aggregation, there is the perennial question regarding content: Do the values and ideas conveyed on television lead or lag those of the audience?

In the case of commercial television programming in developing countries, the values conveyed in program content are likely to differ appreciably from the values of the audience. In some countries, much of the programming is imported. In others, it is locally produced but is tailored to relatively affluent metropolitan viewers—the target audience for advertisers—whose values may differ greatly from those of other, numerically more significant segments of the audience.

Evaluation of educational or motivational campaigns and of other programming intended to influence demographic behavior also presents substantial challenges. While they might be expected to be more effective, larger, longer, and more complex interventions are more difficult to evaluate than more limited IEC efforts for which it may be possible to establish a control group. A second difficulty is that recall of specific messages may well be affected by the salience of the message to the respondent, thus introducing a selection effect to recall in retrospective surveys.

The Evidence

With regard to the general, unintended effects of mass media on demographic behavior, strong empirical associations have been found in census and survey data between exposure to broadcast media and demographic variables such as the total fertility rate or level of contraceptive practice. Such associations have been demonstrated at various levels—across individuals, municipalities, and countries, after adjusting for the effects of possible confounding variables. Interpretations of such correlations have usually been cautious, even when based on longitudinal data. The threats to inference do not all run in the same direction, however, and it is possible that such associations may either under- or overestimate the true underlying influence.

A second source of evidence on unintended effects comes from qualitative studies of audiences, and their reception of radio and television programming. Several such studies in Brazil suggest, at the very least, that audiences engage with narratives about nontraditional roles for women, strains in intergenerational relations, and sensitive topics related to sexuality, infidelity, and abortion. In this context, such ideas provoked further discussion, comparison with local customs and values, and application to viewer's lives.

The interpretation of the evidence from evaluation studies on intended effects is controversial, with the advocates of purposeful communication claiming substantial influences, and others arguing that such effects are often overstated. In a 2001 review, Robert Hornik and Emile McAnany, both specialists in development communication, concluded that evaluation studies have shown that campaigns and entertainment–education programs have been effective in increasing the demand for services at family planning and health clinics, but only rarely have they shown much influence on population-level behavior. Moreover, when data are available over a longer period, it is observed that the program effects do not always outlast the programs. The second kind of evidence regarding intended effects comes from the association found in surveys between self-reports of exposure to messages and contraceptive practice and reproductive intentions. Although such correlations are often very strong, their interpretation must allow for the type of selection bias noted above.

It appears probable that there are both intended and unintended media effects on health and reproductive behavior, but their magnitude is uncertain. The relationship merits further study. As the role of values, ideas, and information in affecting demographic change is given more prominence, scholars are likely to pay increasing attention to the various and burgeoning means by which they are spread.

See also: *Culture and Population; Diffusion in Population Theory; Family Planning Programs; Fertility Transition, Socioeconomic Determinants of; Values and Demographic Behavior.*

BIBLIOGRAPHY

Hamburger, Esther Imperio. 1999. *Politics and Intimacy in Brazilian Telenovelas.* Ph.D. diss., University of Chicago. Ann Arbor, MI: University Microfilms.

Hornik, Robert, and Emile McAnany. 2001. "Mass Media and Fertility Change." In *Diffusion Processes and Fertility Transition: Selected Perspectives,* ed. John B. Casterline. Washington, D.C.: National Academy Press.

Kingcaid, D. L., A. P. Merritt, L. Nickerson, S. Buffington de Castro, M. P. de Castro, and B. M. de Castro. 1996. "Impact of a Mass Media Vasectomy Promotion Campaign in Brazil." *International Family Planning Perspectives* 22: 169–175.

La Pastina, Antonio Carmino. 1999. *The Telenovela Way of Knowledge: An Ethnographic Reception Study among Rural Viewers in Brazil.* Ann Arbor, MI: University Microfilms.

Rogers, E. M., P. W. Vaughan, R. M. A. Swahele, N. Rao, P. Svenkerud, and S. Sood. 1999. "Effects of an Entertainment–Education Radio Soap-opera on Family Planning Behavior in Tanzania." *Studies in Family Planning* 27: 193–211.

Singhal, Arvind, and Everett M. Rogers. 1999. *Entertainment–Education: A Communication Strategy for Social Change.* Mahwah, NJ: Erlbaum.

Westoff, Charles F., and A. Bankole. 1997. *Mass Media and Reproductive Behavior in Africa.* Analytical Reports No. 2. Calverton, MD: Macro International.

Westoff, Charles F., and German Rodriguez. 1995. "The Mass Media and Family Planning in Kenya." *International Family Planning Perspectives* 21: 26–31, 36.

Joseph E. Potter

MATERNAL MORTALITY

Among women of reproductive age in developing countries, complications of pregnancy and childbirth are the major cause of death and disability. According to World Health Organization (WHO) estimates, for each year in the 1990s there were about 515,000 deaths world-wide from pregnancy-related causes, the vast majority (99%) occurring in Africa, Asia, and Latin America. Of all the health indicators monitored by the United Nations, the biggest disparity between developed and developing countries is in maternal mortality. The World Bank reports that an estimated 28 million years of healthy life are lost each year in developing countries due to maternal health conditions.

Even though there is agreement on the leading causes of maternal deaths and the magnitude of the problem, there is considerable disagreement and uncertainty about how to define, measure, and reduce maternal mortality.

Definitions and Levels

WHO defines a maternal death as "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration or site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes" (WHO, 1992). Maternal deaths are divided into direct and indirect obstetric deaths, with direct obstetric deaths accounting for approximately three-fourths of all maternal deaths. The main causes of direct obstetric deaths are hemorrhage, unsafe abortion, eclampsia, infection, and obstructed labor. Indirect obstetric deaths are those related to conditions that are either pre-existing or exacerbated by pregnancy, such as malaria, anemia, hepatitis, and increasingly, HIV/AIDS. A potential source of definitional confusion is that in 2001, the U.S. Centers for Disease Control and Prevention (CDC) defined the term "pregnancy-related death" as "one that occurs during pregnancy or within 1 year of its end and is a result of complications of the pregnancy or a condition that was aggravated by the pregnancy." This is equivalent to the WHO definition of maternal death, except that the time frame is 365 days, rather than 42 days.

Statistics constructed from data on maternal deaths include: the maternal mortality ratio (maternal deaths per 100,000 live births); the maternal mortality rate (maternal deaths per 100,000 women of reproductive age, per year), and the lifetime risk (the probability that a woman will die of maternal causes). The maternal mortality ratio is sometimes erroneously called the maternal mortality "rate," creating confusion.

Lifetime risk is often used to illustrate the disparities between the developed and developing worlds. It takes into account both the risk of death that a woman faces each time she becomes pregnant and the total number of pregnancies she would expect to have over the course of her life. Calculated for a population or a cohort of women, lifetime risk thus depends on both the maternal mortality ratio and the total fertility rate, both of which are higher in developing countries. In many countries the lifetime risk of dying of pregnancy-related causes is staggeringly high. For example, WHO estimates lifetime risk as 1 in 13 women in West Africa, compared to 1 in 3,900 in Northern Europe. Other regional maternal mortality statistics are shown in Table 1.

Data on maternal mortality are difficult and expensive to gather, requiring nearly complete registration of deaths or demographic surveys with large sample sizes as well as accurate reporting of cause of death. For most developing countries only estimates are available.

An alternative to gauging the level of maternal mortality is to measure the availability, utilization, and quality of life-saving obstetric services (known as emergency obstetric care, or EmOC). UNICEF and Columbia University have developed indicators of these service dimensions. They rely on the records kept by health facilities and existing estimates of population size by birth rates, and so can be built into existing record-keeping systems. Known as the UN Process Indicators, they were jointly issued by UNICEF, WHO and UNFPA in 1997. Their use has highlighted the large deficits in the availability and functioning of obstetric care services.

TABLE 1

Estimates of Maternal Mortality by Region, 1995

Region	Maternal Mortality Ratio (maternal deaths per 100,000 live births)	Number of Maternal Deaths	Lifetime Risk of Maternal Death
Africa	1000	273,000	1 : 16
Asia*	280	217,000	1 : 110
Latin America and the Caribbean	190	22,000	1 : 160
Oceania*	260	560	1 : 260
Europe	28	2,200	1 : 2000
Northern America	11	490	1 : 3500
World Total	400	515,000	1 : 75

*Japan and Australia/New Zealand have been excluded from the regional averages and totals

SOURCE: WHO (2001).

Historical Background

Maternal deaths used to be very common in Europe and the United States. As recently as the early-twentieth century, maternal mortality rates and ratios were as high in the United States as they are in areas of the developing world of the twenty-first century. Even though there were improvements in living conditions in the late 1800s and early 1900s, maternal mortality did not decline. The historian Irvine Loudon notes that it was not until the mid- 1930s that a steep and steady decline in maternal mortality rates began. In 1915 the maternal mortality ratio in the United States was 608 maternal deaths per 100,000 live births; in 1933 it was 619, but by 1950 it had fallen to 83. The same pattern prevailed in other western countries. The great decline in maternal deaths in the West was not primarily due to gradual socioeconomic development (e.g., nutrition, education) but to the introduction of effective means of coping with obstetric complications: antibiotics for infection, blood transfusions for hemorrhage, and safer surgical techniques.

Strategies for Reducing Maternal Deaths

In the developing world, the major approaches to reducing maternal mortality are through nutritional programs, programs aimed at predicting or preventing serious obstetric complications, and programs aimed at ensuring treatment for complications.

Nutritional interventions. Serious anemia probably increases a woman's risk of dying of obstetric complications although the existing studies are flawed. Longstanding programs have sought to reduce anemia by giving women iron and folic acid supplements during pregnancy. However, serious anemia is generally due to a combination of factors, including not only iron deficiency, but malaria, intestinal parasites, and other ailments. Therefore, it is unlikely that iron folate supplementation alone will reduce maternal deaths.

More recently, vitamin A supplementation has been proposed as a way to reduce maternal deaths. The supporting evidence for this was a study in Nepal, which found a lower incidence of pregnancy-related deaths (from all causes up to 12 weeks after delivery) among women who received vitamin A. However, the meaning of this study is unclear since the greatest difference in relative risk of death was not in infections (which would support a biological explanation) but in accidents.

Predicting and preventing complications. Programs aimed at predicting and preventing serious obstetric complications include the training of traditional birth attendants (TBAs) and antenatal care. Despite the intuitive appeal of such programs, their potential effectiveness is much less than is generally thought. This is partly the result of the biological nature of the major complications: while some of them may be detected early (e.g., a substantial proportion of serious pre-eclampsia cases, and some cases of malposition of the fetus), they still require medical treatment to prevent harmful or even fatal progression.

Despite the great effort put into it, there are insurmountable obstacles to making this "risk approach" effective. While high-risk groups (e.g., very young women or those with a bad obstetric history) can be identified, the individual women who will develop complications cannot be. Moreover, most maternal deaths will take place in the low-risk group, simply because it is so much larger than the high-risk group. Thus, focusing on high-risk groups takes attention away from most of the women who will die.

Ensuring treatment for complications. Even though most life-threatening obstetric complications cannot be predicted or prevented, they can be effectively treated. Consequently, ensuring access to adequate emergency obstetric care is the central requirement for reducing maternal deaths. Other effective initiatives for reducing maternal mortality include increasing the use of contraception (since it reduces the number of pregnant women, and thus the number of women at risk of maternal death) and improving access to safe abortion procedures. Complications of unsafe abortion are the only major cause of obstetric deaths that is almost completely preventable, as experience in developed and developing countries has shown.

In recent years those concerned about high maternal mortality rates have had high hopes for programs aimed at increasing skilled attendance at delivery in developing countries, but there remain substantial questions about the potential of this initiative. If skilled attendance is interpreted as increasing women's access to treatment of complications, then it may well help reduce maternal deaths. If it only means training peripheral health workers to attend normal deliveries, with no feasible medical backup, then it is unlikely to make a difference in current high rates of maternal death.

Improving access to emergency obstetric care does not necessarily require building new hospitals or training new cadres of workers. Much can be achieved by improving the functioning and utilization of existing facilities and personnel. To a significant extent, this is a problem of policies, priorities, and management, not of resources. For example, there are countries where there are not enough obstetricians or anesthesiologists to post them in rural hospitals, and yet general physicians, nurses, and midwives are not permitted or trained to give life-saving care to women with complications of pregnancy or delivery, or to administer simple forms of anesthesia.

Once adequate emergency obstetric care is provided in district hospitals and health centers, there emerge numerous opportunities to improve the utilization and quality of services with the help of non-governmental organizations, community groups, and professional organizations. But without accessible services, no amount of community education or mobilization can save the lives of women with hemorrhage, eclampsia, or obstructed labor.

See also: *Causes of Death; Induced Abortion: History, Prevalence, Legal Aspects; Infant and Child Mortality; Mortality Differentials, by Sex; Reproductive Health.*

BIBLIOGRAPHY

Bailey, Patricia. E., and Paxton, Anne. 2002. "Using UN Process Indicators to Assess Needs in Emergency Obstetric Services." *International Journal of Obstetrics and Gynecology* 76: 299–305.

Goodburn, Elizabeth, Mushtaque Chowdhury, Rukhsana Gazi, Tom Marshall, and Wendy Graham. 2000. "Training Traditional Birth Attendants in Clean Delivery Does Not Prevent Postpartum Infection." *Health Policy and Planning* 15(4): 394–399.

Graham, Wendy J., Jacqueline S. Bell, and Colin H. Bullough. 2001. "Can Skilled Attendance at Delivery Reduce Maternal Mortality in Developing Countries?" *Studies in Health Services Organisation and Policy* 17: 97–130.

Loudon, Irvine. 1992. *Death in Childbirth, An International Study of Maternal Care and Maternal Mortality 1800–1950.* Oxford, Eng.: Clarendon Press.

Maine, Deborah. 1991. *Safe Motherhood Programs: Options and Issues.* New York: Columbia University, Center for Population and Family Health.

Maine, Deborah, Tessa M. Wardlaw, Victoria M. Ward, James McCarthy, Amanda Birnbaum, Murat Z. Akalin, and Jennifer E. Brown. 1997. *Guidelines for Monitoring the Availability and Use of Obstetric Services.* New York: UNICEF/WHO/UNFPA.

Rooks, J., and Beverly Winikoff. 1994. *A Reassessment of the Concept of Reproductive Risk in Maternal Care and Family Planning Services.* New York: Population Council.

Rush, David. 2000. "Nutrition and Maternal Mortality in the Developing World."*American Journal of Clinical Nutrition* 72(1) Supplement: 212S–240S.

Smith, Jason B., Nii A. Coleman, Judith A. Fortney, Joseph De-Graft Johnson, Daniel W. Blumhagen, and Thomas W. Grey. 2000. "The Impact of Traditional Birth Attendant Training on Delivery Complications in Ghana." *Health Policy and Planning* 15(3): 326–331.

Stephenson, Patricia, et al. 1992. "Commentary: The Public Health Consequences of Restricted Induced Abortion—Lessons from Romania." *American Journal of Public Health* 82(10): 1,328–1,331.

West, Keith P., et al. 1999. "Double Blind, Cluster Randomised Trial of Low Dose Supplementation with Vitamin A or Beta-carotene on Mortality Related to Pregnancy in Nepal." *British Medical Journal* 318: 570–575.

World Bank. 1993. *World Development Report 1993: Investing in Health.* Oxford and New York: World Bank.

World Health Organization. 1992. *International Classification of Diseases, 10th Revision.* Geneva: World Health Organization.

———. 2001. *Maternal Mortality in 1995: Estimates Developed by WHO, UNICEF, UNFPA.* Geneva: World Health Organization.

INTERNET RESOURCES.

Centers for Disease Control and Prevention (CDC). 2002. "Fact Sheet: Pregnancy-Related Deaths in the United States, 1987–1990." <http://www.cdc.gov/nccdphp/drh/mh_prgdeath.htm>.

United Nations. 2002. "The State of the World Population 2001. Monitoring ICPD Goals: Selected Indicators." <http://www.unfpa.org/swp/2001/english/indicators/indicators1.html>.

Deborah Maine
Katrina Stamas

MATHEMATICAL DEMOGRAPHY

See *Actuarial Analysis; Animal Ecology; Life Tables; Multistate Demography; Renewal Theory and the Stable Population Model; Simulation Models; Stochastic Population Theory*

MICROECONOMICS OF DEMOGRAPHIC BEHAVIOR

This article briefly surveys the intellectual development and empirical implications of the literature on the microeconomic theories of demographic behavior. The behaviors discussed in this article include fertility behavior, investment in the human capital of children, marriage, divorce, non-marital childbearing, and selected aspects of female labor supply. Other demographic variables such as mortality and migration have been analyzed using microeconomic theory, but are not treated in this article. This article begins with fertility, the first of these behaviors to be studied using the microeconomic approach.

Microeconomic Fertility Theory

The view that fertility behavior can be analyzed within the choice-theoretic framework of neoclassical economics originated in a model of fertility by economist Harvey Leibenstein (1922–1994) in 1957 that stressed the importance of intergenerational transfers from children as a form of old age security as a motivation for fertility in developing countries. A far more influential economic model of fertility was presented shortly thereafter in a pioneering paper by economist Gary Becker in 1960. Becker attempted to reconcile the prediction from demand theory that increases in income should raise the demand for children with the facts that income growth has been accompanied by secular decline of fertility and that family income is inversely associated with cross-section differentials in the industrialized countries. Becker sought to address this apparent paradox by applying the theory of the consumer to show that these secular changes and cross-sectional differences in the completed family sizes of households in developed countries were the result of variations in family incomes and the *prices,* or opportunity costs of children.

In his 1960 paper, Becker introduced two key elements of all microeconomic theories of household behavior: preferences and constraints. A household consisting of a husband and wife is assumed to have preferences for goods and services that contribute their own adult standard of living and, crucially, also to have preferences for children. The household faces a budget constraint determined by its lifetime resources and market prices or opportunity costs of these resources. Using terminology introduced by economist Pierre-Andre Chiappori in 1992, Becker assumed a *unitary* model of the household in which a husband and wife behave as if their preferences are described by a single household utility function. This common utility function might be justified by assuming that the husband and wife have identical preferences or that one of them controls the household's resources and has the power to dominate household decisions. Later, this article will consider "collective" household models in which husbands, wives, and even children all have their own preferences and household behavior that reflects the interaction of these actors within some kind of bargaining model. Meanwhile, the unitary model is utilized as a convenient simplifying assumption to be replaced by more appropriate assumptions when the question under analysis requires separate consideration of the interests of the husband and wife as, for example, when considering the formation or dissolution of the household through marriage and divorce, the decision of whether to bear children within marriage, or out of wedlock, or how the allocation of resources to children may vary with the resources owned by the father and mother.

Quality versus Quantity of Children

In conventional economic theory, the demand function for a given good can be derived by assuming that a household maximizes its utility subject to its budget constraint. Hypotheses about observable behavior are then developed from *comparative static* analysis that shows how demand varies as the budget constraint shifts due to changes in income, the price of the given good, or prices of related goods. When this methodology is applied to fertility behavior, Becker noted an apparent conflict between the predictions of theory and empirical evidence. As income rises, theory predicts that the quantity of most goods should increase, with the exception of "inferior" goods that tend to be inferior members of a class—the potato as an inferior form of food is a common textbook example. Empirically, Becker noted that fertility had been declining secularly at the same time that incomes had grown enormously and, in cross-sections, that there appeared to be a negative correlation between family incomes and number of children.

Becker rejected the two most obvious ways to reconcile theory and data. He argued that the true effect of income on the demand for children is unlikely to be negative because children are not inferior members of some broader class of goods. He also rejected the idea that the *price* of children is higher because more is spent on them when incomes are high or in higher compared with lower income families. All families in a given market face the same prices regardless of their income. Expenditures on children are a matter of choice, not an exogenous component of the budget constraint.

Becker then introduced the important idea that the demand for children has a qualitative as well as a quantitative dimension such that total expenditures on children are equal to the number of children multiplied by quality per child and by a price index reflecting the cost of inputs into children relative to adult goods. Within the quality–quantity model, expenditures on children tend to increase with income, implying that children are normal goods, but most of the increase is due to rising child quality while fertility does not vary strongly with income.

Further analysis of the quality–quantity model by economist Robert Willis and by Becker and economist H. Gregg Lewis, all in 1973, provided an underlying reason for the differential magnitude of the income effects on the number and quality of children. Within this model, the marginal cost of an additional child is proportional to its quality while the marginal cost of an addition to quality per child is proportional to the number of children. It follows that the relative marginal cost of quantity to quality is equal to the ratio of quality to quantity. As income increases, the relative marginal cost of quantity to quality therefore must shift in favor of whichever of these aspects of children has the larger income elasticity, causing a substitution effect that reinforces the change in that attribute. Thus, if the *true* income elasticity of quality is larger than that of quantity, an increase in income causes an income effect plus an induced substitution effect tending to raise quality per child and an income effect minus an induced substitution effect that may even cause a reduction in fertility.

Household Production and Allocation of Time

The next major steps in the development of a microeconomic model of fertility involved a more careful specification of a household's resource constraints, a correspondingly richer definition of the cost of children, and a linkage of fertility to other household behaviors, especially female labor supply. The key idea in these developments is to consider the household as a productive unit as well as a consumption unit. In the first application of this idea to fertility behavior in 1963, economist Jacob Mincer argued that the mother's time was a crucial input to childcare and that the opportunity cost of this time is measured by the woman's potential market wage. Given that the husband's income and the wife's earnings potential tend to be positively correlated, the marginal cost of children will tend to be higher in higher income families, thus suggesting another reason for a negative correlation between family income and fertility. In a groundbreaking paper on married women's labor supply in 1962, Mincer argued that the productivity of nonmarket time for women led both to a lower level of market labor supply than for men and to greater responsiveness of labor supply to increased real wages than is true for male labor supply. Greater responsiveness arises from the high degree of substitutability between market and nonmarket goods ultimately satisfying the same needs (e.g., home-cooked meals vs. restaurant meals) whereas the relevant margin for male labor supply is more likely between goods and leisure, which are less substitutable. Secular growth of real market wages thus could consistently explain both the secular increase in female labor supply and secular decrease in male labor supply. Labor supplies of both sexes are reduced by the gain in real income and associated increase in the demand for leisure caused by rising real wage rates; however, the substitution effects in favor of work caused by higher real wages tend to outweigh the income effect for married women and to be outweighed by the income effect for married men.

In 1965 Becker produced a formal model of household production and time allocation in which he assumed that all commodities that a household ultimately values appear in the household's utility function. These are produced with inputs of purchased goods and time according to household production functions that reflect technology as distinct from the utility function that reflects taste. Within this framework, for example, differences in household demand for heating oil in Miami, Florida, and Minneapolis, Minnesota, are derived from the demand for the nonmarket household commodity, "comfortable temperature and humidity," which appears in the utility function. This approach provides a useful heuristic device for developing models of related investments such as furnaces and insulation or the study of the impact of air conditioning on the development of the U.S. Sunbelt.

More generally, the household production model, with its emphasis on time allocation, and its capacity to incorporate technological, environmental, and biological variables into economic models of household decisionmaking, has had broad influence on research on demographic behavior. Willis presented a model of fertility behavior that synthesizes the quality–quantity model of Becker using the concepts of household production and human capital investment. It emphasized the role of female time allocation between market and home work based on the earlier work of Becker in 1964 and 1965 and Mincer in 1963. The model assumes that the wife's time is combined with goods purchased in the market to produce two distinct household commodities: adult standard of living and child services where child services are the product of quality per child and number of children. A key technological assumption is that children are intensive users of female time relative to the adult standard of living from which it follows that increases in the marginal value of female time cause an increase in the ratio of the marginal cost of children to the marginal cost of adult standard of living. Increases in the cost of female time therefore tend to cause substitution effects weighted against children which, it is argued, will tend to induce quality–quantity interactions that reduce fertility while perhaps even raising quality per child.

Cost of Time and the Fertility Transition

The cost-of-time hypothesis is one of the leading hypotheses advanced to account for secular fertility decline and for the negative cross-sectional relationship between fertility and potential female market wage rates, often proxied by female education. Empirical tests of this hypothesis have been complicated by the fact that, according to the theory, variables such as the wife's labor supply and her market wage are chosen simultaneously with fertility and expenditures on children and that crucial prices that determine decisions are not directly observable. A woman will enter the labor force if her market wage exceeds the shadow price of time, an unobservable quantity that measures the marginal value of her time in household production, and, given that children are relatively time intensive, is positively related to the shadow price of children—another unobservable quantity. Women who do enter the labor force adjust their labor supply until the shadow price of time is equal to the market wage. Hence, the market wage, which is observable, can be used as a measure of the price of time and, indirectly, of the marginal cost of children. However, the value of time remains unobservable for nonworking women and, worse, these women are a self-selected non-random sample of all women so that the wage rates of observationally similar working women may not provide a suitable estimate of the time value of nonworking women. Methods to allow econometric estimation of theoretically relevant behavioral relationships in this situation were pioneered by economist James Heckman (1974a).

Another important issue, first analyzed by Mincer and economist Solomon Polachek in 1974, is that the value of a woman's time in market work depends on the human capital she acquires through labor market experience. Willis's 1973 study suggests that the dependence of the value of time on market experience may promote "corner solutions" in which some women pursue careers and remain childless while other women have large families and remain out of the labor force. In part, the tension between allocating time to children or to career development may be resolved through the purchase of childcare services in the market, as first analysed by Heckman in 1974. To the extent that market childcare can substitute for the mother's care, the household technology of families of high wage women may actually become relatively *goods intensive.* This is consistent with the declining negative correlation between market work and fertility, noted by economist V. Joseph Hotz, and his fellow researchers, in 1997, that has accompanied the dramatic increase in female labor force participation of mothers with young children.

If children are relatively goods intensive among high wage women who substitute market childcare for their own care, then increases in female wages reinforce income effects and the correlation between income and fertility may become positive in such groups. To the extent that lower wage women supply market childcare, however, the overall opportunity cost of children will increase over time as the real wage of women increases. An analysis by economist Dianne J. Macunovich in 1996, however, suggests that the real female wage, holding education constant, has not increased since the mid-1970s nor has U.S. fertility experienced major changes although rates of childlessness have increased and the mean age of childbearing has also increased.

Dynamic Models

The static models of fertility behavior described so far in this article make the highly unrealistic assumption that decisions about fertility, work, and other household life cycle decisions are made simultaneously at the beginning of marriage with perfect foresight. Recognizing this limitation, economists began to build dynamic models of fertility decision-making under uncertainty, shortly after static models had been introduced. An initial application to imperfect fertility control and contraception by Heckman and Willis, in 1975, built on stochastic models of reproduction developed in 1964 by biostatisticians Edward Perrin and Mindel Sheps with further developments described in more detail by Hotz, Jacob Klerman, and Willis in 1997. While dynamic models make more realistic assumptions, they can also be analytically intractable. In an important advance in the use of dynamic models in 1984, economist Kenneth I. Wolpin showed how numerically specified structural dynamic models of demographic behavior could be estimated and the estimates used to answer counterfactual policy questions. In 2002, economist Marco Francesconi provided an example of a dynamic model of the interaction between fertility and work decisions by married women.

Divergent Interests of Husband and Wife

An important limitation of the theories discussed so far is their assumption that the unit of analysis is a unitary household in which the interests or preferences of the husband and wife are not distinguished. As noted earlier in this article, this assumption must be abandoned before it is possible to analyze the formation and dissolution of households through marriage and divorce or a variety of questions concerning the division of labor, the allocation of household resources and the distribution of welfare among household members. Becker, as usual, made seminal contributions with his theories of marriage and divorce. In these theories, the household is viewed as a productive partnership. For a given marriage to be formed or maintained, each partner must perceive himself or herself to be better off than they could be in an alternative arrangement as single person or in another potential match. Becker shows that a marriage market equilibrium will result in an efficient assignment of males and females such that no alternative assignment could make any individual or set of individuals better off without making some others worse off.

These models allow analysts to address a number of new questions. One concerns sorting in marriage markets. Under what conditions does like marry like or, alternatively, do unlikes marry? One possibility analyzed by Becker emphasizes gains to specialization in market or nonmarket labor, reinforced by incentives to invest in acquiring skills that are proportional to the time spent in market or nonmarket activities. These incentives, Becker argues, lead to a sexual division of labor within the household and to a pattern of negative assortative mating in the marriage market such that the market wage rates of husbands and wives would be negatively correlated. Although a sexual division of labor within households is almost universally in evidence, there are few if any empirical instances of negative assortative mating either on actual market wages or on potential wages as measured by education. A theoretical explanation for this puzzle was provided by economist David Lam in 1988. Lam argued that economies of scale in household production, including the important special case of *household public goods,* create gains to positive assortative mating which, under plausible conditions, more than offset the gains from negative assortative mating associated with specialization of household labor. Evidence presented by demographers Lisa K. Jepsen and Christopher A. Jepsen in 2002, comparing the matching patterns of married couples, opposite-sex cohabiting couples, and same-sex couples, is broadly consistent with Lam's analysis. They found positive assortative mating on all traits for all couple types, but stronger correlations for nonmarket traits than for market traits and stronger correlations for married couples than opposite-sex couples and the weakest correlations for same-sex couples. Lam's model rationalizes these correlations because children are the most prominent examples of household public goods and match-specific investments in other collective household goods tend to be larger for more durable unions.

Divorce and Child Support

Models that allow for separate interests of men and women can help explain phenomena such as the failure of divorced fathers to pay child support and the rise of out-of-wedlock childbearing.

In 1985, Willis and economist Yoram Weiss showed that, relative to marriage, divorce reduces the incentives of both parents to devote resources to their children. In particular, it may cause a non-custodial father who served as an exemplary breadwinner for his wife and children during marriage to become, upon divorce, a "deadbeat dad" who fails to pay child support. This change in behavior upon divorce occurs even if it is assumed that the strength of the father's concern for his children's welfare remains unchanged.

The key assumption underlying their analysis is that children are "collective goods" from the standpoint of their parents because each parent values the welfare of the children. Because an additional expenditure on a child by one parent benefits the other parent, there is a potential gain to both parents in sharing in the cost of the child. The optimal level of child expenditure occurs when the sum of the marginal values of a dollar spent on the child of each parent is equal to one dollar.

Marriage provides an institutional setting that facilitates a cooperative allocation of resources to children. However, non-cooperative behavior by divorced parents tends to reduce child expenditures below the optimal level. For example, consider a divorced couple with one child in the mother's custody. Using only her own resources, the mother will spend on the child up to the point at which the marginal value of a dollar of expenditure equals one dollar. The father may endeavor to increase child expenditures by providing child support payments to the mother. Assuming the mother treats child support payments as ordinary income, she will tend to increase expenditures on both the child and her own consumption. For instance, suppose she receives one hundred dollars in child support leading her to increase expenditures on the child by twenty dollars and on her own consumption by eighty dollars, a response consistent with an analysis of household expenditures by economists Edward Lazear and Robert T. Michael in 1988. In this case, it will cost the father five dollars to increase expenditures on his child by one dollar as compared to a cost equal to a fraction of a dollar when he and the mother cooperatively shared child costs within marriage. Weiss and Willis's theory implies that the increased cost of children caused by non-cooperative behavior in divorce leads to a reduction in child well-being, as measured by total expenditures by both parents, and may also lead to an unwillingness of the non-custodial father to pay any child support voluntarily, thus tending to shift cost of children onto the custodial mother. In 1999, Willis extended this analysis to show how these factors may lead to out-of-wedlock childbearing among low income women under conditions in which such women are economically able to support children with their own resources (including receipt of welfare payments) and when they outnumber men in the marriage market.

See also: *Becker, Gary S.; Easterlin, Richard A.; Economic-Demographic Models; Family Bargaining; Intergenerational Transfers; Leibenstein, Harvey; Partner Choice.*

BIBLIOGRAPHY

Becker, Gary S. 1960. "An Economic Analysis of Fertility." In *Demographic and Economic Change in Developed Countries.* Princeton, NJ: Princeton University Press, National Bureau of Economic Research.

———. 1964. *Human Capital* New York: Columbia University Press.

———. 1965. "A Theory of the Allocation of Time." *Economic Journal* 75: 493–517.

Becker, Gary S., and H. Gregg. Lewis. 1973. "On the Interaction between the Quantity and Quality of Children." *Journal of Political Economy* 81 (Suppl.): S279–S288.

Chiappori, Pierre-Andre. 1992. "Collective Labor Supply and Welfare." *Journal of Political Economy* 100(3): 437–467.

Francesconi, Marco. 2002. "A Joint Dynamic Model of Fertility and Work of Married Women." *Journal of Labor Economics* 20(2) pt 1: 336–380.

Heckman, James J. 1974a. "Shadow Prices, Market Wages and Labor Supply." *Econometrica* 42: 679–694.

———. 1974b. "The Effect of Day Care Programs on Women's Work Effort." *Journal of Political Economy* 82 (Suppl.): S136–S163.

Heckman, James J., and Robert J. Willis. 1977. "A Beta-logistic Model for the Analysis of Sequential Labor Force Participation by Married Women," *Journal of Political Economy* 85(1): 27–58.

Hotz, V. Joseph, Jacob Klerman, and Robert J. Willis. 1998. "Economics of Fertility in Developed Countries: A Survey." In *Handbook of Population Economics,* 1A., ed. M. Rosenzweig and O. Stark. Amsterdam, Netherlands: North-Holland.

Jepsen, Lisa K., and Christopher A. Jepsen. 2002. "An Empirical Analysis of the Matching Patterns of Same-Sex and Opposite-Sex Couples." *Demography* 39(3): 435–453.

Lam, David. 1988. "Marriage Markets and Assortative Mating with Household Public Goods: Theoretical Results and Empirical Implications." *Journal of Human Resources* 23: 462–487.

Lazear, Edward, and Robert T. Michael. 1988. *Allocation of Income within the Household.* Chicago: University of Chicago Press.

Leibenstein, Harvey. 1957. *Economic Backwardness and Economic Growth.* New York: Wiley.

Macunovich, Dianne J. 1996. "Relative Income and Price of Time: Exploring Their Effects on U.S. Fertility and Female Labor Force Participation." In *Fertility in the United States: New Patterns, New Theories.* Suppl. to *Population and Development Review,* Vol. 22, pp. 223–257.

Mincer, Jacob. 1962. "Labor Force Participation of Married Women." In *Aspects of Labor Economics,* ed. H. Gregg Lewis. Princeton: Princeton University Press.

———. 1963. "Market Prices, Opportunity Costs, and Income Effects." In *Measurement in Economics: Studies in Mathematical Economics in Honor of Yehuda Grunfeld.* Stanford: Stanford University Press.

Mincer, Jacob, and Solomon Polachek. 1974. "Family Investments in Human Capital: Earnings of Women." *Journal of Political Economy* 82 (Suppl.): S76–S108.

Perrin, Edward, and Mindel C. Sheps. 1964. "Human Reproduction: A Stochastic Process." *Biometrics* 20: 28–45.

Willis, Robert J. 1973. "A New Approach to the Economic Theory of Fertility Behavior." *Journal of Political Economy* 81 (Suppl.): S14–S64.

———. 1999. "A Theory of Out-of-Wedlock Childbearing." *Journal of Political Economy* 107(6) Part 2: Symposium on the Economic Analysis of Social Behavior in Honor of Gary S. Becker, S33–S64.

Wolpin, Kenneth I. 1984. "An Estimable Dynamic Stochastic Model of Fertility and Child Mortality." *Journal of Political Economy* 92(5): 852–874.

ROBERT J. WILLIS

MICROSTATES, DEMOGRAPHY OF

Attempts to define microstates are fraught with problems. There are no evident breaks in the size distribution of states, whether by population or by land area. Nor do population and area necessarily go together: States may be small in area but large in population (like Singapore) or large in area and small in population (like Greenland).

Somewhat arbitrarily, it is common to define microstates as political units with a population of less than 1 million. The definition of what constitutes a political unit for this purpose is also somewhat arbitrary: the notion of "state" in this context is by convention expansively interpreted. Microstates may be fully independent, or just have distinct geographic-territorial identities, with their political status ranging from full home rule (for instance, Greenland, a part of Denmark) to gradations of autonomy, as exemplified by such "microstates" as Gibraltar (formerly a British Crown Colony, now a dependent territory of the United Kingdom) or Martinique and Guadeloupe (overseas departments of France). The combination of a demographic criterion—a population below 1 million in 2000—and an expansive notion of what constitutes a state yields more than 70 such states: about a quarter of the "states" of the world. Some 38 of these microstates are formally fully-sovereign states, as signaled by membership in the United Nations. The most recent of these in the early twenty-first century is East Timor, with a population of around 750,000. Many of the UN member states have populations much smaller than that: Nauru and Tuvalu each has an estimated 11,000 people and some 11 others have populations of less than 100,000 each. The rest of the microstates are dependent territories. Most microstates are islands. Most are relatively poor.

Diversity characterizes the economies of microstates, though small size, isolation, fragmentation, limited diversification, and distance from markets are commonly a hindrance to economic growth. Several dependent territories have benefited from substantial metropolitan aid and they and most continental microstates have high income levels as a consequence of being economically well-integrated with affluent neighbors. Some of these, and also some formerly poor island states, achieved success with the new economies of banking and finance.

Various microstates that enjoy attractive climate and topography as well as stable administration, especially those in the Caribbean, have vibrant tourism economies.

With few exceptions the populations of microstates, in the early twenty-first century, are as large as they have ever been and, despite declines in fertility, growth rates usually remain at high levels. By global standards, population densities, especially on islands, are also high, and most microstates—other than the minority experiencing significant economic growth—are characterized by emigration, though only rarely is there absolute population decline. Economically successful continental microstates, such as Monaco and Liechtenstein, are characterized by both population growth (at least, as measured in de facto rather than de jure terms) and high levels of international commuting.

Fertility

Microstates have generally, if sometimes belatedly, experienced the significant fertility declines that occurred in most developing countries in the last half of the twentieth century. A number of countries have, since the 1980s, entered the demographic transition, such as those in Melanesia (Vanuatu and the Solomon Islands), the Comoros, Equatorial Guinea, and the Marshall Islands, retaining annual growth rates of over 2.5 percent. States where fertility has not fallen significantly tend to be poorer and have higher death rates. High rates of natural increase are usually associated with poverty, but also with the possibility of emigration, which is widely regarded as both a safety valve and a means of securing economic growth through remittances.

Many microstates have responded to high population growth rates by adopting family planning policies, but few of their family planning programs have been effective, especially in the African and Pacific island states. Total fertility rates remain very high in several states; in the Marshall Islands, Vanuatu, and the Solomon Islands they have fallen below six children per woman only since the 1990s. Much the same is true of Djibouti and the Maldives. Rates of natural increase are generally highest among Pacific island states, but are also very high in the Comoros, Equatorial Guinea, and the Maldives. The limited recourse to family planning reflects the continued economic value of children, the inclination of wives to comply with their husbands' preferences, the prevalence of adoption, and limited access to family planning services, especially where most populations are rural. However, acceptance of the small family system is more common in the Caribbean and in continental microstates. In a number of microstates, including Barbados, Luxembourg, Malta, and Martinique, total fertility rates are well below two children per woman.

Mortality

Good information on mortality in many microstates is limited. Crude death rates are generally low, reflecting a young age structure in many states. But age-specific mortality rates are often also low: Indeed Andorra, Iceland, Malta, and the French Antilles (Guadeloupe and Martinique) are among the places with the highest life expectancies in the world. The mortality rates in dependent territories tend to be lower than those in independent states, because of superior access to health services. Health services are least adequate and mortality rates highest in microstates that are classified as least developed, including Cape Verde, the Comoros, the Maldives, and East Timor. Life expectancy is below 50 years in the African state of Djibouti and in East Timor.

Mortality rates, especially infant mortality rates, everywhere fell rapidly in the second half of the twentieth century. This decline was associated with the epidemiological transition from infectious and parasitic diseases to chronic non-communicable diseases. The transition occurred in the Caribbean microstates prior to occurring in the Pacific. Indeed, in some Pacific microstates, such as the Solomon Islands, the decline in mortality may have stopped as a result of reduced access to health services.

Migration

In continental microstates such as Monaco and Gibraltar populations have long been urban. Most other microstates are becoming increasingly urbanized. Only in the smallest microstates does more than a quarter of the population live in rural areas. In most cases rapid urban growth followed increased post-World War II and post-independence expansion of government activity and spending and the growth of bureaucracies. Urban bias in resource allocation is fairly prevalent. Natural increase is now more significant than rural migration as a contribution to urban growth, posing economic, environmental and social problems in urban centers. Efforts to decentralize populations have occasionally had partial success, such as in Kiribati, but by and large have failed.

A number of continental, politically dependent, and resource rich microstates have experienced substantial immigration. The populations of oil-rich Bahrain and Brunei almost tripled in the last quarter of the twentieth century, through labor migration; the Netherlands Antilles, Turks and Caicos, the Cayman Islands, San Marino, Andorra, and the Channel Islands have also experienced rapid growth through tourism and finance. Several political dependencies, including Guam, Ceuta and Melilla, Mayotte, and the French Caribbean islands have experienced similarly rapid immigration from nearby but impoverished independent states.

A number of mainly small and remote island microstates have experienced sustained emigration, notably Pitcairn (which may become totally depopulated), Niue, the Cocos (Keeling) Islands, and Montserrat. A few dependent territories, notably the United States Virgin Islands, Guam, the Northern Marianas, and American Samoa, have become stepping stones for onward migration to affluent metropolitan states, usually the United States. In each of these territories, population growth has also been very rapid.

In most island microstates, international population flows are the major regulators of demographic change. Emigration characterizes many states, especially such Pacific states as Tonga, Samoa, Tokelau, and the Cook Islands. In those states and elsewhere migration is oriented to former or existing colonial powers and is primarily due to economic reasons. Remittances, from migrants in metropolitan states, sometimes sustained over generations, are the main source of national income—often contributing more than foreign aid and exports combined. Remittances are primarily directed toward consumption rather than investment, although less so than formerly, and thus tend to reinforce dependency. The rise in the significance of migration and remittances in several microstates has caused them to be characterized as MIRAB economies, an acronym referring to their heavy dependence on Migration, Remittances, and Aid, thereby promoting a Bureaucratic form of development.

In several states, such as Tokelau, Niue, Anguilla, and Montserrat, the majority of citizens live outside the country. International migration is selective by age and skills, and has caused a skill-drain from many states. Return migration has been small and is usually dominated by those in unproductive age groups. Despite limits imposed by destination countries, hope of opportunities for emigration in most island states remains undiminished. In some atoll states, concerns over rising sea levels are a further stimulus to emigration.

Achieving sustainable development is a formidable challenge for most microstates, especially the smaller, more remote island states. Young populations place strains on land and other resources, and on education systems, employment, and social organization. Some states are experiencing a fall in the standard of living and a rise in crime rates. Development in most states will be increasingly urban, is unlikely to be self-sustaining, especially if aid fatigue occurs, and will continue to be linked to migration. Yet there is no single observable pattern for the future: Microstates are enormously diverse, demographically as well as in other respects. They represent every global extreme.

See also: *States System, Demographic History of.*

BIBLIOGRAPHY

Aldrich, Robert, and John Connell. 1998. *The Last Colonies.* Cambridge, Eng.: Cambridge University Press.

Bertram, Geoff, and Ray Watters. 1985. "The MIRAB Economy in South Pacific Microstates." *Pacific Viewpoint* 26: 497–519.

Caldwell, John, Graham Harrison, and Pat Quiggin. 1980. "The Demography of Microstates." *World Development* 8(12): 953–968.

Connell, John. 1988. "The End Ever Nigh: Contemporary Population Change in Pitcairn Island." *Geo Journal* 16: 193–200.

———. 1999. "Environmental Change, Economic Development and Emigration in Tuvalu." *Pacific Studies* 22: 1–20.

Connell, John, and Dennis Conroy. 2000. "Migration and Remittances in Island Microstates: A Comparative Perspective on the South Pacific and the Caribbean." *International Journal of Urban and Regional Development* 24(1): 52–78.

Connell, John, and John Lea. 1992. "My Country Will Not Be There: Global Warming, Development and the Planning Process in Small Island States." *Cities* 9: 295–309.

———. 2002. *Urbanisation in the Island Pacific. Towards Sustainable Development.* London: Routledge.

JOHN CONNELL

MIGRATION

See *Forced Migration; Immigration, Unauthorized; Immigration Policies; Immigration Trends; Internal Migration; International Migration; Labor Migration, International; Refugees, Demography of; Resettlement; Temporary Migration; Trans-Atlantic Migration; Urbanization*

MIGRATION MODELS

Decisions about migration are shaped by economic, social, and cultural factors. Migration models formalize these determinants. They also may describe the effects of migration at its origin and destination and the interactions between those effects.

Economic Determinants

Most formal migration models focus on economic determinants: opportunities and constraints on income at migrant origins (limited capital and technology, scarcity of employment, imperfect market environments), income opportunities at migrant destinations (demand for migrant labor in urban centers), and migration costs (travel costs, networks of contacts at prospective migrant destinations, border policies). Not all context variables are exogenous to migration; some may be influenced by migration decisions, as occurs when migrant remittances create labor scarcities or loosen financial constraints on production in migrant-sending areas, with ramifications for both migrant and nonmigrant households. A growing body of migration research attempts to elucidate these indirect or feedback effects of migration.

Although the results of sociological research usually agree that migration is the result of rational decisions by individual actors, such research often adds noneconomic variables to the list of determinants, viewing migration as a social process. Anthropological research generally deemphasizes formal or quantitative modeling in favor of ethnographic research, viewing migration within a cultural, historical, and political-economic context. This article focuses on formal approaches that employ quantitative and statistical methods to model migration phenomena.

Objectives

The primary objective of migration models is to provide an analytic structure through which the direct and indirect influences on migration are identified, migration trends are charted, and the impact on migration of exogenous shocks, including policy changes, are predicted. Statistical models are used to test specific hypotheses derived from migration theories and estimate the magnitude of migration determinants and impacts. Estimated models, along with programming techniques, are used to explore or simulate the effects of policy and other influences on migration decisions. Simulations alter exogenous context variables, which are the only variables that researchers and policy makers are free to change directly.

The evolution of migration theory shapes both models and data collection. The earliest migration models are rooted in the theory of the geographer E. G. Ravenstein (1834–1913), who proposed 11 laws of migration based on the observation of migration patterns in Great Britain and, later, the United States. He proposed that although most migrants travel short distances, longer-distance migrants prefer to go to centers of commerce or industry; each stream of migration produces a counterstream; large towns owe more of their growth to migration than to natural increase; the volume of migration increases with the development of industry and commerce and as transportation improves; most migration is from agricultural areas to centers of commerce and industry; and the main causes of migration are economic. These observations motivated a plethora of quantitative models of migration flows and the aggregate variables that affect those flows.

Gravity Models

Ravenstein's (as well as Newton's) influence is clear in gravity models, which posit that migration between place i and place j, M_{ij}, is a positive function of repulsive forces at i (R_i) and attractive forces at j (A_j) and is inversely related to the "friction" or distance between i and j (D_{ij}):

$$M_{ij} = f(R_i, A_j)/g(D_{ij})$$

In practice, most formulations of the gravity model simply assume that migration between *i* and *j* is directly proportional to the product of the two places' populations and inversely proportional to the intervening distance ($M_{ij} = P_iP_j/D_{ij}$). Stouffer (1940) extended gravity models by introducing the notion of intervening opportunities: Migration over a given distance is held to be directly proportional to the number of opportunities at that distance and inversely proportional to the number of possible alternative migration destinations between *i* and *j*. In this approach the nature of particular places may be more important than distance in determining where migrants go.

These aggregate models, particularly gravity models, had the advantage of being simple to estimate, but they offered no insight into who migrated and who did not; how changes in policies, markets, and trade affected migration; or the social process of migration. Distance and population alone were not sufficient to explain migration behavior. Lee (1966) hypothesized that both the destination and the origin have characteristics that attract or repel migrants and that perceptions of these characteristics differ between migrants. The complexity of migration models has increased as research has evolved to address these and other questions.

Table 1 summarizes different migration models in terms of the variables included. The models range from early formulations, which included only a few variables, to new economics of labor migration (NELM) models, which contain many variables at the individual, household, and community levels, as well as policy instruments to influence migration.

The Models of Lewis and Schultz

In the 1950s and especially the 1960s economic models assumed a central role in migration research. W. Arthur Lewis's (1954) dual economy model of economic development with unlimited supplies of labor was not an explicit model of migration. Nevertheless, in this model migration is the means by which surplus labor in the traditional (agricultural) sector is redeployed to fill rising modern (urban) sector labor demands. Migration is demand- or employment-driven rather than being driven by wages, which are assumed to be fixed. The Lewis model assumes that a labor surplus exists. Thus, the loss of

TABLE 1

Variables Included in Migration Models

Migration Model	Population	Distance	Place Characteristics	Migration Costs	Individual Human Capital	Migration Networks	Source-Household Variables	Remittances and Their Use	Nonremittance Expenditures	Community Variables	Policy Focus to Influence Migration
Gravity	x	x									NA
Stouffer	x	x	x								Create intervening opportunities
Neoclassical wage-driven			x	x							NA
Todaro			x	x							Create jobs in migrant-source areas
Cumulative causation			x	x		x					NA
Human capital			x	x	x	x					NA
Remittance-use							x	x			NA
New economics of labor migration	x	x	x	x	x	x	x	x	x	x	Alleviate market imperfections in source areas

Note: NA: not applicable either because policy variables are not included (e.g., gravity models) or because, in light of the model's assumptions, the social welfare rationale for policy interventions is not evident (e.g., neoclassical wage-driven models). Many studies employ a mixture of the models in this table.

SOURCE: Compiled by author.

labor to migration does not reduce agricultural production or affect wages. This assumption, which accords with a classical economic perspective, was called into question by some economists, most notably Theodore W. Schultz (1964).

Once migration eliminates rural labor surpluses, urban wages must rise to lure additional workers from the rural sector. Wages adjust to ensure that both rural and urban labor markets clear. This is the essence of neoclassical migration models, which are of the form:

$$M_{ij} = f(W_i, W_j, C_{ij})$$

where W_i denotes wages at place i; W_j denotes wages at place j, and C_{ij} denotes migration costs.

In neoclassical models, intersectoral wage differentials are the primary factors driving migration. Population and distance play a role only insofar as they influence or are "proxies" for wages or migration costs and condition the scale of the overall process. Empirical models document that migrant flows are usually from low-wage to high-wage places and respond negatively to migration costs. However, wage-driven migration models cannot explain migration in the context of high rates of urban unemployment and explain only a small share of the variation in migration flows.

Alternative Models

Michael P. Todaro (1969) proposed an alternative formulation of neoclassical migration models in which prospective migrants maximize their expected income; in the aggregate migration equation above, W_i and W_j are replaced by expected incomes at places i and j, respectively. Nearly all empirical tests of the Todaro expected-income hypothesis use aggregate data on migration flows and wages and assume a random job-allocation process so that expected income equals the wage times the employment rate (or 1 minus the unemployment rate). The wage-driven neoclassical model may be viewed as a special case of the Todaro model in which the probabilities of employment at migrant destination and origin equal 1.

The power of the Todaro model lies in its ability to explain the persistence of migration in the context of unemployment at migrant destinations. A higher wage in the urban sector than in the rural sector is not a sufficient or even necessary condition for migration because the probability of finding a job at the prevailing wage also matters. Like its neoclassical precursors, expected-income models imply that an equilibrium eventually is reached, after which migration pressures abate. The Todaro equilibrium is where expected incomes (not wages) are equalized across sectors, adjusting for migration costs.

In the 1970s most statistical tests of the Todaro hypothesis used data on aggregate place characteristics and migration flows. They generally supported the hypothesis that migration flows from places where expected incomes are low to places where they are high and that unemployment rates have an effect on migration that is independent of wages. These aggregate models, however, were an uneasy fit with the theoretical models of migration behavior on which they ostensibly were based. They left fundamental questions unanswered: Why do some individuals migrate while others do not? What distinguishes the labor "lost" to migration from that remaining in the rural sector?

Micro Behavioral Models

In the 1980s research emphasis shifted from aggregate to "micro" behavioral models that focus on individuals' migration decisions. Most migration behavior models are based on the assumption that an individual n at place i will migrate to place j if the net benefits from migration exceed the migration costs, that is, if

$$B_j^n - B_i^n > C_{ij}^n.$$

The diversity of migration models in the last two decades of the twentieth century reflects differing hypotheses about what constitutes migration benefits and costs, and those hypotheses in turn reflect evolving theories of migration behavior. For example, in a wage-driven neoclassical model, B_i and B_j are replaced by wages at places i and j, respectively. In a Todaro model, they are replaced by expected wages: $p_i^n W_i^n$ and $p_j^n W_j^n$. (The model posited by Todaro actually was dynamic and hypothesized that individuals migrate if their discounted future stream of urban-rural expected income differentials exceeds migration costs.) Extensions of these models incorporate job search, migration networks, and risk as benefits or costs. In risk models migration benefits are hypothesized to be functions of both expected incomes and income risk.

Methodologically, micro models of migration behavior shift the researcher's focus from aggregate migration flows (estimated by using standard regression techniques) to individual migration decisions (modeled with probit or logit models or other related statistical methods). They require explicit consideration of differences among individuals in terms of migration benefits and costs. Human capital theory had a fundamental impact on migration research by positing that differences in individuals' earnings, and thus the economic returns from migration, can be explained by differences in skill-related attributes across workers, including experience and schooling.

Human capital migration models usually replace migration benefits and costs with human capital and other variables. In a few cases these benefits and costs are explicitly modeled as a function of human capital and other variables and their effects on migration decisions are estimated directly by using simultaneous-equation methods. In addition to human capital, social capital in the form of migration networks, or contacts with family and friends at prospective migrant destinations, plays a key role in some migration models. Migration networks may assist migrants in job searches and reduce migration costs and risks while creating a process of cumulative causation by which past migration makes future movements more likely. Empirically, networks are often the most significant variables explaining migration behavior.

The Impact of Remittances

Models of individual migration behavior do not provide a rationale for continuing interactions between migrants and source households, especially through income remitted, or sent home, by migrants. They also do not provide a useful basis for understanding the impacts of migration and remittances on migrant source areas. In the 1970s and early 1980s some researchers attempted to model the impacts of remittances separately from migration determinants, based on surveys of remittance use for productive investments by migrant source households. However, those studies did not investigate the indirect effects of remittances on migration decisions in the migrant source areas.

The New Economics of Labor Migration

The need to integrate the analysis of migration determinants and impacts stimulated a new genre of migration research in the 1980s and 1990s known as the new economics of labor migration (NELM). NELM models hypothesize that migration decisions are made not by isolated actors but by larger units of related people, typically households or families; that people act collectively not only to maximize income but also to minimize risks and loosen the constraints created by various inadequacies of markets in source areas, including missing or incomplete capital and insurance markets; and that migration decisions may be influenced by the behavior of other actors within the prospective migrant's social group.

In the imperfect-market environments that characterize most migration source regions, migrants create benefits and impose costs that are ignored by individual-decision migration models. In the absence of well-functioning credit and insurance markets, migrants serve as "financial intermediaries," providing source households with capital to invest in local production as well as income insurance (e.g., a promise to remit if a crop or family business fails). NELM theory implies new migration determinants (household capital constraints, risk, and community-level variables), as well as new potential impacts (positive effects of remittances on family production but also negative impacts of losing family labor to migration). It also draws attention to new forms of policy interventions to influence migration. Whereas a Todaro model would call for policy interventions in labor markets to influence migration, NELM modelers emphasize that interventions in capital and insurance markets can provide alternatives to migration as a means for households to obtain investment capital or income security.

A trademark of NELM models is their simultaneous consideration of migration determinants, remittance behavior, and impacts. This makes the application of NELM models relatively demanding in terms of both estimation methods and data needs. Empirical modeling provides evidence that production and incomes in migrant source areas are affected negatively by the loss of labor to migration but positively by migrant remittances and that household and community variables as well as individual variables affect migration and remittance behavior. It also offers support for the hypothesis that the characteristics of social groups, such as average incomes and inequality, both influence and are influenced by migration. Village-wide general-equilibrium models incorporating migration and remittances allow explanation of the effects of policy changes on overall village economic outcomes. These models reveal that many of the determinants and effects of migration are found outside the households that actually send migrants and receive remittances.

See also: *Economic-Demographic Models; Multistate Demography.*

BIBLIOGRAPHY

Knowles, James C., and Richard B. Anker. 1981. "Analysis of Income Transfers in a Developing Country: The Case of Kenya." *Journal of Development Economics* 8: 205–226.

Lee, Everett S. 1966. "A Theory of Migration." *Demography* 3: 47–57.

Lewis, W. Arthur. 1954. "Economic Development with Unlimited Supplies of Labour." *Manchester School of Economic and Social Studies* 22: 139–191.

Lucas, Robert E. B. 1987. "Emigration to South Africa's Mines." *American Economic Review* 77: 313–330.

Massey, Douglas S. 1990. "Social Structure, Household Strategies, and the Cumulative Causation of Migration." *Population Index* 56: 3–26.

Massey, Douglas S., Joaquin Arango, Graeme Hugo, Ali Kouaouci, Adela Pellegrino, and J. Edward Taylor. 1998. *Worlds in Motion: Understanding International Migration at the End of the Millennium.* Oxford: Clarendon Press.

Mincer, Jacob. 1974. *Schooling, Experience, and Earnings.* New York: Columbia University Press.

Oberai, Amarjit S., and H. K. Manmohan Singh. 1980. "Migration, Remittances and Rural Development: Findings of a Case Study in the Indian Punjab." *International Labor Review* 119: 229–241.

Ranis, Gustav, and John C. H. Fei. 1961. "A Theory of Economic Development." *American Economic Review* 51: 533–565.

Ravenstein, Ernest G. 1885. "The Laws of Migration." *Journal of the Royal Statistical Society* 48: 167–227.

Schultz, Theodore. 1964. *Transforming Traditional Agriculture.* New Haven, CT: Yale University Press.

Sjaastad, Larry A. 1962. "The Costs and Returns of Human Migration." *Journal of Political Economy* 70(5): 80–93.

Stark, Oded. 1991. *The Migration of Labor.* Cambridge, Eng.: Basil Blackwell.

Stouffer, Samuel A. 1940. "Intervening Opportunities: A Theory Relating Mobility and Distance." *American Sociological Review* 5: 845–867.

Taylor, J. Edward, and Irma Adelman. 1996. *Village Economies: The Design, Estimation and Application of Village-Wide Economic Models.* Cambridge, Eng.: Cambridge University Press.

Taylor, J. Edward, and Philip L. Martin. 2001. "Human Capital: Migration and Rural Population Change." In *Handbook of Agricultural Economics,* ed. Bruce L. Gardner and Gordon C. Rausser. New York: Elsevier Science.

Todaro, Michael P. 1969. "A Model of Migration and Urban Unemployment in Less-Developed Countries." *American Economic Review* 59: 138–148.

Yap, Lorene. 1977. "The Attraction of Cities: A Review of the Migration Literature." *Journal of Development Economics* 4: 239–264.

J. Edward Taylor

MILL, JOHN STUART

(1806–1873)

John Stuart Mill, English political economist and philosopher, was the son of James Mill, the utilitarian economist, who was responsible for his son's precocious upbringing, described in the latter's autobiography. Much of Mill's career, like his father's, was spent with the East India Company, based in London, in a period when the Company was effectively India's administering authority. From 1865 to 1868 he was a member of parliament. His formal occupations did not greatly interfere with his writing—in the 1820s and 1830s, essays for the *Westminster Review;* then *A System of Logic* (1843); and his major works, *The Principles of Political Economy* (1848) and *On Liberty* (1859). (Page references to the *Principles* below are to the 1965 variorum edition from the

University of Toronto Press.) He was a longtime companion and eventually husband of Harriet Taylor, whose strong stance on women's rights accorded with his own, set out in his essay *The Subjection of Women* (1869).

Mill's views on population issues were in many respects Malthusian, but he went further in approving of contraception within marriage, in promoting the emancipation of women, and in calling for curtailment of population increase on environmental grounds. The combination of utilitarianism, feminism, and environmentalism yielded an outlook that is surprisingly modern.

In his *Autobiography* (1873), Mill describes how the Philosophical Radicals, the group with which he was associated in the 1830s, interpreted T. R. Malthus's principle of population, seeing it not, as most of Malthus's readers did, as an argument against the improvability of human affairs, but "as indicating the sole means of realizing that improvability . . . [for] the whole labouring population through a voluntary restriction of the increase of their numbers" (Mill 1924, p. 74). The later Malthus, of course, also believed in prudential restraint, but more as an exercise of individual virtue than as an outcome of social policy. The policies Mill advocated to promote escape from a low-level Malthusian equilibrium were popular education (convincing people that producing a large family should be "regarded with the same feelings as drunkenness or any other physical excess"—*Principles*, 1965, p. 368); land reform, to establish a system of peasant proprietorship; and subsidized emigration, especially of young couples. But a big push was called for: "Unless comfort can be made as habitual to a whole generation as indigence is now, nothing is accomplished; and feeble half-measures do but fritter away resources" (*Principles,* 1965, p. 378). A further policy measure implied in *The Subjection of Women* was to prevent women being forced into the role of child-producers by "the press-gang of society." In a letter written shortly before his death, Mill agreed with the opinion that "a necessary condition for over-population is woman's subjugation, and the cure is her enfranchisement" (Mill, 1910, vol. 2, p. 303).

Mill was an early, though circumspect, supporter of artificial birth control, presumably under the influence of the radical reformer Francis Place, an associate of his father. He expressed amazement that, in England at least, the idea of voluntarily limiting the size of family after marriage was never mentioned. "One would imagine that children were rained down upon married people, direct from heaven, without their being art or part in the matter" (*Principles,* 1965, p. 369). (Mill is not usually known for a lightness of touch, but in a footnote in the *Principles* [1965, p. 156n] he comments on the relevant proximate determinant: "The most rapid known rate of multiplication is quite compatible with a very sparing use of the multiplying power.")

Most of Mill's views on population and even on women's rights are of interest mainly to historians of ideas. On one issue, however, he is still frequently read and quoted: his vision of the stationary state, set out in Book 4, Chapter 6 of the *Principles.* Classical economists like Adam Smith, James Mill, and David Ricardo saw economic growth leading eventually to stagnation at subsistence wages as profits fell toward zero and consumer demand flagged. This was their view of the stationary state. Mill's stationary state, in contrast, was arcadian—consistent with the prospect of indefinite human improvement in a world without the "unmeaning bustle of so-called civilized existence":

> If the earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, for the mere purpose of enabling it to support a larger, but not a better or happier population, I sincerely hope, for the sake of posterity, that they will be content to be stationary, long before necessity compels them to it. (*Principles,* 1965, p. 756)

See also: *Malthus, Thomas Robert; Optimum Population; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY JOHN STUART MILL.

Mill, John Stuart. 1871. *Principles of Political Economy with Some of Their Applications to Social Philosophy.* (1848). 7th edition. London: Parker. A variorum edition appears as volumes 2 and 3 (1965) of Mill's *Collected Works,* published by the University of Toronto Press, 1963–91.

———. 1869. *The Subjection of Women.* 1869. London: Longmans.

———. [1873] 1924. *Autobiography.* New York: Columbia University Press.

———. 1910. *The Letters of John Stuart Mill.* London, Longmans.

SELECTED WORKS ABOUT JOHN STUART MILL.

Himes, Norman E. 1928. "The Place of John Stuart Mill and of Robert Owen in the History of English Neo-Malthusianism." *Quarterly Journal of Economics* 42(4): 627–640.

Hollander, Samuel. 1985. *The Economics of John Stuart Mill.* Oxford: Blackwell.

Ryan, Alan. 1975. *John Stuart Mill.* London: Routledge and Kegan Paul.

Geoffrey McNicoll

MINORITY POPULATIONS

See *African-American Population History; Ethnic and National Groups; Indigenous Peoples; Nomads; Racial and Ethic Composition*

MOHEAU, JEAN-BAPTISTE

(1745–1794)

Jean-Baptiste Moheau was a French protodemographer. He was born in 1745, and died in 1794; he would not have been thirty years old at the writing of a treatise entitled *Recherches et Considérations sur la population de la France,* published in 1778 under his name. There remains some doubt about the authorship of the work, but it is now proven that Moheau was the personal secretary of Montyon, *Intendant* of the *généralité* of La Rochelle on the Atlantic coast of France, to whom the work was sometimes attributed. It appears that Moheau was substituting for Montyon, and took a special interest in the collection of population statistics that were requested by the royal administration. He made no other contribution to science. The book consists of two distinct parts, probably written by different persons. It is a remarkable achievement for its time, and deserves an important place in the history of demography. The title could be roughly translated, as "Empirical Studies on the Population of France, and their Interpretation." The work is characterized by a dual concern to present hard data and use them to make politically and socially relevant inferences. The first part ("State of the Population") is a demographic monograph, and contains chapters that are strikingly similar to those in any demographic description of a national population of the twenty-first century on the topics of data collection; an estimate of population size; the distribution by age, sex, and social characteristics; fertility; mortality; and migration. Especially noteworthy is the chapter on fertility. Moheau distinguishes fertility from what is now called the birth rate, and marital fertility from overall fertility. He is interested in fertility's variability in space, national and international, urban and rural, and analyzes the seasonality of births.

The second part of the book examines the causes of the progress or decay of the population. This is the part described by the word *considérations* in the title of the book. It distinguishes between physical causes (e.g., climate, food, dangerous occupations) and political, social, or moral causes. The latter factors include the effects of law, government, religion, taxes, war, and the possession of colonies. The most noteworthy passage is the allusion to *funestes secrets* (fatal secrets), a phrase widely quoted by French demographers. It has been often interpreted as a reference to the spread of contraception in marriage. In context, however, it would appear that Moheau had in mind the growing impact of various types of extramarital behavior, both before marriage and in prostitution and adultery.

See also: *Demography, History of.*

BIBLIOGRAPHY

Moheau, Jean-Baptiste. 1994. *Recherches et Considérations sur la population de la France* (1778). Paris: Institut national d'études démographiques, Presses universitaires de France.

Etienne van de Walle

MOMENTUM OF POPULATION GROWTH

Population momentum is the tendency for changes in population growth rates to lag behind changes in childbearing behavior and mortality conditions. Momentum operates through the population age distribution. A population that has been growing rapidly for a long time, for example, acquires a *young* age distribution that will result in positive population growth rates for many decades even if childbearing behavior and mortality conditions imply zero population growth in the very long run. Population momentum is important because of the magnitude and duration of its effects.

An Example

Consider the population of Nigeria, estimated at 114 million persons at mid-year 2000. Life expectancy rose from 36 to 51 years over the preceding half century, while completed family size remained at around six children per woman. In consequence, population grew very rapidly, with an average annual growth rate of 2.7 percent. (Statistics here and below are from United Nations 2000 projection series unless otherwise indicated.)

Rapid population growth implies a young age distribution because larger numbers of persons were born in the recent past than in the more distant past. During the period 1995 to 2000, for example, 22 million children were born in Nigeria, as compared with only 8 million from 1950 to 1955. Even if everyone in the earlier cohort had survived, there would have been far fewer persons aged 45 to 49 years than persons aged 0 to 4 in the year 2000.

Because of this young age distribution, the population of Nigeria will tend to grow rapidly in the future even if fertility declines rapidly to replacement level. The relatively large numbers of women and female children in and approaching reproductive age will generate large numbers of births, while the smaller numbers of persons at older ages will generate small numbers of deaths. The resulting population growth will slow as the population ages, but this will occur only over the many decades it takes for young persons to become old.

The United Nation's "instant replacement" population projections show that even with two-child families from the year 2000 forward, the population of Nigeria would grow from 114 million in 2000 to 183 million persons in 2050, an increase of 60 percent. The same projections show that the less developed world as a whole would grow from 4.9 to 7.1 billion persons, an increase of 2.2 billion persons, even with an immediate fall of fertility to replacement level in 2000.

Momentum and World Population Growth

The importance of momentum as a cause of future world population growth has increased as fertility levels throughout the world have declined. In 1994, John Bongaarts estimated that population growth due to momentum could account for nearly half of world population increase during the twenty-first century. He pointed out that this growth could be reduced without any change in completed fertility by raising the average age of childbearing. This is a consequence of the *tempo effect* identified by Norman Ryder, whereby shifts in the timing of births result in a bunching up or thinning out of births during the years in which the shifts occur.

For populations with very young age distributions, however, reducing population growth due to momentum may lead to undesirable changes in the population age distribution. The *constant stream of births* model proposed by Li Shaomin in 1989 is useful in this connection. Fertility declines that produce a constant stream of births will result in age distributions for which numbers of persons decline slowly with increasing age through old age. More rapid fertility declines will result in age distributions in which numbers of young persons in younger age groups are lower than numbers of persons in older age groups.

Returning to the example of the population of Nigeria, suppose that fertility declines after 2005 in such a way as to maintain numbers of births constant at the level observed during the period 2000 to 2005. On this assumption, the population would grow from 114 million persons in 2000 to 250 million in 2050. The later number is not much less than the United Nations medium-variant projection of 279 million. Further reduction in population growth would require more rapid fertility decline.

To eliminate growth during the period 2005 to 2010, for example, it would be necessary to reduce the number of births from the 26 million projected in the medium variant to 8.4 million, the projected number of deaths. This precipitous decline in births would be followed by similarly precipitous falls in the numbers of persons entering primary school (after a delay of 5 or 6 years), in numbers of persons entering the labor force (after a delay of 15 or 20 years), and so on through the life cycle.

Some decline in numbers in these age groups might be advantageous, but such extreme declines would be problematic. Any sustained fertility decline will yield an age distribution with a larger proportion of old persons relative to those at working ages, but the momentum effect—although ultimately transient—will greatly accentuate this dependency burden for a period of many decades.

Generality of the Momentum Concept

Population momentum is most often thought of in the context of fertility declining to replacement level, but the concept applies to all changes in childbearing behavior and mortality conditions. Consider for example a population that has a very old age distribution as a result of an extended period of population decline resulting from below replacement fertility. Should fertility rise to and remain at replacement level, population decline would nevertheless continue for many decades. Large numbers of persons in post-reproductive ages would generate relatively large numbers of deaths, because death rates in old age are high, but no births. Population decline would slow only as the large cohorts of older persons die out, so that the population age distribution ceases to be old.

To illustrate momentum resulting from changes in mortality conditions, imagine a hypothetical population in which 1,000 children are born every year and in which everyone dies on reaching their 60th birthday. Total population is the product of the annual number of births and life expectancy at birth, 60,000 persons. Suppose that at some time *t* mortality conditions change in such a way that persons alive at time *t* die only when they reach their 70th birthday. Then no deaths will occur for 10 years, during which period the population will grow from 60,000 to 70,000 persons. This growth is due to population momentum.

The constant-stream-of-births model may be used to generalize the concept of momentum to populations that do not reproduce biologically. Consider for example the population of PhD degree holders in the United States, for which new PhDs constitute "births" and "age" may be understood as time since PhD. According to the U.S. Bureau of the Census, the number of degrees granted annually grew from 1 in 1870 to just under 30,000 in 1970, with an average annual growth rate of 7 percent. Because of this very rapid growth, the population of PhD holders in 1970 had a very young age distribution, and therefore a strong tendency to future growth. On the assumption that there were 330,000 PhD holders in 1970 (the precise number is not pertinent for this example), holding the annual number of degrees constant at 30,000 after 1970 would result in a population of about 1.2 million PhD holders in 2010, an increase of over 360 percent.

Definition of Population Momentum

The definition of population momentum requires three concepts from stable population theory. First, a population that experiences fixed age schedules of fertility and mortality will over time approach a stable state in which the age composition (the proportions of persons in each age group) and the population growth rate (which may be positive, zero, or negative) are constant. Second, this age composition and growth rate are determined by the age schedules of fertility and mortality. They do not depend on the initial population age distribution. Third, two age distributions (giving numbers of persons in each age group) are *asymptotically equivalent* with respect to given age schedules of fertility and mortality if the ratio $P_1(t)/P_2(t)$ approaches 1 as t gets large, where $P_1(t)$ and $P_2(t)$ are the total populations projected from the two age distributions.

Given any age distribution and any age schedules of fertility and mortality, two stable age distributions may be calculated, both with the age composition implied by the age schedules of fertility and mortality, but with different total populations. Let the total population for the first stable distribution equal the total population for the given age distribution, and denote this number by P_1. Let the total population for the second stable distribution be chosen so that the second stable distribution is asymptotically equivalent to the given age distribution. Let this population be denoted P_2. The *momentum* of the given age distribution with respect to the given age schedules of fertility and mortality is the ratio P_2/P_1. This formulation was first stated by Paul Vincent in 1945, following Alfred Lotka's seminal 1939 monograph on stable population theory.

A necessary condition for momentum effects to exist is that risks of birth or death vary with age. If age schedules of birth and death are constant over age, the age distribution does not influence numbers of births and deaths and population dynamics are fully described by crude birth and death rates. The population growth rate will equal zero (assuming no migration) for any period in which birth and deaths rates are equal.

See also: *Keyfitz, Nathan; Population Dynamics; Projections and Forecasts, Population; Renewal Theory and Stable Population Model.*

BIBLIOGRAPHY

Bongaarts, John. 1994. "Population Policy Options in the Developing World." *Science* 263: 771–776.

Keyfitz, Nathan. 1971. "On the Momentum of Population Growth." *Demography* 8(1): 71–80.

Li, Shaomin. 1989. "China's Population Policy: A Model of a Constant Stream of Births." *Population Research and Policy Review* 8: 279–300.

Lotka, Alfred J. 1939. *Théorie Analytique des Associations Biologiques.* Paris: Hermann et Cie.

Preston, Samuel H., Patrick Heuveline, and Michel Guillot. 2001. *Demography: Measuring and Modeling Population Processes.* Oxford: Blackwell.

Ryder, Norman B. 1983. "Cohort and Period Measures of Changing Fertility." In *Determinants of Fertility in Developing Countries,* Vol. 2, ed. Rudolfo Bulatao and Ronald D. Lee. New York: Academic Press.

United Nations. 2001. *World Population Prospects: The 2000 Revision.* CDROM. New York: United Nations. Sales No. E.01.XIII.13

United States Department of Commerce. 1975. *Historical Statistics of the United States, Colonial Times to 1970.* Part I. Washington, D.C.: U.S. Government Printing Office.

Vincent, Paul. 1945. "Potentiel d'accroissement d'une population." *Journal de la Société de Statistique de Paris* 86(1–2): 16–39.

GRIFFITH FEENEY

MORBIDITY

See *Disease, Burden of; Disease and History; Disease, Concepts and Classification; Diseases, Chronic and Degenerative; Diseases, Infectious; Epidemics; Epidemiological Transition*

MORTALITY, AGE PATTERNS OF

The risk of death varies markedly with age. The death rate is high in the first month after birth, declines during the rest of infancy and childhood, remains low during adolescence and young adulthood, and then rises gradually in middle age and steeply in old age (see Figures 1A and 1B). The decrease and increase in mortality reflect the rise of physiological abilities and disease resistance during child development and their decline during senescence. This basic pattern has been observed for most human populations in different historical eras, for both males and females.

The age pattern of death rates determines the age distribution of the number of deaths and the age trajectory of the number of survivors. Because the death rate declines during childhood and rises later in life, the age distribution of the number of deaths usually has two peaks, one in the first year of life, and the other in old age (Figure 1C). The later peak is usually between 70 and 90 years of age in modern human populations, but it is estimated to have been between 20 and 40 years in Stone Age populations.

The number of individuals who survive from birth to a given age x is a decreasing function of x. Usually, the number of survivors plummets during infancy and early childhood, decreases gradually at young adult and middle ages, and then falls steeply at old ages (Figure 1D).

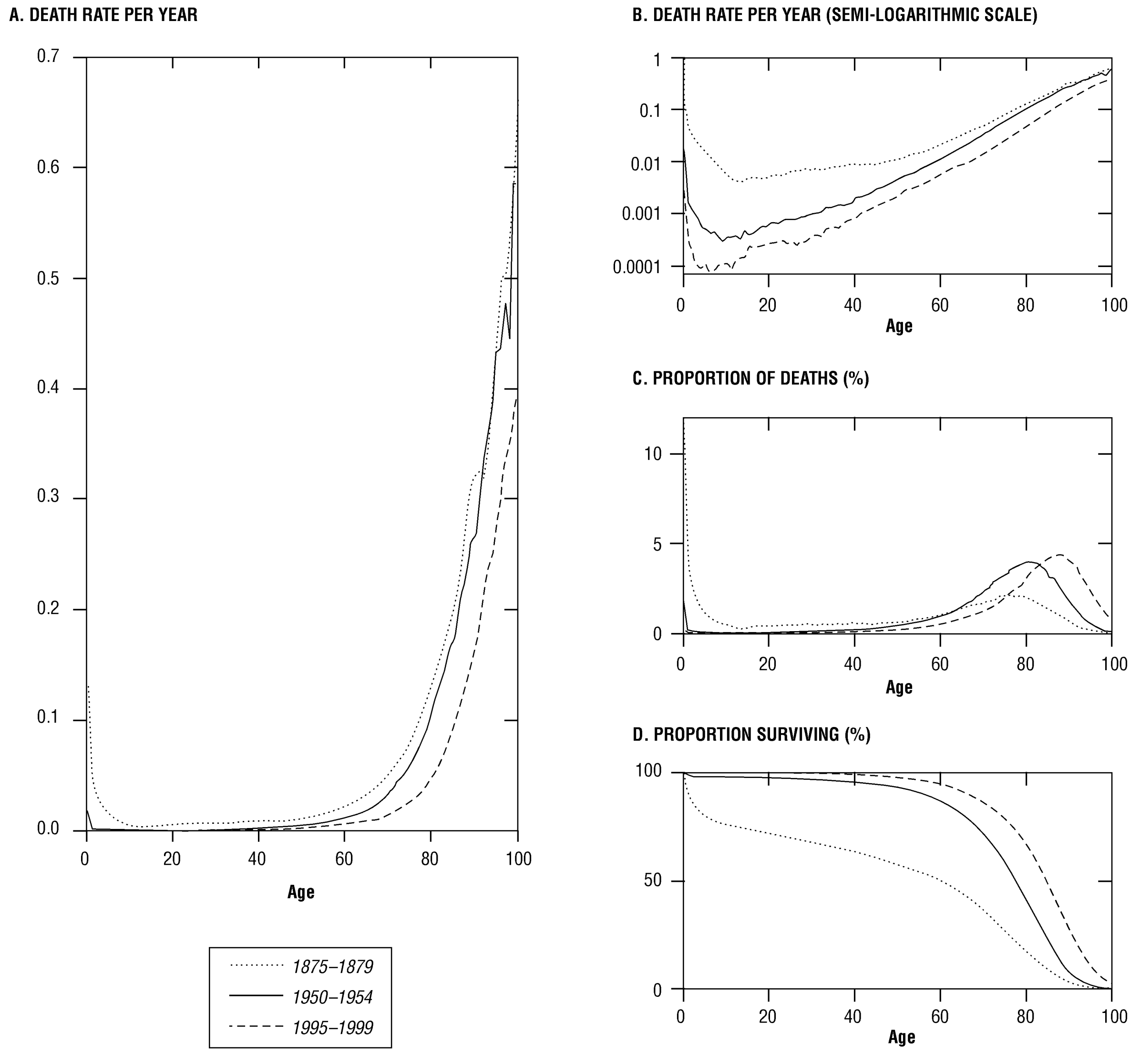
Mathematical Regularities

Because of the universality of this fundamental age pattern and the smoothness of mortality curves, several mathematical models have been developed for expressing mortality as a function of age. Generally these mathematical models fit observational data well.

Some of these models (including the Thiele model, the Siler model, and the Heligman-Pollard model) cover the entire life span by combining separate components that represent mortality patterns in different stages of life. For example, in the Siler model, the death rate (or force of mortality) at exact age x, denoted by $m(x)$, is expressed as the sum of three terms: $m(x) = ge^{-hx} + c + ae^{bx}$ where g, h, c, a, and b are parameters of the model. The three components (ge^{-hx}, c, and ae^{bx}) represent mortality decline in childhood, stable mortality during adoles-

FIGURE 1

Age Patterns of Mortality among Swedish Females in Three Periods: 1875–1879, 1950–1954 and 1995–1999



SOURCE: Human Mortality Database. <http://www.mortality.org>.

cence and young adulthood, and mortality rise at middle and old ages, respectively. The three components can be additively combined because in each life stage one of the three components largely determines the age-specific death rate with only small numerical contributions from the other two terms.

Most other models (including the Gompertz model, the Makeham model, the Weibull model, and different versions of the logistic model) are concerned with describing adult mortality only. The rising mortality curve at middle and old ages appears fairly straight on a semi-logarithmic scale (Figure 1B), suggesting that the death rate increases nearly exponentially with age. This exponential rise was discovered by the British actuary Benjamin Gompertz (1779–1865) in the early nineteenth century. In the Gompertz model, the death rate at exact age x is expressed simply as: $m(x) = ae^{bx}$ where a and b

are parameters of the model. The Gompertz model appears as one of the three components of the Siler model.

The parameter *b* of the Gompertz model, the slope of the logarithmic mortality curve, is called the Gompertzian rate of aging. In biodemographic research, the Gompertz model has been applied to mortality data of various species, and the Gompertzian rate of aging is widely used for comparing the pace of senescence among species, and also for studying effects of genetic and environmental factors on senescent processes.

Mortality Deceleration at Older Ages

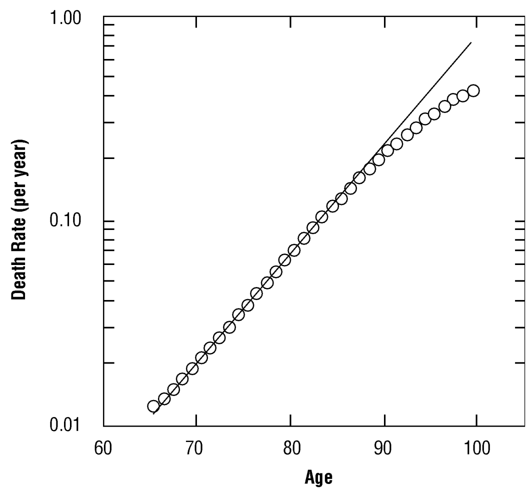
The exponential increase of adult mortality tends to slow at very old ages, as illustrated in Figure 2. Thus the logistic equation, which sets an upper limit to mortality rise, usually fits observed death rates at very old ages more closely than the exponential equation does. This mortality deceleration is observed in most large human populations as well as in several non-human animal species (including fruit flies, earthworms, wasps, and beetles) for which old-age mortality patterns have been examined in detail. Although the slowing-down of mortality increase can be clearly seen in human populations, it is less pronounced than in the non-human species. Some fruit fly populations even exhibit notable age-related *declines* of mortality at very old ages.

In modern human populations, the deceleration can be visually detected in the data for mortality above age 90, but age-specific rates of relative mortality increase (called *life table aging rates*) indicate that the slowing-down actually starts earlier, typically between ages 75 and 80. In populations with lower levels of old-age mortality, the deceleration tends to be delayed to higher ages.

The reason for the mortality deceleration is not fully known. One possible explanation is selective survival. Because less-healthy individuals are more likely to die at younger ages, survivors to older ages tend to have favorable health endowments and/or healthy lifestyles. This selection process could slow down the age-related increase in the death rate in the *population* data. Another possible explanation is that the age-related increase of mortality risk in each *individual* may slow down at old ages for physiological reasons.

FIGURE 2

Age-Specific Death Rates among Women, Ages 65–99, France, 1971–1980



Note: Circles are death rates per year for single years of age. The line was fitted to death rates between ages 70 and 80 by an ordinary least squares regression.

SOURCE: Human Mortality Database. <http://www.mortality .org>.

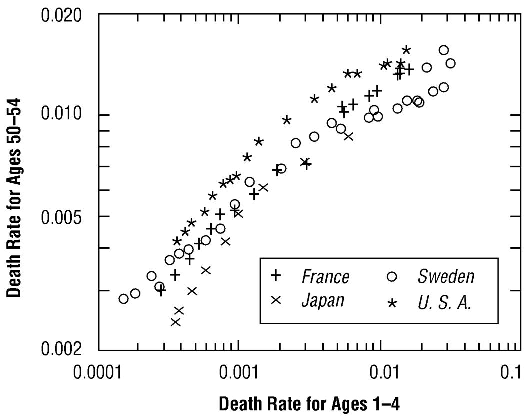
Orchestrated Variations of Mortality Schedule

A *mortality schedule* is a set of age-specific death rates observed during a given period or over the lifetime of a cohort. As described earlier, empirical mortality schedules generally exhibit a three-phase pattern (downward, stable, and upward). Thus it might seem reasonable to expect mortality schedules that produce the same life expectancy at birth to be similar. However, very different combinations of age-specific death rates (e.g., a combination of relatively high child mortality and low adult mortality and a combination of relatively low child mortality and high adult mortality) can show the basic three-phase age pattern and produce the same life expectancy. Various hypothetical mortality schedules with the same life expectancy could be generated by adjusting the parameter values of, for example, the Siler model.

Nevertheless, data from various areas and countries in different periods suggest that age-specific death rates tend to change over time and vary among populations in fairly orchestrated ways. Death rates at even widely different ages are strongly positively

FIGURE 3

Relationship between the Annual Death Rate for Females Aged 1–4 and the Annual Death Rate for Females Aged 50–54



Note: Computed for five-year periods: France, between 1901 and 1995; Japan, between 1951 and 1995; Sweden, between 1861 and 1995; United States, between 1901 and 1995.

SOURCE: Human Mortality Database. <http://www.mortality.org>.

(though not linearly) correlated with each other (Figure 3). The reason that mortality schedules vary in orchestrated ways is probably that the overall level of socioeconomic and technological development in the population is reflected in various determinants of health and survival, including the standard of living, nutritional status, available medical technologies, and level of public health services. These factors, in turn, affect death rates of all age groups simultaneously.

High correlations among age-specific death rates make it possible to construct a set of *typical* mortality schedules corresponding to different levels of life expectancy. Such a typical schedule is called a model life table. Two well-known systems of model life tables are the Coale-Demeny model life tables and United Nations (Heligman-Preston) model life tables; both are widely used. The most typical patterns in the two systems are called the West model life tables in the Coale-Demeny system and the General Pattern in the U.N. system. Not surprisingly, the West life tables and General Pattern life tables are very similar.

However, some empirical mortality schedules depart systematically (though not greatly) from these typical patterns, probably reflecting mortality impacts of different natural and cultural environments. Thus both the Coale-Demeny and U.N. systems include additional sets of model life tables to describe these departures.

Demographers have developed several mathematical formulations of the relationships among age-specific death rates. These are called "relational models" and include the Brass logit model, the Heligman-Preston principal-component model, the Lee-Carter model, and Azbel's "law of survival." For example, in the Lee-Carter model, the death rate at age x and time t, denoted by $m(x, t)$, is expressed as:

$$\log m(x,t) = a(x) + k(t)b(x)$$

where $a(x)$, $k(t)$, and $b(x)$ are estimated from a set of observed age-specific death rates for multiple periods. This implies that logarithms of age-specific death rates are linear functions of each other. The Lee-Carter model has been shown to closely fit mortality schedules of the United States between 1933 and 1987 and those of the G-7 countries (Canada, France, Germany, Italy, Japan, United Kingdom, and United States) during the second half of the twentieth century.

Historical Changes in Mortality Schedules

Two major health transitions affected age patterns of mortality differently. In Figure 1, these two transitions are illustrated by changes in Swedish female mortality from 1875–1879 to 1950–1954 and changes from 1950–1954 to 1995–1999. The first type of transition (called the epidemiological transition) is the significant reduction of mortality from highly contagious infectious diseases, nutritional disorders, and complications of pregnancy and childbirth. In many countries that are at high levels of economic and technological development, this transition occurred mainly in the nineteenth century and the first half of the twentieth century. Early childhood mortality fell considerably, but old age mortality declined only modestly (Figure 1A). Because the relative reduction of adult mortality was greater at younger ages, the slope of the logarithmic mortality curve became steeper (Figure 1B).

The epidemiological transition greatly reduced the proportion of deaths in early childhood and concentrated deaths into a relatively narrow range of old age. Thus the earlier peak in the distribution of deaths fell and the later peak rose (Figure 1C). The transition made the survival curve more rectangular. The survival curve has become fairly flat from birth to middle age because of the low mortality in this age range, and slopes steeply downward in old age because of the high concentration of deaths (Figure 1D).

The second transition is the substantial decline of mortality from degenerative diseases, including heart disease, stroke, and chronic kidney disease. In economically developed countries, this change started in the third quarter of the twentieth century. The absolute reduction of mortality was greater at older ages (Figure 1A), and the relative reduction of mortality was fairly constant over adult ages, producing a nearly parallel downward shift of the logarithmic mortality curve without appreciably changing the slope (Figure 1B). Because of the decline of old age mortality, the peak of the distribution of adult deaths moved toward older ages instead of rising higher (Figure 1C), and the downward slope of the survival curve shifted horizontally to the right without becoming noticeably steeper (Figure 1D).

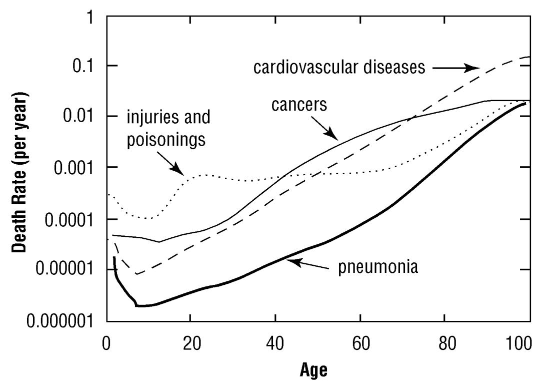
Age Patterns of Cause-Specific Mortality

The age pattern of mortality differs among major causes of death. The differentials help in investigating the relationships between disease development and age-associated physiological changes, particularly the processes of senescence. Some typical age patterns of cause-specific mortality are shown in Figure 4. They are shown on a semi-logarithmic scale, because notable differences are found in the patterns of relative (rather than absolute) changes of mortality with age. Figure 4 displays data for France, but similar patterns are observed in other low mortality countries.

Above age 85, the curvatures of most cause-specific trajectories are concave (i.e., the gradients of the curves diminish with age), as seen for the four causes of death in Figure 4. Under age 85, the patterns are more variable. The death rate from cardiovascular diseases keeps rising steeply and exponentially throughout the adult ages. The death rate from cancers increases sharply at middle ages (the 30s and 40s), but slows down markedly at older ages, making the mortality curve of adult cancers concave already from around age 40. Most site-specific cancer death

FIGURE 4

Death Rates per Year from Cancers, Cardiovascular Diseases, Pneumonia, and Injuries and Poisoning, by Age, Both Sexes Combined, France, 1979–1994



SOURCE: National Institute of Demographic Studies (France). <http://matisse.ined.fr>.

rates follow this pattern as well. In contrast, the death rate from pneumonia increases relatively slowly around age 30 but the increase accelerates at old ages. Thus the mortality curve for adult pneumonia tends to be convex in the entire adult age range below 85.

Concave and convex curvatures on a logarithmic scale indicate deceleration and acceleration, respectively, of age-related relative increases in mortality. Overall, the curvature of the mortality age-pattern seems related to the selectivity of the disease. Concave patterns are likely to be seen for diseases that develop in persons with specific genetic, environmental, and lifestyle risk factors. Convex curvatures tend to be found for diseases to which most persons are vulnerable when they become old and frail. Concave patterns are seen for acute myocardial infarction, hemorrhagic stroke, and chronic liver diseases. In addition to cancers, convex patterns are observed for congestive heart failure, infarctive stroke, chronic kidney diseases, and some infectious diseases such as influenza and septicemia.

A very different pattern is seen for mortality from injuries and poisoning, including accidents, homicide, and suicide. The death rate remains stable from age 20 to 60. In this age range, the risk of external injury is strongly related to behavioral patterns but not directly to physiological changes in the processes of senescence. At older ages the death rate from injury and poisoning increases fairly rapidly. This is mainly due to rising mortality from accidents such as falls and the inhalation or ingestion of harmful substances, reflecting the weakening of the musculoskeletal system and diminishing effectiveness of neural control of the body.

See also: *Aging and Longevity, Biology of; Causes of Death; Epidemiological Transition; Gompertz, Benjamin; Life Tables.*

BIBLIOGRAPHY

Azbel, Mark Y. 1999. "Empirical Laws of Survival and Evolution: Their Universality and Implications." *Proceedings of the National Academy of Sciences of the United States of America* 96(26): 15368–15373.

Coale, Ansley J., and Paul Demeny. 1983. *Regional Model Life Tables and Stable Populations,* 2nd edition. New York: Academic Press.

Finch, Caleb E. 1990. *Longevity, Senescence, and the Genome.* Chicago: University of Chicago Press.

Gage, Timothy B. 1990. "Variation and Classification of Human Age Patterns of Mortality: Analysis Using Competing Hazards Models." *Human Biology* 62(5): 589–617.

Gavrilov, Leonid A., and Natalia S. Gavrilova. 1991. *The Biology of Life Span: A Quantitative Approach.* Chur, Switzerland: Harwood.

Heligman, Larry, and John H. Pollard. 1980. "The Age Pattern of Mortality." *Journal of the Institute of Actuaries* 107: 49–80.

Horiuchi, Shiro, and John R. Wilmoth. 1997. "Age Patterns of the Life-Table Aging Rate for Major Causes of Death in Japan, 1951–1990." *Journal of Gerontology: Biological Sciences* 52A: B67–B77.

Horiuchi, Shiro, and John R. Wilmoth. 1998. "Deceleration in the Age Pattern of Mortality at Older Ages." *Demography* 35(4): 391–412.

Kohn, Robert R. 1985. "Aging and Age-Related Diseases: Normal Processes." In *Relations Between Normal Aging and Disease,* ed. Horton A. Johnson. New York: Raven Press.

Lee, Ronald D., and Lawrence R. Carter. 1992. "Modeling and Forecasting U.S. Mortality." *Journal of American Statistical Association* 87: 659–671.

United Nations. 1982. *Model Life Tables for Developing Countries.* New York: United Nations.

Vaupel, James W., et al. 1998. "Biodemographic Trajectories of Longevity." *Science* 280(5365): 855–860.

Vaupel, James W., Kenneth G. Manton, and Eric Stallard. 1979. "The Impact of Heterogeneity in Individual Frailty on the Dynamics of Mortality." *Demography* 16: 439–454.

Wilmoth, John R., and Shiro Horiuchi. 1999. "Rectangularization Revisited: Variability of Age at Death within Human Populations." *Demography* 36(4): 475–495.

SHIRO HORIUCHI

MORTALITY, INFANT AND CHILD

See *Infant and Child Mortality*

MORTALITY DECLINE

One of the greatest human achievements has been the decline in mortality that has occurred during the modern era. This article describes major trends in human mortality and longevity, especially during the nineteenth and twentieth centuries. The data are derived mostly from detailed mortality statistics collected by national governments. Prior to 1950 reliable information of this kind was collected by only a small number of countries, mostly in Europe, North America, and East Asia. As leaders in industrialization and other forms of social change during this period, these areas have also led the mortality decline and offer valuable statistical documentation of historical trends.

Substantial mortality decline in other parts of the world is a more recent phenomenon, sharply accelerating after 1950, although demographic data to document these trends are deficient in many cases. Similar changes in society and technology underlie mortality declines in all parts of the world, although there are also some regional patterns and exceptional trends.

TABLE 1

Life Expectancy and Infant Mortality throughout Human History

	Life expectancy at birth (in years)	Infant mortality rate (per 1000 live births)
Prehistoric Era	20–35	200–300
Sweden, 1750s	37	210
India, 1880s	27	230
United States, 1900	48	133
France, 1950	66	52
Japan, 1999	81	3

SOURCE: Wilmoth (2002, updated); Bhat (1989).

Sources of Information

It is not known with accuracy how long individuals lived before 1750. Around that time the first national population data were collected for Sweden and Finland. After 1750 and even now in the twenty-first century there is extensive and highly reliable mortality information for only a subset of national populations. For many less developed countries modern mortality estimates are based on sample surveys or other study designs that do not include the entire population and, especially for adults, are not highly reliable.

For the period from around 1500 to 1750 there are several examples of reliable mortality data referring to municipal populations, members of the nobility, and other groups that cannot be considered representative of the total population. For the Middle Ages and earlier periods mortality levels have been estimated through the use of data gleaned from tombstone inscriptions, genealogical records, and skeletal remains. Such estimates are prone to various forms of error but provide a useful description of the general contours of human mortality before the great mortality decline of the modern era.

Mortality data often include information on the cause of death, although this concept is difficult to define and measure consistently. Data on the cause of death always must be analyzed with great caution: Although some trends are irrefutable such as the historical decline of infectious disease, others appear to be influenced by changes in diagnostic procedures and reporting practices (e.g., cancer trends, especially among older persons).

Historical Trends

Historical changes may be described along various dimensions. The following sections examine the rise of life expectancy, changes in the age pattern of human mortality, and trends in extreme longevity.

Life expectancy. Most scholars agree that life expectancy at birth (or $\mathring{e}_0$, in the notation of demographers and actuaries) was probably in the 20s among early human populations (Table 1). Some less fortunate populations may have had life expectancies below 20 years. If early levels of life expectancy at birth were around 20–30 years compared to 75–80 years in the early twenty-first century in some countries, one may conclude that there has been roughly a tripling over the course of human history in the average life span that can be attained by large populations. Much of this increase has been due to the near elimination of infant and childhood deaths. In early human populations the available evidence suggests that around a quarter of all babies died in the first year of life. In the early twenty-first century in the most advanced countries, less than half a percent of infants meet a similar fate.

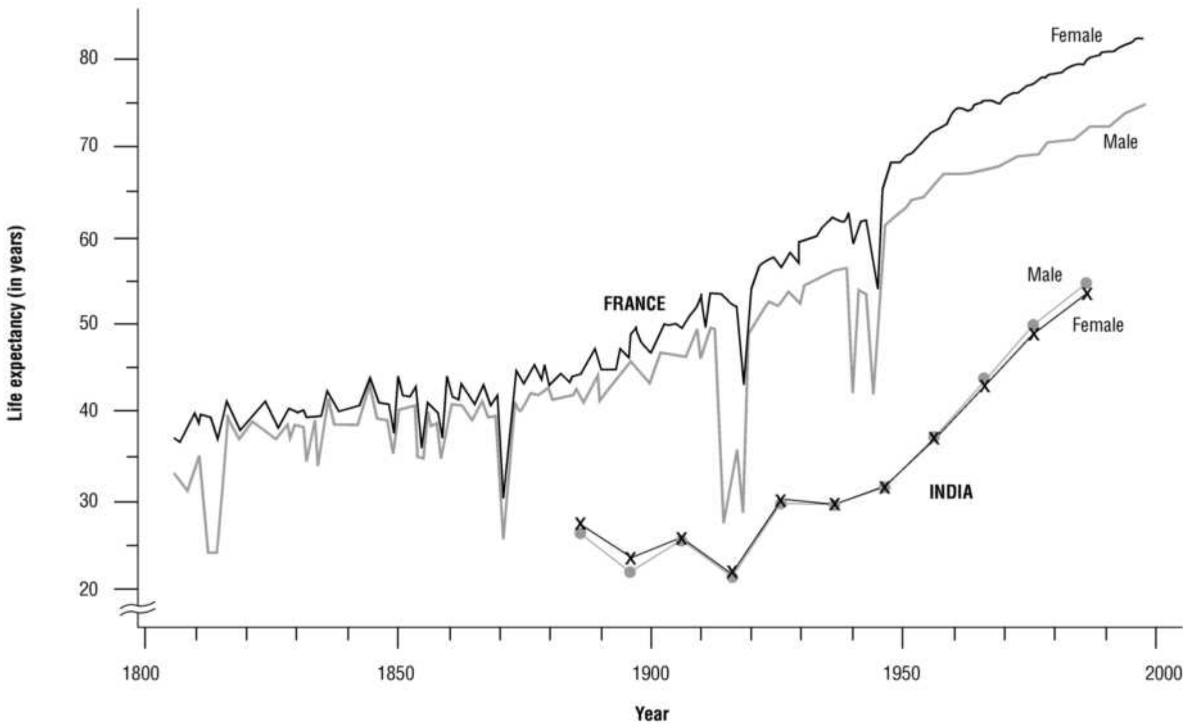
Most of the increase in human longevity is recent. By 1900 the average newborn in Australia and New Zealand could be expected to live about 55 or 57 years, respectively, based on mortality levels in those countries, which were the lowest in the world at that time. In 2000 the world's healthiest nation, Japan, had a life expectancy at birth of around 81 years. Thus, in the leading countries almost half the historical increase in human life expectancy occurred during the twentieth century.

The rise in life expectancy at birth probably began before the industrial era in some parts of Europe and North America. By the 1750s, when data for national populations first became available, life expectancy in some areas of northern Europe was already in the high 30s. Over the next century or more the increase in life expectancy was slow and irregular. After about 1870, this increase became stable and more rapid, especially during the first half of the twentieth century. Since 1950 the rise in life expectancy has slowed somewhat in those areas that led the longevity revolution, such as Europe and North America.

Figure 1 shows trends in life expectancy at birth for males and females in France since 1806. This graph summarizes key aspects of French mortality history over the nineteenth and twentieth centuries. First, life expectancy increased from the high 30s at the beginning of the nineteenth century to the 70s or 80s at the end of the twentieth. Second, the im-

FIGURE 1

Life Expectancy at Birth, by Sex, in France, 1806–1997, and India, 1881–1891 to 1981–1991



SOURCE: Vallin and Meslé (2000); Bhat (1989, 1998, 2002).

pact of various wars was different for the sexes. The Napoleonic wars and World War I were fought mostly at the front and thus affected male life expectancy strongly, but their effect was minor on females in most parts of the country. On the other hand, the Franco-Prussian war and World War II involved widespread occupations of the French territory by enemy forces and thus affected men and women in a similar fashion. Third, a large male–female gap in life expectancy emerged even during peacetime, increasing from a difference of less than two years at the beginning of the period shown to around eight years at the end.

The mortality decline of the modern era began in countries that were leaders in the process of industrialization, but it has spread across the entire world. Alongside the trend for France mentioned earlier, Figure 1 also shows the rise in life expectancy at birth for India from the 1880s until the 1980s. As in most of the poorer regions of the world, the majority of this increase has occurred since around 1940. Fragmentary evidence suggests that life expectancy in the period 1935–1939 was around 30 years in Africa and Asia and 40 years in Latin America. Around 2000, estimates for these regions were much higher at 53, 67, and 71 years, respectively, as summarized in Table 2.

Many factors have contributed to the rise of life expectancy all around the world. Prior to the last decades of the nineteenth century most of the reduction of mortality rates in the early industrializing countries was likely the result of improved living conditions (e.g., better nutrition, shelter, and clothing) made possible by the increased wealth brought about by industrialization. In addition, confirmation of the germ theory of disease in 1882—as a result of Koch's rigorous identification of the bacillus that cause tuberculosis—led to a flourishing of public health measures (e.g., anti-malarial programs, immunization campaigns, and other government health initiatives) and associated improvements in personal health practices. Such developments were

TABLE 2

Life Expectancy at Birth for Major World Regions and Selected Countries, around 2000

Region/Country	Life expectancy at birth (in years)	Region/Country	Life expectancy at birth (in years)
World	67	Europe	74
More developed	76	France	79
Less developed	65	Germany	78
Africa	53	Italy	80
Congo, Dem. Rep. of	49	Poland	74
Egypt	66	Russia	65
Ethiopia	52	Ukraine	68
Nigeria	52	United Kingdom	78
South Africa	51	Latin America & Caribbean	71
Tunisia	72	Argentina	74
Zimbabwe	38	Brazil	69
Asia	67	Chile	77
Bangladesh	59	Colombia	71
China	71	Cuba	76
India	63	Guatemala	66
Indonesia	68	Haiti	49
Iran	69	Mexico	75
Japan	81	North America	77
Laos	54	Canada	79
Pakistan	63	United States	77
Philippines	68	Oceania	75
Turkey	69	Australia	80
Vietnam	68	Papua-New Guinea	57

Note: Following the U.N. classification, "more developed" regions include all of Europe, North America, Japan, Australia, and New Zealand. All other areas are classified as "less developed."

SOURCE: Population Reference Bureau (2002).

probably the major factor in mortality reduction, in both rich and poor countries, from the late-nineteenth century until the 1960s. As discussed below, the main contributions of therapeutic medicine to the historical mortality decline arrived relatively late in this process: antibacterial drugs from the 1930s and 1940s onward, and improved management of cardiovascular disease beginning around 1970.

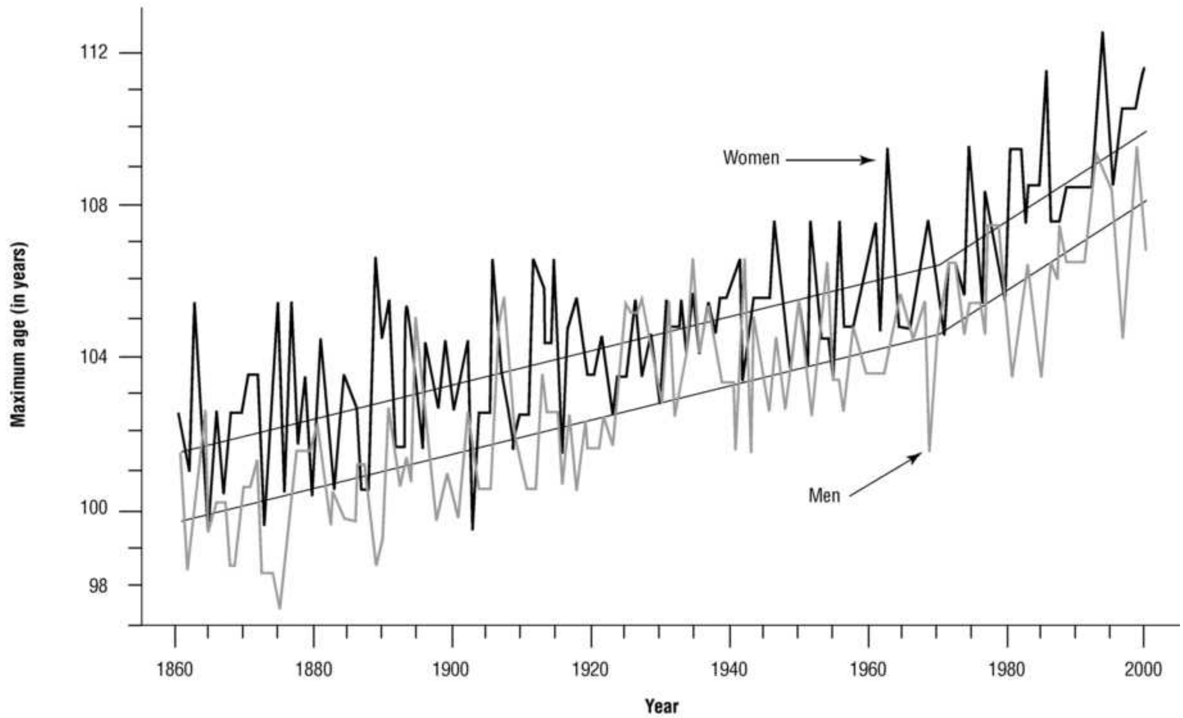
Although the general trend toward lower mortality and higher life expectancy has become worldwide, there are a few notable exceptions. During the 1990s the major exception was a stagnation and even reversal of earlier progress in parts of Africa because of the AIDS epidemic and in parts of the former Soviet Bloc (especially Russia) resulting from social disruptions and instability.

Age pattern of human mortality. The age pattern of human mortality can be characterized in various ways. Age-specific death rates depict the changing risks of mortality over the life course. During the historical mortality decline, death rates typically have fallen much more rapidly at younger than at older ages. A complete set of age-specific death rates implies a particular distribution of deaths by age for a cohort of individuals. Because mortality decline has been more rapid at younger ages, the distribution of ages at death has become more concentrated at older ages. Thus, not only is life longer on average, but also the age range in which most deaths occur has been reduced substantially.

One measure of variability in the timing of death is the interquartile range of ages at death, thus the age span of the middle 50 percent of deaths over the life course of a cohort. The calculation is most simply done for the synthetic cohort of a period life table. During the late-eighteenth century in Sweden, the life-table interquartile range was around 60 to 65 years, since more than one quarter of infants died before age 5, while another quarter survived to age 65 or older. The distribution of age at death was compressed over the next two centuries. In the 1950s the life-table interquartile range in the industrialized countries was around 15 to 20 years. Since 1960 there has been little further reduction in the variability of age at death in the developed world, even

FIGURE 2

Maximum Reported Age at Death, by Sex, in Sweden, 1861–2000



SOURCE: Wilmoth et al. (2000, updated).

though the average age at death (as reflected in life expectancy at birth) has continued to increase.

Extreme longevity. It is difficult to study trends in extreme longevity because of frequent errors in the age at death reported for very old individuals. For this specialized purpose the longest available series of reliable data begins in the 1860s for Sweden. Figure 2 shows the trend in the maximum age at death for men and women over the period 1861–2000. The trend is clearly upward, especially from about 1970. The maximum age rises by 0.44 years (of age) per decade prior to that date and by 1.1 years per decade since then. More than two-thirds of this increase can be attributed to reductions in death rates above age 70, with the rest being due to the fact that more people reach old age (and thus have a chance to die at a very old age) as a result of mortality decline at younger ages and a modest increase in the size of birth cohorts.

These Swedish data provide the best available evidence for the gradual extension of the maximum human life span that has occurred over this time period. Similar trends are evident for other countries as well, although problems of age misreporting complicate the task of interpretation.

Components and Causes of Mortality Decline

The mortality decline of the last two centuries has many components and causes. Two major components of the trend are discussed below: (1) the decline of infectious disease, known as the epidemiologic transition, and (2) the decline of old-age mortality in more recent years. In both cases the causes of the change are complex and can be linked to socioeconomic conditions, public health measures, individual behaviors, and medical interventions.

Epidemiologic transition. The epidemiologic transition is the most important historical change that has affected the level and pattern of human mortality. The transition refers to the decline of acute, infectious diseases and the rise of chronic, degenerative conditions. This shift does not necessarily imply that degenerative diseases became more common for individuals of a given age. It merely means that infectious diseases nearly disappeared, and so something else had to take their place as the major cause of death.

Increasingly, people survived infancy and childhood without succumbing to measles, tetanus, whooping cough, diphtheria, and other infectious causes of juvenile mortality. Once people pass these critical early years, survival to advanced ages is much more likely, and at older ages various degenerative diseases present mortality risks even when infections are well controlled.

The cause of the historical decline of infection-related mortality has been a topic of much discussion. It has become widely acknowledged that most of this decline occurred before the availability of effective medical treatments: In the wealthy countries that industrialized early a substantial reduction had occurred by the 1930s and 1940s, the period when effective antibacterial drugs (sulfanomides and antibiotics) were introduced. Instead, the decline can be attributed mostly to the general improvement in living standards that accompanied industrialization (food, housing, clothing, etc.) and to public health measures that helped control the spread of germs (sanitation, clean drinking water, education about hygiene, quarantine, etc.).

In the countries of Europe and North America this process of epidemiologic transition began during the nineteenth century and was completed mostly before 1960. A similar process began later in the economically less advantaged regions of the world. Mortality decline began in the early-twentieth century in some parts of Latin America and East Asia. In sub-Saharan Africa, in contrast, there is little evidence of mortality reduction before the late 1940s. Even in the early twenty-first century residents of poor countries bear an undue burden of mortality linked to infection. In these cases the successes brought about by organized public health campaigns have not been matched by comparable improvements in the general standard of living.

Mortality decline among the elderly. By around 1960 mortality resulting from infectious diseases had been reduced to very low levels in industrialized countries, and it appeared to many observers that a further extension of the human life span was unlikely. Few people anticipated the coming reduction in old-age mortality that would prolong the historical trend toward longer life into the twenty-first century. Before the late 1960s death rates at older ages seemed to have declined slowly, if at all, and rates of mortality decline were much higher at younger ages than at older ages.

In wealthy nations of the late twentieth century, the most significant change affecting life expectancy was mortality decline among the elderly. The decade of the 1960s marked a turning point from an earlier era of longevity increase caused primarily by the decline of acute, infectious diseases among children and young adults to a more recent era characterized by the decline of chronic, degenerative diseases among the elderly.

Mortality decline at older ages in the last decades of the twentieth century was linked mainly to the reduction of deaths resulting from cardiovascular disease (CVD)—essentially, heart disease and stroke. For the United States it is estimated that 73 percent of the decline in the total death rate from 1950 to 1996 was due to a reduction in CVD mortality. Although the exact cause of this decline is open to debate, several factors have been proposed: (1) a decline in cigarette smoking among adults; (2) a decrease in mean blood pressure levels; (3) changes in diet, especially a reduction in the consumption of saturated fat and cholesterol; and (4) improvements in medical care, including better diagnosis and treatment of heart disease and stroke, the development of effective medications for hypertension and hypercholesterolemia, and an increase in coronary-care units and emergency medical services for heart disease and stroke.

A rapid decline in old-age mortality beginning in the late 1960s has been observed for many industrialized nations. Given the precipitous onset of this decline, which occurred simultaneously across a broad age range, it is plausible that improvements in medical therapy were responsible at least for the initiation of the new trend. Landmark investigations such as the Framingham Heart Study that began in the late 1940s provided significant breakthroughs in the scientific understanding of cardiovascular disease during the 1960s, leading to more effective medical prevention and management. Since modifications in diet and lifestyle should have led to a more gradual pattern of mortality change, it seems unlikely that such factors have been the main cause of the

TABLE 3

Summary of Major Trends in Human Longevity in Industrialized Countries

Indicator	Before 1960	After 1970
Average life span (life expectancy at birth)	Increasing rapidly because averted deaths are among younger people. Very rapid reduction in infant/child mortality linked mostly to effective control of infectious diseases.	Increasing moderately because averted deaths are among older people. Accelerated reduction in old-age mortality linked mostly to better management of cardiovascular disease.
Maximum life span (observed and verified maximum age at death)	Increasing slowly due mostly to gradual reductions in death rates at older ages.	Increasing moderately due almost entirely to accelerated reduction in death rates at older ages.
Variability of life span (standard deviation, interquartile range, etc.)	Decreasing rapidly due to reductions in mortality at younger ages.	Stable, because death rates at older ages are decreasing as rapidly as at younger ages.

SOURCE: Author.

recent decline in old-age mortality. Nevertheless, it is possible that behavioral changes or other factors have reinforced a trend that was set in motion initially by improvements in medical therapy.

After CVD, cancer is the most important cause of death in low-mortality countries of the twenty-first century. In most of these countries cancer mortality began to decline in the late 1980s, although the change has been less rapid and more varied than the trend in CVD mortality. Cancer occurs in many different forms, and trends vary greatly by the site of the primary tumor. For example, lung cancer has become more common over time as a result of increased cigarette smoking, whereas the incidence of stomach cancer has declined. Among women mortality from cervical cancer has fallen markedly as a result of successful medical intervention (screening and early treatment), whereas breast cancer has been on the rise apparently as a result of a number of interrelated factors, such as lower and later fertility and changes in diet and lifestyle.

Summary of Major Trends in Low-Mortality Countries

A summary of major trends in human longevity in industrialized countries is presented in Table 3. Amid the remarkable detail available in historical mortality statistics two major epochs are discernible: before 1960, and after 1970. The driving force in the earlier period was a rapid decline in mortality from infectious diseases, which had an impact across the age range but a much larger effect at younger ages. The sharp reduction in infant and child mortality led to a rapid increase in average life span and a marked reduction in the variability of age at death. It did not, however, have a major impact on the maximum life span, which rose very slowly as a result of the more gradual improvement in death rates at older ages.

From the mid-1950s to the late 1960s mortality trends in industrialized countries seemed to stabilize. Then, starting from about 1970, death rates at older ages entered a period of unprecedented decline. Compared with the earlier era of rapid reductions in infant and child mortality, these changes yielded a slower increase in life expectancy at birth. However, the rise in the maximum life span accelerated, driven by a more rapid decline in death rates at older ages. The variability of the life span tended to stabilize during this period, as the entire distribution of ages at death—now concentrated at older ages—moved upward in a parallel fashion. The difference between these two eras is illustrated in Table 4 for Sweden.

Prospects for the Future

The rapid rise in life expectancy before 1950 and its subsequent deceleration are linked to trends in mortality at young ages. By around 1950 infant mortality in wealthy countries was in the range of 20 to 30 per 1,000 births, compared with perhaps 200 to 300 per 1,000 births historically. Since that time infant mortality has continued to decline, and early in the twenty-first century it is below 4 per 1,000 births in the healthiest parts of the world. As babies were saved from infectious disease, their chances of survival to old age improved considerably. Once mortality at young ages was reduced substantially, improvements in life expectancy caused by the reduction of mortality in this age range had to slow down, and further gains had to come mostly from mortality reductions at older ages.

The rise of life expectancy in the leading industrial countries was slower during the second half of the twentieth century than during the first half because it depended on the reduction of death rates at older ages rather than in infancy and childhood. Put simply, saving an infant or child from infectious disease, who then lives to age 70, contributes much more to the average life span than does saving an adult of 70 years from heart disease, who may then live another 10 years. Thus, the deceleration in the historical rise of life expectancy is a product of the J-shaped age pattern of human mortality: relatively high in infancy and childhood, low through adolescence and early adulthood, and rising steeply after age 30. Gains in life expectancy at birth that result from reducing mortality among the young are large, whereas gains resulting from a reduction in old-age mortality are necessarily much smaller.

It is a common mistake to assert that deceleration in the rise of life expectancy at birth, $\mathring{e}_0$, reflects a slowdown in progress against mortality. In fact, the reduction of death rates changed its character in the late-twentieth century, but it did not slow down. At older ages the decline of mortality has accelerated since around 1970. As long as the decline of old-age mortality continues, life expectancy will continue to increase, driven now by the extension of life at older ages rather than by saving juveniles from premature death.

The historical rise in human longevity is the result of a complex set of changes that began several centuries ago. Before the 1930s most of this decline was due to factors other than medical therapy and is generally attributed to improvements in living conditions and public health. With the advent of antibacterial drugs in the 1930s and 1940s, medical treatment began to play an important role in these changes. The role of medicine expanded in the late-twentieth century because of interventions in cardiovascular disease and cancer that have contributed to the rapid decline of old-age mortality. It is important to keep this complex causality in mind when speculating about future trends in human mortality.

It seems reasonable to expect that future mortality trends in the most advanced countries will resemble past changes. Although the focus of efforts to improve health will evolve, the net effect on death rates probably will be similar. Most extrapolations of past trends for the leading industrial countries yield predictions of life expectancy at birth for the sexes combined of around 85 to 87 years by the middle of the twenty-first century. Unexpected events could change the course of these trends. Nevertheless, the historical stability of mortality trends over at least the twentieth century offers strong support for the belief that trends in the twenty-first century will be similar in character.

TABLE 4

Average Change (in Years per Decade) in Key Mortality Indicators, Sweden

Indicator	1861–1960	1970–2000
Average life span (life expectancy at birth)	3.1	1.8
Maximum life span (max. reported age at death)	0.4	1.5
Interquartile range (of deaths in life table)	−5.3	−0.4

Note: The average change shown here equals the difference between mean values for the last and first 10-year periods (within the indicated time interval) divided by the number of years in between.

SOURCE: Author.

See also: *Causes of Death; Demographic Transition; Epidemiological Transition; Health Transition; Life Span; Maternal Mortality; Oldest Old.*

BIBLIOGRAPHY

Acsádi, György, and János Nemeskéri. 1970. *History of Human Life Span and Mortality.* Budapest: Akadémiai Kiadó.

Bell, Felicitie C., Alice H. Wade, and Stephen C. Goss. 1992. Life Tables for the United States Social Security Area. Actuarial Study No. 107, Social Security Administration Pub. No. 11–11536.

Bhat, Mari P. N. 1989. "Mortality and Fertility in India, 1881–1961: A Reassessment." In *India's Historical Demography: Studies in Famine, Disease and Society,* ed. Tim Dyson. London: Curzon Press. pp 73–118.

———. 1998. "Demographic Estimates for Post-independence India: A New Integration." *Demography India* 27(1): 23–57.

———. 2002. "Completeness of India's Sample Registration System: An Assessment Using the General Growth Balance Method." *Population Studies* 56(2): 119–134.

Centers for Disease Control. 1999. "Decline in Deaths from Heart Disease and Stroke—United States, 1900–1999." *Morbidity and Mortality Weekly Report* 48: 649–656.

Crimmins, Eileen M. 1981. "The Changing Pattern of American Mortality Decline, 1940–77, and Its Implications for the Future." *Population and Development Review* 7: 229–254.

Davis, Kingsley. 1951. *The Population of India and Pakistan.* Princeton, NJ: Princeton University Press.

McKeown, Thomas. 1979. *The Role of Medicine: Dream, Mirage, or Nemesis?* Oxford: Basil Blackwell.

Population Reference Bureau. 2002. *World Population Data Sheet.* Washington, D.C.: Population Reference Bureau.

Preston, Samuel H. 1980. "Causes and Consequences of Mortality Decline in Less Developed Countries during the Twentieth Century." In *Population and Economic Change in Developing Countries,* ed. Richard Easterlin. New York: National Bureau of Economic Research.

Riley, James C. 2001. *Rising Life Expectancy: A Global History.* Cambridge, Eng.: Cambridge University Press.

Tuljapurkar, Shripad, Nan Li, and Carl Boe. 2000. "A Universal Pattern of Mortality Decline in G7 Countries." *Nature* 405: 789–792.

Vallin, Jacques, and France Meslé. 2000. *Tables de Mortalité Françaises 1806–1997.* Paris: INED.

Wilmoth, John R., and Shiro Horiuchi. 1999. "Rectangularization Revisited: Variability of Age at Death within Human Populations." *Demography* 36: 475–495.

Wilmoth, John R., Leo J. Deegan, Hans Lundström, and Shiro Horiuchi. 2000. "Increase of Maximum Life Span in Sweden, 1861–1999." *Science* 289: 2,366–2,368.

Wilmoth, John R. 2002. "Human Longevity in Historical Perspective." In *Physiological Basis of Aging and Geriatrics,* 3rd edition., ed. Paola S. Timiras. Boca Raton, FL: CRC Press. pp. 11–24.

INTERNET RESOURCE.

Human Mortality Database. <http://www.mortality.org>.

John R. Wilmoth

MORTALITY DIFFERENTIALS, BY SEX

Sex differences in mortality have varied in different countries, historical periods, and age groups (see Figure 1). During the last quarter of the twentieth century, males had higher mortality than females at all ages in all developed countries and in most less developed countries. However, higher mortality for females was relatively common among young children in less developed countries. During the mid-twentieth century, females also had higher mortality among older children, teenagers, and/or young adults in some less developed countries, particularly in South Asia.

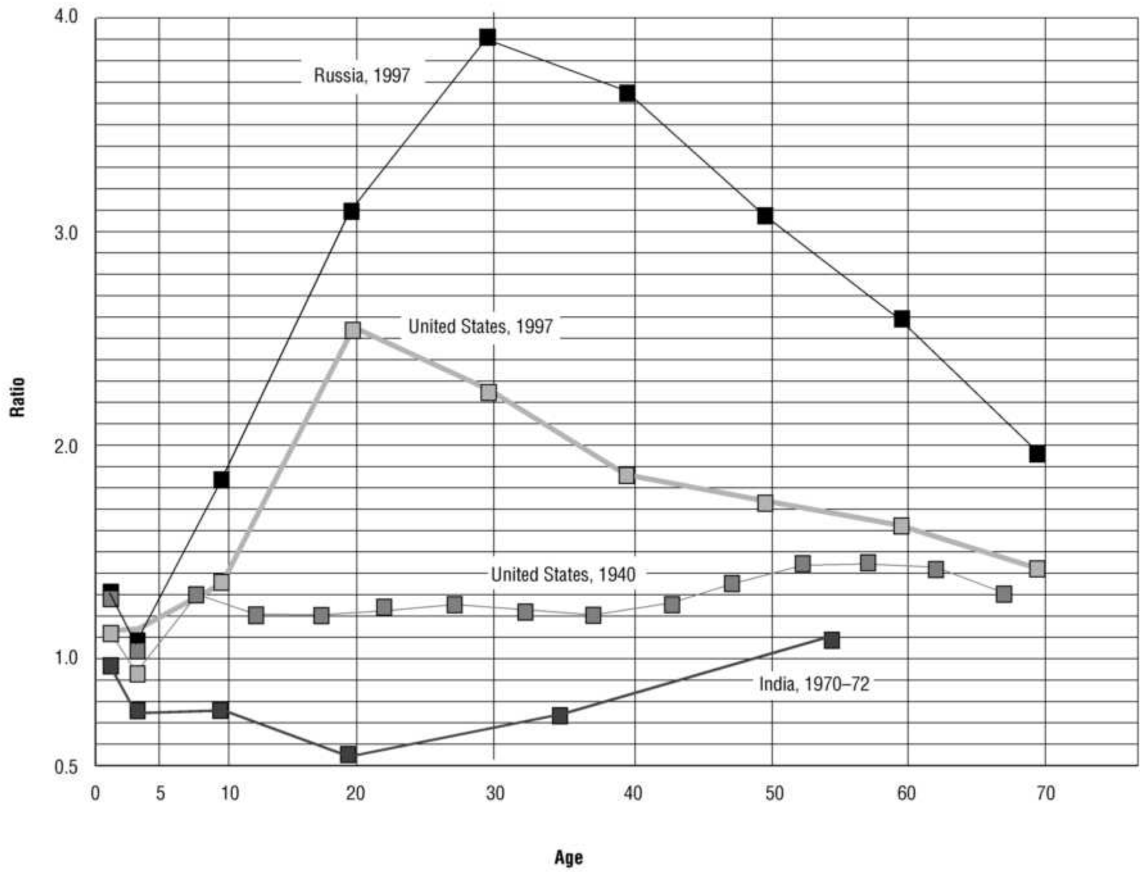
Because males generally had higher mortality than females, males had shorter life expectancies than females in most countries during the period 1950–2000. During the late 1990s, male life expectancy at birth was shorter than female life expectancy by approximately eight years in Europe, six years in North America, seven years in Latin America and the Caribbean, three years in Asia, and two years in Africa. Sex differences in life expectancy varied for different countries within each continent. Probably the largest recorded male disadvantage was in Russia during the late 1990s, when male life expectancy was more than twelve years shorter than female life expectancy. In contrast, males had longer life expectancies than females in some South Asian countries during the mid-twentieth century. For example, in India in the period 1950–1975 male life expectancy was one to two years longer than female life expectancy.

Causes of Death

Major contributors to higher male mortality include coronary heart disease (also known as ischemic heart disease) and injuries, suicide, and homicide (known collectively as external causes of death). For coronary heart disease and for the external causes of

FIGURE 1

Ratio of Male Death Rates to Female Death Rates by Age: Russia, United States, and India, Selected Years



SOURCE: Lopez and Ruzicka (1983); World Health Organization (2002); U.S. Department of Commerce, Bureau of the Census. *Vital Statistics of the United States, 1940, Part 1*. Washington DC: United States Government Printing Office, 1943.

death, males have had higher mortality than females at all ages in all or almost all countries and time periods. Often male death rates have exceeded female death rates by 100 to 300 percent for these causes of death.

Sex differences in cancer mortality and infectious diseases mortality have varied, depending on the specific type of cancer or infectious disease as well as the age range, country, and time period considered. For example, males have had higher lung cancer mortality, but females have much higher breast cancer mortality. Males have often had higher infectious disease mortality than females, particularly in developed countries and among infants and older adults. However, females have had higher infectious disease mortality for children and/or young adults in some less developed countries.

Variation in sex differences in total mortality has been due to variation in the sex differences for specific causes of death and variation in the relative importance of the different causes of death. For example, higher total mortality for females has been observed most often among children and young adults in less developed countries where infectious disease mortality is more likely to show a female excess and where infectious diseases and maternal mortality make substantial contributions to total mortality. In contrast, these causes of death are less important in developed countries where the dominance of external causes of death, coronary heart disease, and lung cancer in total mortality results in males having consistently higher total mortality than females.

Biological, Behavioral, and Environmental Causes

Sex differences in mortality have been influenced by the interacting effects of multiple biological and environmental factors, including the effects of sex hormones on physiology and behavior, as well as cultural and social influences on sex differences in behavior and access to health-promoting resources. The following paragraphs illustrate the diversity of causal factors that have influenced sex differences in mortality for different causes of death.

Males' higher mortality for accidents, suicide, and homicide has been due primarily to a variety of sex differences in behavior and life roles, including males' higher rates of gun use, heavy drinking, physical risk taking in recreation, employment in physically hazardous occupations, and speeding and other risky driving practices. These behaviors have been more expected and accepted for males, and cultural and social influences on sex differences in behavior have contributed to males' higher mortality for the external causes of death. In addition, males' brains are exposed to higher testosterone levels in utero as well as after birth, and this may predispose males to more vigorous physical activity and physical aggressiveness, which contribute to males' higher mortality for the external causes of death.

The consistent male excess in coronary heart disease mortality appears to be due in large part to biological sex differences, including males' greater propensity to accumulate abdominal fat and the apparently protective effects of females' natural sex hormones. These biological effects have been reinforced by males' greater risk as a result of higher rates of tobacco use, especially cigarette smoking, in most countries and time periods.

Sex differences in cigarette smoking have been the main cause of sex differences in lung cancer mortality. In many developed countries in the twentieth century sex differences in smoking increased initially as males adopted cigarette smoking earlier and in greater numbers than did females; subsequently, sex differences in smoking decreased as female smoking became more common and male smoking rates decreased. These trends in sex differences in smoking have been followed by corresponding initial increases and subsequent decreases in sex differences in lung cancer mortality. The delay between the trends in smoking and lung cancer is explained by the substantial lag between initial smoking adoption and the consequent lung cancer mortality.

Sex differences in mortality resulting from infectious diseases have been influenced by multiple and sometimes counteracting biological and environmental factors. Hormonal and genetic effects appear to contribute to lower immune function and greater vulnerability to infectious diseases among males. However, in some regions, especially in South Asia, girls may receive less medical care for infectious diseases, and this may increase their risk of infectious disease mortality. The factors that influence sex differences in infectious disease mortality vary for different types of infectious diseases. For HIV/AIDS, biological sex differences result in a greater female risk of infection as a consequence of heterosexual intercourse with an infected partner, but a greater male risk of infection as a consequence of homosexual contacts. In addition, in many societies males have greater exposure to HIV infection because of greater use of intravenous drugs and multiple sexual partners. Thus, both biological factors and culturally influenced behavioral differences influence sex differences in HIV/AIDS infection and mortality rates.

Trends

Historical data for economically developed countries that are economically developed at the beginning of the twenty-first century show that sex differences in mortality have varied substantially in magnitude and have even reversed direction in some cases in which higher mortality for females during earlier periods was subsequently replaced by higher mortality for males. Higher mortality for females was relatively common among children, teenagers, and/or young adults during the late-nineteenth and/or early-twentieth century. Contributing causes appear to have included higher infectious disease mortality for females and maternal mortality. By the mid-twentieth century these causes of death had become less important and females' status and life circumstances had improved, and so females had lower total mortality than males did at all ages.

By the late-twentieth century in economically developed countries, external causes of death became the largest contributor to total mortality for teenagers and young adults, so in this age range males had much higher mortality than females. The male mortality disadvantage also increased among older adults during the mid-twentieth century, partly as a result of the delayed harmful effects of males' early and widespread adoption of cigarette smoking. As a result of all of these mortality trends, the male disadvantage in life expectancy increased from approximately zero to four years around 1900 to approximately five to nine years in the late 1970s.

During the last few decades of the twentieth century, sex differences in mortality showed contrasting trends in different developed countries. The male mortality disadvantage began to decrease in the United States and some Western European countries, but it increased substantially in Russia and some other Eastern European countries. The increasing male mortality disadvantage in Russia was due primarily to increasing male death rates for external causes of death and cardiovascular diseases, apparently partly as a result of increased binge drinking and other harmful effects of the substantial social and economic disruptions during this period.

In light of the many different interacting factors that influence sex differences in mortality and the difficulty of predicting future trends in many of those factors, it is not surprising that there is a wide range of predictions concerning future trends in sex differences in life expectancy. For example, for developed countries different researchers have predicted increasing or decreasing sex differences in life expectancy during the early decades of the twenty-first century. For Asia and Africa there appears to be a more general agreement that sex differences in life expectancy will show a growing female advantage during the early-twenty-first century, repeating the experience of developed countries during the mid-twentieth century. However, uncertainty concerning future trends in the HIV/AIDS epidemic contributes to uncertainty concerning future trends in sex differences in life expectancy in Asia and Africa.

See also: *Biology, Population; Causes of Death; Infant and Child Mortality; Sex Ratio; Tobacco-Related Mortality.*

BIBLIOGRAPHY

Bobadilla, Jose Luis, Christine A. Costello, and Faith Mitchell, eds. 1997. *Premature Death in the New Independent States.* Washington, D.C.: National Academy Press.

Feachem, Richard G. A., Tord Kjellstrom, Christopher J. L. Murray, Mead Over, and Margaret A. Phillips. 1992. *The Health of Adults in the Developing World.* Washington, D.C.: Oxford University Press.

Lopez, Alan D., and Lado T. Ruzicka, eds. 1983. *Sex Differentials in Mortality: Trends, Determinants and Consequences.* Canberra: Australian National University, Miscellaneous Series No. 4.

United Nations. 1998. *Too Young to Die: Genes or Gender?* New York: United Nations.

———. 2000. *The World's Women 2000: Trends and Statistics.* New York: United Nations.

———. 2001. *World Population Prospects: The 2000 Revision,* Vol. 1: *Comprehensive Tables.* New York: United Nations.

Weidner, Gerdi, Maria Kopp, and Margareta Kristenson, eds. 2002. *Heart Disease: Environment, Stress and Gender.* Amsterdam: IOS Press.

Wizemann, Theresa M., and Mary-Lou Pardue, eds. 2001. *Exploring the Biological Contributions to Human Health: Does Sex Matter?* Washington, D.C.: National Academy Press.

INTERNET RESOURCE.

World Health Organization. 2002. *1997–1999 World Health Statistics Annual.* <http://www3.who.int/whosis/whsa>.

INGRID WALDRON

MORTALITY DIFFERENTIALS, SOCIOECONOMIC

Research on differential mortality generates answers to questions such as the following: To what extent are there within-country differences in mortality between subpopulations defined by area of residence, socioeconomic status, marital status, and other variables? What are the causes of such differences? How and why does the extent of the differences change in time and vary between countries?

The answers to these questions are important from a social and health policy perspective because mortality differentials are useful indicators of the health and well-being of population groups. Studies on differential mortality also contribute to the understanding of the determinants of mortality levels and trends in national populations. For epidemiologists cause-specific mortality differences provide clues to the etiology of diseases.

Research on differential mortality has long traditions. As early as 1901 the Danish researcher Harald Westergaard published a 700-page treatise that summarized the results of hundreds of studies carried out in the nineteenth century. The book by Evelyn M. Kitagawa and Philip M. Hauser published in 1973 is a classic American study on this topic.

This article discusses mortality differentials by socioeconomic status, racial/ethnic group, marital status, geographic area, and rural-urban division. The article focuses on developed countries. The data and research on less developed countries are relatively scarce and mainly concern infant and child mortality.

Mortality Differentials by Socioeconomic Status

Several indicators, such as occupational class, level of education, and income, have been used in studies of socioeconomic differentials in mortality. Information about these differentials usually is not available in regular statistics because the ordinary sources of mortality statistics do not include reliable information on the socioeconomic characteristics of deceased persons. Most knowledge about socioeconomic differences in mortality comes from studies for which data have been specifically collected for an analysis of socioeconomic differences.

Despite the measurement problems there is abundant evidence from different periods and countries showing that persons in lower socioeconomic positions die on average younger than do those in higher socioeconomic positions. For example, Eileen M. Crimmins and Yasuhito Saito (2001) estimated that the difference in life expectancy at age 30 between persons with 13 or more years of schooling and those with less than nine years was 6.7 years among white men and 3.8 years among white women in 1990 in the United States. Among African Americans these differences were, respectively, 11.8 years and 10.5 years.

Many hypotheses about the causes of socioeconomic mortality differences have been offered, but experts differ about their validity. Some hypotheses emphasize the causal effects of differences between classes in working and living conditions, health-related behaviors (e.g., smoking, alcohol use, diet), the prevalence of psychosocial stressors, or access to health services. According to other hypotheses, poor health and certain characteristics of individuals (e.g., social background and intelligence) may affect both their socioeconomic position and their risk of premature death.

Cross-national variation in the extent of socioeconomic differences in mortality in the 1980s was studied in a large project coordinated by John P. Machenbach and Anton E. Kunst from the Erasmus University Rotterdam (1997). Data for thirteen European countries and the United States were used. The mortality of men in manual occupations was higher than that of men in nonmanual occupations in all those countries. The relative excess mortality of the manual class was remarkably similar (ranging from 32% to 44%). However, larger differences were observed for France, the Czech Republic, and especially Hungary.

The results for mortality by cause of death showed that the mortality of manual workers was higher than that of nonmanual employees for nearly all the causes of death distinguished in the study. There was, however, an interesting exception: No class difference was found in mortality from ischemic (coronary) heart disease in France, Switzerland, Italy, and Spain. In Portugal mortality rates were higher in the nonmanual classes than in the manual classes. However, socioeconomic gradients in mortality from causes other than ischemic heart disease were steeper in southern European than in northern European countries.

Socioeconomic differences in mortality have widened in almost all the countries for which data are available, including the United States. The main reason for the increase has been a more rapid than average decline in mortality from cardiovascular diseases among persons with high socioeconomic status.

Differentials by Race/Ethnicity

Few countries report mortality differences by race or ethnicity, but in the United States the white-black division has been used as a standard classification for more than a hundred years. The life expectancy of the black population has always been lower, but the size of the difference has varied. It narrowed from 15.8 years in 1900 to 5.7 years in 1982, increased to 7.1 years in 1993, and declined to 6.0 years in 1998. The increase in the gap from 1983 to 1993 was largely the result of increases in mortality among the black male population caused by HIV infection and homicide.

Since the 1990s more detailed classifications than the white-black dichotomy have been used. For example, Richard G. Rogers and colleagues (2000) studied mortality differences among adult Americans in the period 1989–1995 by using seven race/ethnicity groups. The age- and sex-adjusted excess mortality of African Americans compared to white Americans was found to be 41 percent, but after controlling for social and economic factors (education, income, employment status, and marital status) the excess mortality was only 17 percent. Sixty percent of the excess thus was due to the difference in the composition of the two groups. The mortality of Asian Americans was 31 percent lower than that of white Americans and remained 19 percent lower after controlling for nativity and social and economic factors. The four Hispanic groups distinguished in the study displayed varied mortality levels.

Marital Status

Hundreds of studies since the nineteenth century have shown that married persons live longer than do single, divorced, and widowed persons. One cause for the longer life of married persons is the selection of healthier than average persons into the married state. Selection also occurs on the basis of personal characteristics that affect the risk of death, such as level of education, psychological characteristics, and drinking habits. Another reason for the longer life of married persons is the protective effect of the married state associated with psychosocial factors (less stress and more social support), financial circumstances (more income and better housing conditions), and health behavior (healthier diet, less smoking and alcohol consumption). The adverse effects of divorce and loss of a spouse account for part of the excess mortality of divorced and widowed persons.

A comparative study of seventeen countries from the 1950s to the 1980s by Yuanreng Hu and Noreen Goldman (1990) showed that unmarried (single, divorced, and widowed) men of working age had a clear excess mortality (100% on average) compared to married men in all countries. In most countries divorced men had the highest death rates among the three unmarried groups. Unmarried women also had excess mortality compared with married women, but the excess was smaller (50% on average) than it was among men.

There is variation in the size of marital status differences between both countries and time periods. A general tendency has been an increase in the relative excess mortality of the unmarried groups. As shown by Tapani Valkonen (2002), this increase was particularly pronounced among elderly women in Western and Northern European countries as well as in Canada.

Geographic Differentials and Rural-Urban Differentials

Statistics on mortality for areas within countries, such as states, provinces, municipalities, and neighborhoods, usually show more or less systematic geographic variations. For example, life expectancy is several years higher in southern than in northern regions in many European countries, such as the United Kingdom, Russia, France, and the Scandinavian countries. In the United States there is a zone of low mortality in the north-central part of the country (e.g., Minnesota, North Dakota, and Iowa had life expectancies above 77 years in 1990) and a zone of high mortality in the southeastern region (e.g., Missouri, Louisiana, and South Carolina had life expectancies of 73.5 years or less).

Geographic differentials in mortality can be accounted for partly by differences in the composition of the population by occupational class, education, race/ethnicity, and other characteristics of individuals, but they are not due only to population composition. A large number of studies have shown associations between the level of mortality and a multitude of characteristics of areas, such as climate, mineral content of drinking water or soil, environmental pollution, quality of health services, dietary traditions, income inequality, and social cohesion. The causal interpretation of these results is, however, controversial.

Statistics on mortality by rural-urban division are available for relatively few countries. In the United States mortality is higher in urban than in rural areas. James S. House and colleagues (2000) have shown that this difference cannot be accounted for by differences in the socioeconomic and racial composition of the population. The age-adjusted mortality of city residents was found to be 60 percent higher than that of residents of small towns and rural areas and 40 percent higher than that of suburbanites after the effects of differences in population composition were adjusted for. In Russia and most other former socialist countries mortality is higher in rural than in urban areas. For the Western European countries the evidence is scarce, but it seems that rural-urban differences are small and that their direction varies from country to country.

The size and direction of the rural–urban mortality gap are determined by the balance of the influence of two factors. The higher average income and educational levels favor the urban areas, but the risks connected with urban life (environmental pollution, social stress, violence, smoking, and the use of alcohol and drugs) reduce the positive effects of higher living standards.

See also: *Alcohol, Health Effects of; Causes of Death; Epidemiological Transition; Health Transition; Infant and Child Mortality; Mortality Decline; Tobacco-Related Mortality.*

BIBLIOGRAPHY

Crimmins, Eileen M., and Yasuhiko Saito. 2001. "Trends in Healthy Life Expectancy in the United States, 1970–1990: Gender, Racial, and Educational Differences." *Social Science and Medicine* 52: 1,629–1,641.

House, James S., James M. Lepkowski, David R. Williams, Richard P. Mero, Paula M. Lanz, Stephanie A. Robert, and Jieming Chen. 2000. "Excess Mortality among Urban Residents: How Much, for Whom, and Why?" *American Journal of Public Health* 90(12): 1,898–1,904.

Hu, Yuanreng, and Noreen Goldman. 1990. "Mortality Differentials by Marital Status: An International Comparison." *Demography* 27(2): 233–250.

Kitagawa, Evelyn M., and Philip M. Hauser. 1973. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology.* American Public Health Association. Vital and Health Statistics Monographs. Cambridge, MA: Harvard University Press.

Kunst, Anton E. 1997. "Cross-National Comparisons of Socio-Economic Differences in Mortality." Ph.D. diss., Erasmus University, Rotterdam.

Machenbach, John P., Anton E. Kunst, Adriënne E. J. M. Cavelaars, Fejke Groenhof, José J. M. Geurts, and the EU Working Group on Socioeconomic Inequalities in Health. 1997. "Socioeconomic Inequalities in Morbidity and Mortality in Western Europe." *The Lancet* 349: 1,655–1,659.

Pickle Linda W., Michael Mungiole, Gretchen K. Jones, and Andrew A. White. 1996. *Atlas of United States Mortality.* Hyattsville, MD: National Center for Health Statistics.

Preston, Samuel H., and Irma T. Elo. 1995. "Are Educational Differentials in Adult Mortality Increasing in the United States?" *Journal of Aging and Health* 7(4): 476–496.

Rogers, Richard G., Robert A. Hummer, and Charles B. Nam. 2000. *Living and Dying in the USA: Behavioral, Health, and Social Differentials of Adult Mortality.* San Diego, CA: Academic Press.

Valkonen, Tapani. 2001. "Trends in Differential Mortality in European Countries." In *Trends in Mortality and Differential Mortality,* ed. Jaques Vallin, France Meslé, and Tapani Valkonen. Population Studies No. 36. Strasbourg: Council of Europe Publishing, pp. 185–328.

Williams, David R., and Chiquita Collins. 1995. "U.S. Socioeconomic and Racial Differences in Health: Patterns and Explanations." *Annual Review of Sociology* 21: 349–386.

World Health Organization. 1997. *Atlas of Mortality in Europe: Subnational Patterns, 1980/1981 and 1990/1991.* World Health Organization Regional Publications, European Series, No. 75.

Tapani Valkonen

MORTALITY-FERTILITY RELATIONSHIPS

It is axiomatic that, once death rates in a population have fallen steeply and irreversibly, birth rates must eventually follow. The alternative is rapid population growth that is unsustainable in the long term. However, the characterization of the link between mortality and fertility in classic statements of demographic transition theory has differed. As described in the pioneering 1953 study of the population scientist Frank Notestein, societal modernization was the common cause of declines in both mortality and fertility, though falls in death rates preceded falls in birth rates. In his view, improved survival was a contributory cause of fertility reduction, among many others. By contrast, in 1963, Kingsley Davis the eminent demographer, saw improved survival as the central cause of such decline—both necessary and sufficient. To Davis, societal modernization was largely irrelevant; the effect of improved survival was as strong in subsistence, agrarian societies as in more urban, industrialized settings.

Since these early theoretical contributions, scientists have accumulated a great deal of empirical evidence on the mortality–fertility link at the societal and family level. It has become clear that the relationship is not a simple mechanical one. Though it remains true that mortality decline has always preceded secular declines in fertility, the degree of prior mortality improvement, the absolute level and age pattern of mortality at the onset of fertility decline, and the time lags involved vary widely among societies.

In Europe, improvement in life expectancy typically started in the eighteenth century with the gradual elimination of mortality crises. In the latter half of that century and the early decades of the nineteenth century, gains in life expectancy appear to have been widespread; but this period was followed in some countries by an era of stabilization before further and more pronounced improvements started at the end of the nineteenth century, when the onset of fertility decline also occurred. In much of Europe, declines in childhood mortality preceded falls in infant mortality: Indeed, large improvements in infant survival coincided with fertility decline in many provinces. In some Northern European countries, the crude death rate had fallen to 15 per 1,000 population and infant mortality to about 100 per 1,000 births by the start of fertility transition. Conversely, the crude death rate was about 30 and infant mortality over 250 in much of Eastern Europe and Germany when their fertility transitions started.

In the developing regions, the prior imprint of mortality decline was much more substantial than in Europe. In Asia and Latin America, by 1960, which broadly marks the onset of fertility transition in these regions, mortality at all ages, including infancy and childhood, had been falling sharply for several decades, mainly in response to public health initiatives rather than improved living standards. As a consequence, and also because the pre-transition levels of the crude birth rate were higher than were those in Europe, rates of natural increase were much higher than in Europe at the end of the nineteenth century. In sub-Saharan Africa, large gains in life expectancy occurred a decade or so later, as did the onset of fertility decline. But even in the developing world, societal levels of mortality varied widely at the onset of fertility decline—for instance, ranging from life expectancies of 67 and 60 years in Costa Rica and China to 47 and 45 years in Bolivia and Bangladesh.

These irregularities in the mortality–fertility relationship do not disprove the existence of a strong underlying causal connection between the two. Rather, they may reflect the influence on reproductive behavior of many intervening factors—economic, cultural, and political—that mediate its response to improved survival. Opinion on the causal centrality of the relationship is divided and the difference in emphasis between Notestein and Davis is not yet reconciled. The main reason for this continued uncertainty is the failure to identify strong and convincing linkages between improved survival and fertility.

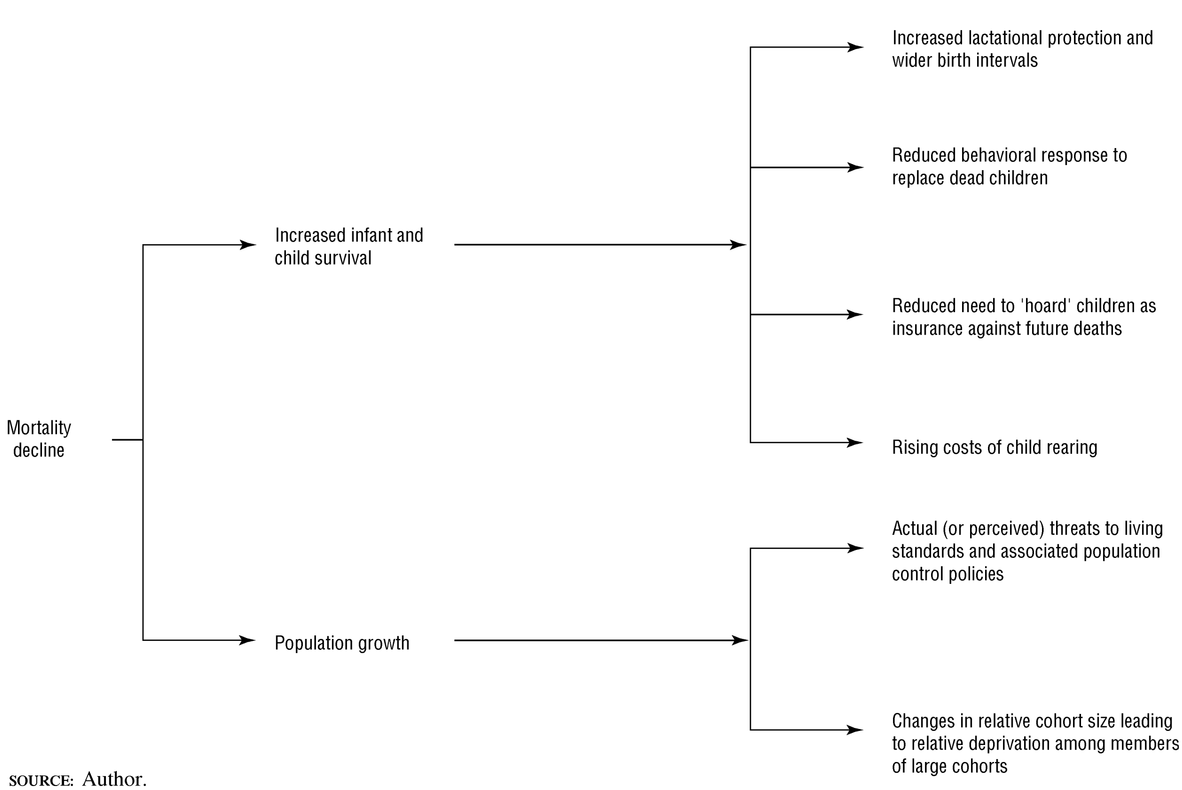
Family-level Links

Possible links between mortality decline and fertility are depicted in Figure 1. Four main links at the family level have been identified. One of these is physiological. Early death of a child necessarily stops breastfeeding; thus lactational protection against conception is lost and the interval to next birth shortened. Moreover, in societies where the custom of prolonged sexual abstinence during lactation is observed, the death of a child may trigger the resumption of intercourse, also contributing to a shortening of the next birth interval. Ample evidence confirms that, in societies characterized by prolonged breastfeeding, reductions in infant mortality will act to lengthen birth intervals and hence reduce the frequency of childbearing. However the effect on fertility of even major reductions in infant mortality in these societies is minor.

Improved survival of children reduces any tendency to replace children who have died and thus represents a second possible pathway of influence. Intentional replacement of children who have died

FIGURE 1

Possible Links between Mortality Decline and Reproductive Behavior



SOURCE: Author.

can only be an important consideration in societies where birth control is widely practiced. But, of course in most of these societies, child mortality is already low and any need to replace dead children is uncommon. In a synthesis of evidence from a variety of transitional and low fertility societies, the demographer Samuel Preston concluded that parents who had lost a child were only 20 to 30 percent more likely to proceed to the next birth than other parents. This effect is also too small to constitute an important part of any overall explanation.

The theory that parents insure against possible future deaths of children by having more children than they would otherwise want is highly plausible. When life expectancy is 30 years (typical of many pre-transitional societies), 4.5 births are required to ensure that two children, on average, survive to the next generation. When life expectancy has risen to 65 years, only a fraction over two births are required to achieve the same outcome. All that is required to imbue this *insurance hypothesis* with causal force is for the adult generation to perceive that survival has improved and to respond by bearing fewer children. Surprisingly, the actualization of this hypothesis has little empirical support. An individual's perception of mortality change corresponds weakly with actual change, and perceptions correlate poorly with reproductive behavior. Moreover, improved child survival is rarely proffered by parents as a reason for having fewer births.

The last of the four family-level links between mortality decline and fertility concerns rising costs of childbearing. To understand the potential explanatory power of this factor, some characteristics of pre-transitional societies need to be outlined. In such societies, only two children per family survived to adulthood per family on average but there was wide inter-family variability. Parents with many children alleviated the costs of nurture by transferring *surplus* offspring to those with few or no children: by fostering, adoption, or offering them as servants or apprentices, for instance. Such redistributive mechanisms appear to have been a common feature in most traditional societies.

Consider the effects of a sustained decline in mortality. The number of surviving children per family doubles, ratcheting up expenditures on food, clothing, education, and so on. At the same time opportunities for children to be adopted by the childless decrease. Moreover, parents themselves survive longer, thus delaying inter-generational transfer of assets. In short, improved survival places a strain on families. Emigration represents a possible, but typically short-term, solution. Sooner or later, reproduction itself is modified, perhaps by postponement of marriage but ultimately by birth control within marriage. This characterization is the kernel of Kingsley Davis's theory.

Several features of this proposed link, between higher survival and lower reproduction, need to be stressed. Unlike the insurance mechanism, it does not depend on accurate perceptions of changes in mortality. The pressure on families does not suddenly appear. Rather it increases gradually but relentlessly. The increase in numbers of surviving children is experienced first by relatively privileged urban sectors of society, the very groups most concerned with providing children with sufficient means to maintain the social position of the family.

This theory is consistent with evidence that, even in subsistence economies, children consume more than they produce until at least the early teenage years. It is also consistent with the most commonly cited reason for wishing to reduce childbearing, namely that childrearing costs are too high. The demographer John Cleland claims that the theory provides coherence to an otherwise baffling body of evidence. Improved survival is the most plausible common underlying cause of the fertility declines that have arisen over a relatively short period (1950–2000) in most developing countries despite their wide economic, cultural, and political diversity. This interpretation, however, is not amenable to empirical appraisal and offers a less compelling explanation of the earlier transition in Europe, when fertility fell in the context of more modest mortality improvements.

Societal Links

Identification of the main societal link between mortality and fertility decline is attributable to English economist T. R. Malthus who claimed that population growth, resulting from an imbalance between death and birth rates, would drive down living standards and thereby produce a resurgence of mortality (the positive check) or a lowering of fertility (the preventive check). The role of such homeostatic forces has been a major theme of historical demography and assumed a new relevance in the context of rapid population growth in the latter half of the twentieth century. In the 1960s, a broad—but by no means universal—consensus arose that rapid population growth posed a serious threat to development goals in Asia, Latin America, and Africa. The main policy response took the form of state-sponsored family planning programs. Such policies have facilitated reproductive change in many developing countries (particularly in Asia), played a minor role in others (particularly in Latin America), and of course played no role at all in the European transition.

The fact that government policies, driven by neo-Malthusian concerns, do not constitute a central part of the mortality–fertility relationship, does not necessarily imply that a Malthusian perspective is invalid. Yet the thesis that negative feedback from population growth, at a societal level, can trigger a fertility response has little support. Fertility has declined in buoyant economies (e.g., Republic of Korea) and stagnant ones (e.g., Kenya), in densely populated countries (e.g., Bangladesh) and in ones with abundant under-utilized land (e.g., Colombia). Nor, despite intensive empirical investigation, is there decisive evidence that rapid population growth has had negative effects on improvements in living standards. Whatever threats further population growth in the twenty-first century may bring, the twentieth century has seen unprecedented improvement in living standards in parallel with unprecended population growth, the exact opposite of Malthusian predictions.

Relative, rather than absolute, deprivation resulting from the effect of mortality decline on age structure is a further possible link. The central idea, derived from the economist Richard Easterlin, is that the economic and social fortunes of a cohort tend to be inversely proportional to its size relative to other cohorts. Mortality decline at younger ages results, some 20 years later, in an increase of young adults relative to older generations. Compared with their parents, these young adults are vulnerable to relative deprivation: The labor market becomes saturated leading to stagnation in wage increases and family assets have to be divided among more survivors. In short, the natural desire of the younger generation to maintain or improve upon the living standards of its parents is jeopardized and this pressure stimulates a reduction in childbearing. In a simple statistical test using data from 184 countries, economist Diane Macunovich found that increases in the ratio of males aged 15 to 24 years to males aged 25 to 59 were more strongly predictive of declines in fertility than were declines in infant mortality. Pending further assessment of such linkages, this thesis remains an interesting possibility.

Conclusion

Mortality decline must remain at the center of attempts to understand the fertility transition of the past 120 years. Steep declines in childbearing from over five births to around two births per woman were only possible in the context of vastly improved survival. Beyond this obvious truth, few other generalizations can be stated with confidence. Because fertility decline occurs under widely differing mortality conditions, it is clear that improved survival, while it is probably the underlying cause, is not the sole nor, in the short term, necessarily the dominant influence.

See also: *Demographic Transition; Fertility Transition, Socioeconomic Determinants of.*

BIBLIOGRAPHY

Cleland, John. 2001. "The Effects of Improved Survival on Fertility: a Reassessment." *Population and Development Review* 27(Supplement):60–92.

Davis, Kingsley. 1963. "The Theory of Change and Response in Modern Demographic History." *Population Index* 29: 345–366.

Macunovich, Diane H. 2000. "Relative Cohort Size: Source of a Unifying Theory of Global Fertility Transition." *Population and Development Review* 26(2): 235–261.

Notestein, Frank W. 1953. "Economic Problems of Population Change." In *Proceedings of the Eighth International Conference of Agricultural Economists.* Oxford: Oxford University Press.

Preston, Samuel H. 1978. "Introduction." *The Effects of Infant and Child Mortality on Fertility,* ed. Samuel H. Preston. New York: Academic Press.

van de Walle, Francine. 1986. "Infant Mortality and the European Demographic Transition." In *The Decline of Fertility in Europe,* ed. Ansley J. Coale and Susan Cotts Watkins. Princeton, NJ: Princeton University Press.

John G. Cleland

MORTALITY MEASUREMENT

This article gives a nontechnical account of the principal indexes used by demographers to measure the level of mortality in a population. For each index, the main advantages and disadvantages are also noted.

Crude Death Rate

The crude death rate is the number of deaths in a population during a specified time period divided by the population "at risk" of dying during that period—that is, for a time period measured in years, the number of person-years lived during the period. For a one-year period, the population at risk is simply the average population size over the year; for a calendar year, the mid-year population is usually taken. By convention, the resulting fraction is applied to a standard-sized population of 1,000, thus making the crude death rate the number of deaths per 1,000 population per year. The adjective "crude" is used since none of the structural characteristics of the population that might affect the number of deaths that occur in the time period—in particular the age distribution—is taken into account, only total population size.

The crude death rate is normally calculated for a single calendar year, although in order to smooth out year-to-year fluctuations, published estimates often give an average rate over several years—typically a five-year period. Calculation of the crude death rate for France in 2000 is shown in Item 1 of the Formula Table.

Pros: It requires less detailed data than other mortality measures, and uses data that are more likely to be available for a very recent time period. The crude death rate is needed for calculation of the rate of natural increase (the crude birth rate minus the crude death rate).

FORMULA TABLE

Examples of Calculation of Mortality Rates

ITEM 1: CRUDE DEATH RATE, FRANCE, 2000

$$\textit{Crude Death Rate (CDR)} = \frac{\textit{Deaths in } 2000}{\textit{Total Population}, \text{ July 1, 2000}} = \frac{536{,}300}{58{,}891{,}913} = 0.00911 = 9.11 \textit{ per } 1{,}000$$

ITEM 2: AGE-SPECIFIC DEATH RATE, RUSSIA, 1999 (MALE)

Age Specific Death Rate (ASDR) for males in age group 55–59

$$= \frac{\textit{Deaths in 1999 to males aged } 55\text{–}59}{\textit{Number of males aged } 55\text{–}59 \textit{ at mid year}} = \frac{87{,}584}{2{,}780{,}444} = 0.031 = 31.5 \textit{ per } 1{,}000$$

ITEM 3: INFANT MORTALITY RATE, IRELAND, 1999

$$\textit{Infant Mortality Rate (IMR)} = \frac{\textit{Deaths in 1999 to infants under age one}}{\textit{Live births in 1999}} = \frac{293}{53{,}354} = 0.0055 = 5.5 \textit{ per } 1{,}000$$

ITEM 4: STANDARDIZED DEATH RATE, EGYPT, 1995

Standardized Death Rate for Egypt 1995 (US standard) — see Table 1

$$= \frac{4{,}443{,}559}{262{,}755{,}270} = 0.0169 = 16.9 \textit{ per } 1{,}000$$

SOURCE OF DATA: Council of Europe (2000); Goskomstat of Russia (2000); National Center for Health Statistics (1997), United Nations Statistics Division (2000).

Cons: It is affected by the population age structure—in particular, by the proportions of elderly, who have a higher than average probability of dying in any given period. For that reason, the crude death rate is not a good indicator of overall mortality for comparisons among countries or regions with differing age structures. For example, the crude death rate of Sweden in 2000, 11 per 1,000 population, is much higher than that of Venezuela, 5 per 1,000. But Sweden had a proportionately much larger elderly population than Venezuela: 17 percent of the population of Sweden was aged 65 and over, compared to only 5 percent in Venezuela. By the measure of life expectancy at birth, Sweden has the lower mortality: its life expectancy in 2000 was 80 years, compared to Venezuela's 73 years.

Age-Specific Death Rates

Age-specific death rates (or age-specific mortality rates) (ASDR) are similar to the crude death rate, but calculated for a individual age groups, typically five-year groups. If calculated for a single year, the numerator of the rate is the number of deaths to persons in the age group during the year and the denominator is the average population in the age group during the year (or the mid-year population). Age-specific death rates are often calculated for each sex separately.

Age-specific death rates normally have a J-shaped distribution over the age range. Death rates are relatively high for infants and young children, low for older children and from the young adult years to middle age, and then become higher with increasing age. (Countries with severe AIDS epidemics are an exception to this pattern: AIDS mortality among young adults and persons of middle age has created a sharp rise in age-specific mortality rates in those ages.) Calculation of the age-specific death rate for Russia in 1999 is shown in Item 2 of the Formula Table.

Pros: It allows analysis of mortality patterns by age and sex. Age-specific death rates are required for the calculation of life tables.

Cons: It requires detailed data on deaths by age group, data that are often not available in developing countries.

TABLE 1

Comparison of Death Rates in Egypt and in the United States, 1995

Age group	US population thousands	US ASDRs (x 1000)	Egypt ASDRs (x 1000)	Actual US deaths in 1995	US deaths in 1995 if Egypt's ASDRs applied
0–4	19,595	1.836	8.1	35,976	158,718
5–9	19,188	0.197	0.9	3,780	17,269
10–14	18,886	0.255	0.8	4,816	15,109
15–19	18,071	0.835	1.0	15,089	18,071
20–24	17,885	1.071	1.0	19,155	17,885
25–29	19,012	1.193	1.3	22,681	24,715
30–34	21,874	1.603	1.6	35,064	34,998
35–39	22,253	2.089	2.4	46,487	53,408
40–44	20,219	2.759	3.5	55,783	70,765
45–49	17,448	3.761	5.8	65,623	101,200
50–54	13,630	5.677	8.6	77,377	117,217
55–59	11,085	8.718	13.9	96,641	154,085
60–64	10,046	13.823	25.0	138,871	251,159
65–69	9,928	20.583	40.9	204,347	406,053
70–74	8,831	31.314	68.2	276,543	602,294
75+	14,773	82.138	162.5	1,213,436	2,400,613
Total	**262,755**			**2,311,669**	**4,443,559**

Note: ASDR is age-specific death rate.

SOURCE: U.S. Census Bureau (www.census.gov); National Center for Health Statistics. 1997. Report of Final Mortality Statistics, 1995; United Nations Statistics Division (2001).

Infant Mortality Rate

The infant mortality rate (IMR) is the proportion of infants who die in their first year. It is conventionally calculated as the number of deaths under age one in a given year divided by the number of live births, with the result expressed per 1,000 births. Calculation of the infant mortality rate for Ireland is shown in Item 3 of the Formula Table.

To be strictly accurate, the IMR in this case should be the number of deaths before age one to infants born in 1999 divided by the number of live births in 1999. This formula would relate infant deaths to the population at risk—in this instance, comprising the births among which such deaths could occur. (It is equivalent to the life table death rate between age zero and exact age one.) The practical problem this precise formulation raises is that deaths under age one from among births in a given calendar year consist of some fraction of infant deaths during the calendar year in question and some fraction of infant deaths that occur in the following calendar year. Hence the precise IMR calculation would require information about infant deaths in two calendar years, and the deaths would need to be classified by the double criterion of age and year of birth. Such detail is rarely available.

Pros: The infant mortality rate is usually considered a good indicator of overall health conditions in a country, particularly child health. Frequently it is used to infer ("impute") the entire age schedule of mortality, using a set of model life tables.

Cons: Accurate registration data on births and infant deaths are unavailable in many countries. (In the absence of such data, estimates of IMR—and of proportions of births surviving to later ages of childhood—at a period several years in the past can be derived from retrospective survey data on survivorship rates of children. Demographic surveys routinely ask women how many children they have had and how many are living.)

Standardized Death Rate

The standardized death rate of a population is the death rate that it would have if the population had the age distribution of some different specified population—the "standard." The concept can be explained in terms of weighted averages. The crude death rate of a population can be represented as the weighted average of the prevailing age-specific death rates, the weights being the proportions of the population at each age. If the weights used in the calculation are instead taken from the age distribution of some different population, chosen as the standard, the resulting weighted average is the standardized (or strictly, the age-standardized) death rate.

For comparisons of death rates among populations, standardization (with the same standard used throughout) removes the effects of the different actual age distributions on the rates. In the example in Table 1, standardization is used to compare the mortality of Egypt and the United States in 1995, using the U.S. age distribution as the standard. In 1995 the United States had 2.311 million deaths in a population of 262.755 million, giving a crude death rate of 8.8 per 1000. The corresponding crude death rate for Egypt was 6.5. The lower level of mortality in Egypt by this measure, however, is an artifact of the age distribution: Egypt's life expectancy at birth, about 65, is some twelve years less than that of the United States. Since reported age-specific death rates of reasonable quality for Egypt are available, it is possible to calculate the number of deaths the United States would have if it had the reported age-specific death rates of Egypt. Table 1 compares the number of deaths at each age using ASDRs of both Egypt and the United States applied to the U.S. age distribution. The deaths that would have occurred in the United States if it experienced Egypt's mortality at each age are about 4.4 million, compared to the 2.3 million deaths that did occur. The resulting death rate for Egypt in 1995, standardized on the U.S. population, is 16.9 per 1,000 population rather than 6.5. (See Item 4 in the Formula Table.)

The technique of standardization is much more general than this example may suggest. Death rates can be standardized by other characteristics than age, or by other characteristics as well as age, the choice depending on the intended comparison.

Pros: Standardization by age allows comparison of death rates abstracting from influences of differences in age distributions.

Cons: It requires data on deaths or death rates by age for both countries and the age distribution of one country. The comparison depends to some degree on the choice of the standard.

Life Expectancy

Life expectancy at any given age is the average number of additional years persons of that age would live under the mortality conditions prevailing at the time. Most frequently, life expectancy is quoted in terms of life expectancy at birth: the number of years a newborn infant can be expected to live under mortality rates at each age existing at the time of its birth.

Life expectancy at age x is calculated in a life table by summing the number of survivors at each single year of age above x (which gives the total person-years lived beyond x in the life table population) and dividing by the number at age x. It is most commonly calculated from age 0, giving the expectation of life at birth.

Pros: Life expectancy at birth is the single best summary measure of the mortality pattern of a population. It translates a schedule of age-specific deaths rates into a result expressed in the everyday metric of years, the average "length of life."

Cons: It requires a full schedule of age-specific death rates. Since mortality typically declines over time, a calculated life expectancy, derived from cross-sectional mortality data, understates the true expected length of life. Subtracting actual age from life expectancy at birth is often erroneously interpreted as giving average remaining years to live.

See also: *Actuarial Analysis; Fertility Measurement; Life Tables; Maternal Mortality; Mortality, Age Patterns of; Population Dynamics.*

BIBLIOGRAPHY

Bogue, Donald J., Eduardo E. Arriaga, and Douglas L. Anderton, eds. 1993. "Readings in Population Research Methodology," Vol. 2: *Mortality Research.* Chicago: United Nations Population Fund and Social Development Center.

Coale, Ansley J., and Paul Demeny. 1983. *Regional Model Life Tables and Stable Populations,* 2nd edition. New York: Academic Press.

Council of Europe. 2000. *Recent Demographic Developments in Europe 2000.* Strasbourg: Council of Europe.

Goskomstat of Russia. 2000. *The Demographic Yearbook of Russia 2000.* Moscow: Goskomstat of Russia.

Lancaster, Henry O. 1990. *Expectations of Life.* New York, Berlin, Heidelberg: Springer-verlag.

National Center for Health Statistics. 1997. *Report of Final Mortality Statistics, 1995.* Hyattsville, MD: National Center for Health Statistics

Pressat, Roland. 1972. *Demographic Analysis: Methods, Results, Applications.* London: Edward Arnold.

Ruzicka, Lado, Guillaume Wunsch, and Penny Kane. *Differential Mortality, Methodologocal Issues and Biosocial Factors.* Oxford: Clarendon Press.

Shryock, Henry S., Jacob S. Siegel, and Associates. 1976. *The Methods and Materials of Demography,* condensed edition. New York: Academic Press.

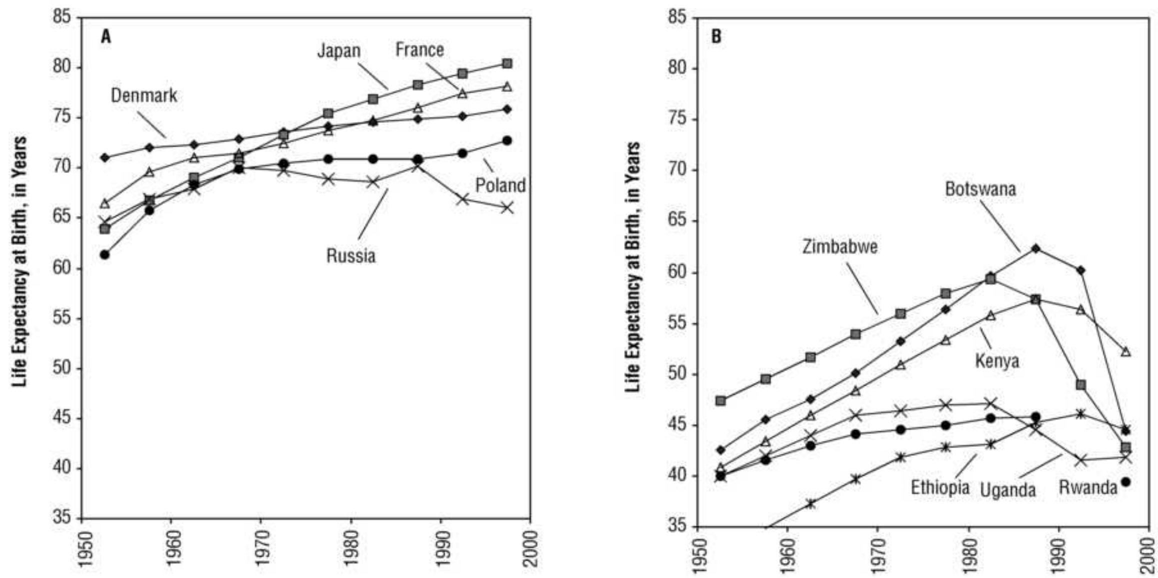
United Nations Statistics Division. 2001. *Demographic Yearbook 1999.* New York: United Nations.

Vallin, Jaques, Stan d'Souza and Alberto Palloni. 1990. *Measurement and Analysis of Mortality, New Approaches.* Oxford: Clarendon Press.

Carl Haub

FIGURE 1

Life Expectancy Trends in Two Groups of Countries, 1950–1955 to 1995–2000



Note: Life expectancy in Rwanda in 1990–1995 is estimated to be 22.

SOURCE: UN *World Population Prospects* (2001). After Caselli, Meslé, and Vallin (2002).

MORTALITY REVERSALS

Declining mortality has long been a routine expectation in most of the world, aside from wartime interruptions. Many forecasts envisage a global convergence to low mortality over coming decades. Mortality reversals refer to exceptions to this long-run trend—situations in which the decline ceases or is even reversed.

Until the last decades of the twentieth century, significant mortality reversals were nearly unknown. The only example occurred in Europe in the first half of the nineteenth century during the early stages of the industrial revolution. Since the 1970s, however, many countries have experienced mortality reversals—most remarkably in Eastern Europe, where mortality increased from the 1970s through the 1990s, and in sub-Saharan Africa, with rising AIDS-related mortality beginning in the 1980s. In both regions, adult-age mortality was much more affected than was the mortality of children or the elderly.

Figure 1 displays trends in life expectancy for two groups of countries. Panel A illustrates a widening of the life expectancy gap between Russia and Poland and selected high-income countries.

Panel B shows striking cases of abrupt drops of life expectancy to extremely low levels in Africa.

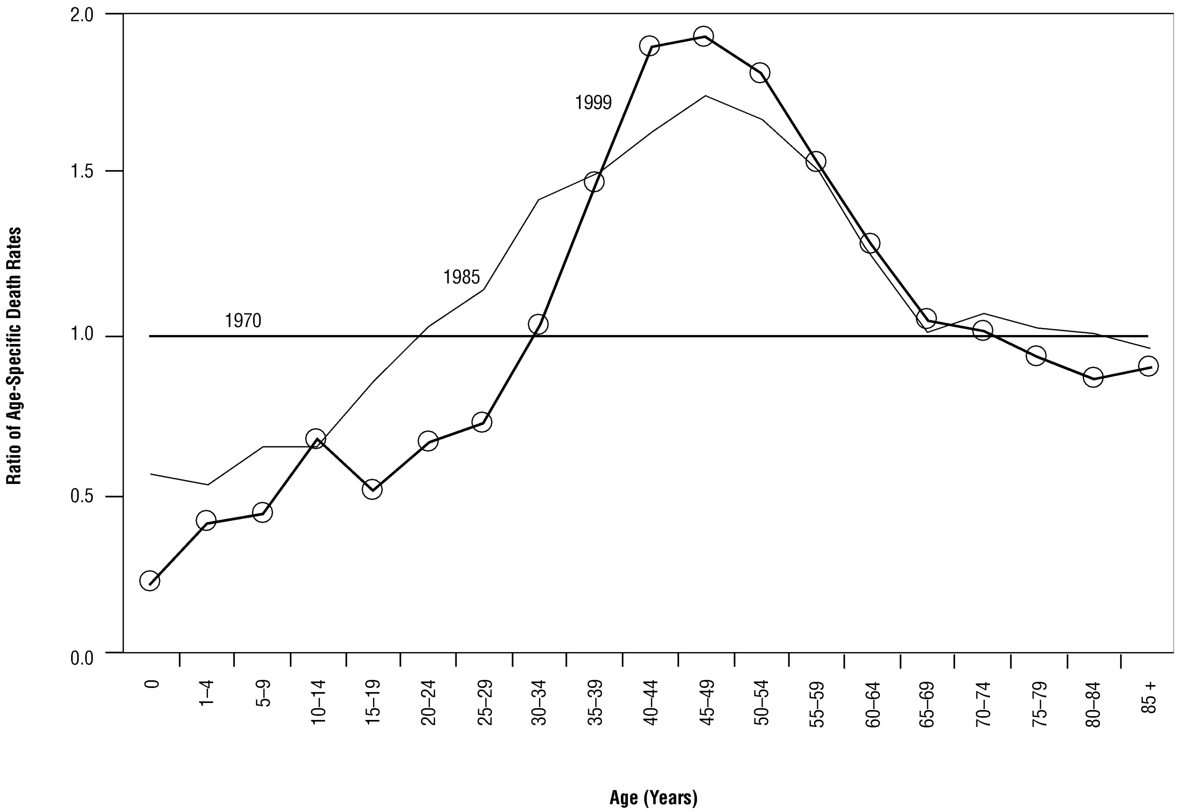
Mortality Reversals in Eastern Europe

Panel A in Figure 1 shows that converging trends in life expectancy between East and West were observed only in the 1950s and the early 1960s. Later the trends in the former Communist countries diverge from those in the market-economy countries. Most remarkably, Russia (and other countries of the former Soviet Union) experienced a gradual decline in life expectancy in the 1970s and a further drop in the 1990s to a low of 66 years. In the 1990s, a previously small gap between Russia and Poland widened, reflecting the probable emergence of a new mortality divide between the former Soviet Union and the rest of Eastern Europe.

The health crisis in Eastern Europe and the former Soviet Union has been analyzed extensively. The effects were seen predominantly in the male population. In the year 2000 male life expectancy at birth in Russia was 59 years—below its level of 60 years in 1955–1956. The corresponding figures for the female population were 72 and 68 years, respec-

FIGURE 2

Proportional Changes in Male Age-Specific Mortality Rates, Hungary: Rates for 1985 and 1999 Compared to 1970



SOURCE: Calculation from data in WHO Mortality Database (2002).

tively. The gender gap in life expectancy varies from 8 to 13 years across the Eastern European region. The concentration of increasing mortality at adult ages is shown for Hungary in Figure 2. In Russia in 2000, men aged 20 had only a 45 percent probability of surviving to age 65; the equivalent probability in Western Europe was about 80 percent.

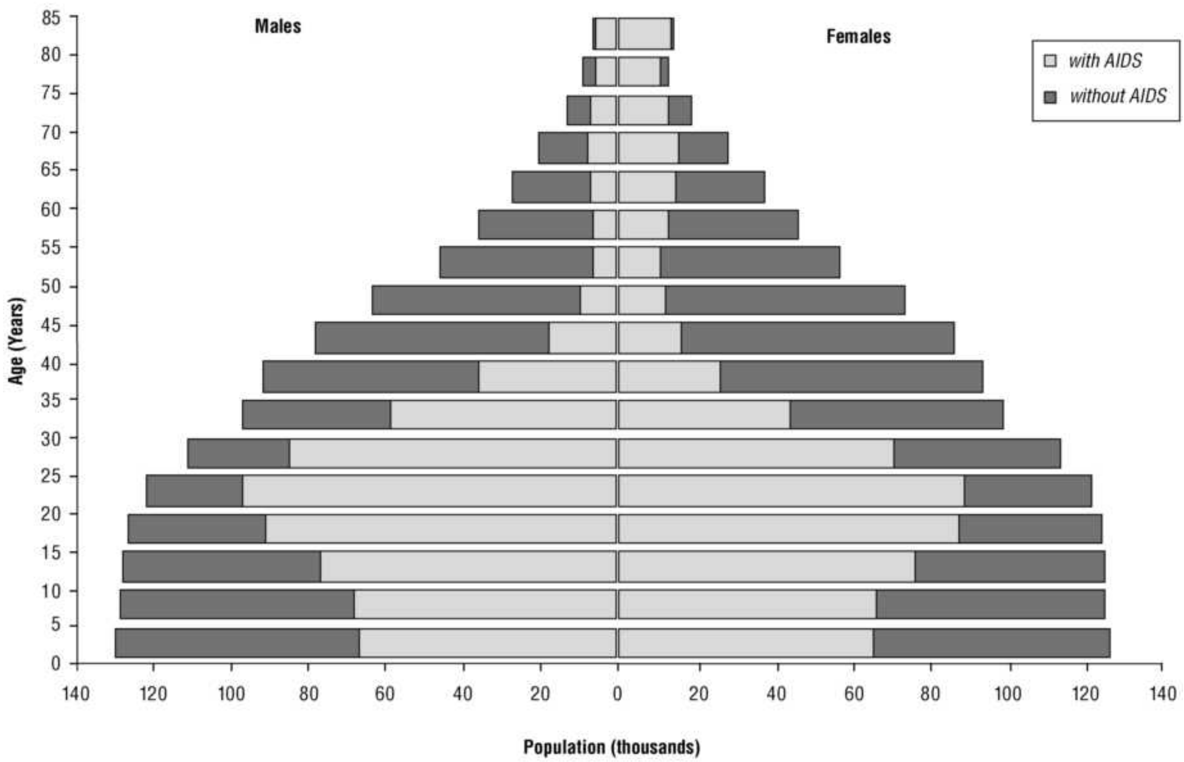
At the same time, in contrast, child mortality in Eastern Europe has been continuously decreasing. Cardiovascular disease, lung cancer, liver cirrhosis, and other behaviorally-linked diseases and injuries were contributing to the mortality increase at adult ages. In countries of the former Soviet Union, mortality from accidents and violence had reached very high levels by the late 1970s and increased through the 1990s. In the 1990s in Russia, mortality attributed to homicide approached the world's highest levels.

Excess mortality in Eastern Europe has been increasingly concentrated among manual workers and low education groups. It is important to note that the worst patterns of excess mortality affecting population groups in Western countries are quite similar to those in Eastern Europe according to age and cause-of-death structures.

The factors underlying the unfavorable mortality trends probably include lack of preventive health programs and inadequate quality of medical services; smoking and alcohol abuse; general neglect of individual health and other individual societal values; and stress, whether caused by a lack of life choices under the former Communist regimes, or by unemployment, relative deprivation, and inability to cope with the economic challenges of post-Communist times.

FIGURE 3

Projected Population Showing Effect of HIV/AIDS Epidemic: Botswana, 2020



SOURCE: UNAIDS (2000).

Mortality Effects of Infectious Disease in Sub-Saharan Africa

Panel B in Figure 1 shows the UN estimates of decreases in the African life expectancies after the late 1980s. Losses are especially high in Zimbabwe and Botswana, bringing life expectancy down to levels not seen in these countries since the 1950s. In Rwanda, the natural trend in life expectancy was severely disrupted by the 1994 genocide and subsequent civil war.

Regular mortality statistics are generally unavailable in the region. Existing estimates are based on household surveys or censuses that include questions about recent household deaths, orphanhood, and survival of children, and *verbal autopsy* questions on causes of death. Mortality increases are found mostly among young adults. The male probability of death between ages 15 and 55 in Zimbabwe increased from 0.15 in the mid-1980s to 0.5 in the late 1990s. The probability of dying between ages 20 and 60 doubled in Uganda and Zambia. In rural Uganda, mortality rates among HIV-positive adults were 15 times higher than those among HIV-negative adults and the probability of death between ages 20 and 60 was about 0.5. Adult mortality rose substantially in East, Central, and Southern Africa; adult mortality also rose in West Africa, but to a far lesser extent. Survey data also show increases in child mortality in countries with the highest prevalence of HIV.

High levels of adult-age mortality and consequent drops in the number of children born will result in profound changes in future population size and age structure, as indicated in the projections for Botswana given in Figure 3.

The factors facilitating a rapid spread of HIV/AIDS in the region are poverty, lack of education, spread of violence, increased spatial mobility (inducing greater promiscuity), gender inequalities, and inadequate health systems.

Poverty increases the risk of infectious diseases in general. Low education is an obstacle to promoting healthy behavioral patterns.

Wars, which have affected many countries in the region, spread HIV through increased prostitution and sexual violence. HIV transmission may also be promoted by polygyny, extramarital sex, and sex between teenage girls and older men.

Economic hardships and an already high burden of infectious diseases account for a lack of access to medical care, resulting in untreated sexually transmitted diseases, unchecked mother-to-child HIV transmission, and a lack of treatment of AIDS-related illnesses.

Conclusion

The experience of the last several decades of the twentieth century suggests that health progress does not continue automatically. Certain combinations of epidemiological situations, socio-economic and socio-psychological conditions, and cultural and behavioral patterns can cause significant mortality reversals.

See also: *AIDS; Alcohol, Health Effects of; Mortality Decline.*

BIBLIOGRAPHY

Caselli, G., F. Meslé, and J. Vallin. 2002. "Epidemiologic Transition Theory Exceptions." *Genus* 58(1): 9–51.

Cockerham, William C. 1999. *Health and Social Change in Russia and Eastern Europe.* New York: Routledge.

Corina, G.A., and R. Paniccià. 2000. "The Transition Mortality Crisis: Evidence, Interpretation and Policy Responses." In *The Mortality Crisis in Transitional Economies,* ed. G. A. Cornia and R. Paniccià. Oxford: Oxford University Press.

Leon, D. A. 2000. "Common Threads: Underlying Components of Inequalities in Mortality Between and Within Countries." In *Poverty, Inequality and Health,* ed. D. A. Leon and G. Walt. Oxford: Oxford University Press.

Quinn, T.C. 2001. "AIDS in Africa: A Retrospective." *Bulletin of the World Health Organization* 79(12): 1156–1158.

Shkolnikov, V. M., F. Meslé, and J. Vallin. 1996. "Health Crisis in Russia I. Recent Trends in Life Expectancy and Causes of Death from 1970 to 1993." *Population: An English Selection* 8: 123–154.

Timæus, I. 2001. "Impact of the HIV Epidemic on Mortality in Sub-Saharan Africa: Evidence from National Surveys and Censuses." *AIDS* 12: S15–S27.

UNAIDS. 2000. *Report on the Global HIV/AIDS Epidemic. June 2000.* Geneva. Joint United Nations Programme on HIV/AIDS.

Vladimir M. Shkolnikov

MULTIPLE BIRTHS

Nearly one in every hundred deliveries is a twin birth. Triplet, quadruplet, and higher order deliveries occur far less frequently—only 1 in 10,000 deliveries. This article concerns only twins.

Twins are of two kinds: identical and fraternal. Biologists call the former monozygotic twins and the latter dizygotic twins, in reference to their different origins.

Identical (monozygotic) twins derive from a single fertilized egg, or zygote, that has divided in two in the course of its development. The two resulting embryos are genetically identical, which explains the close resemblance of monozygotic twins. They are always of the same sex.

Fraternal (dizygotic) twins derive from the ovulation and fertilization of two different ova during the same menstrual cycle. Each of these ova is fertilized by a spermatozoon and the twins resulting from these two eggs or zygotes are no more similar, from a genetic point of view, than ordinary brothers and sisters. Fraternal twins can be of the same sex or male and female, both variants occurring with equal frequency.

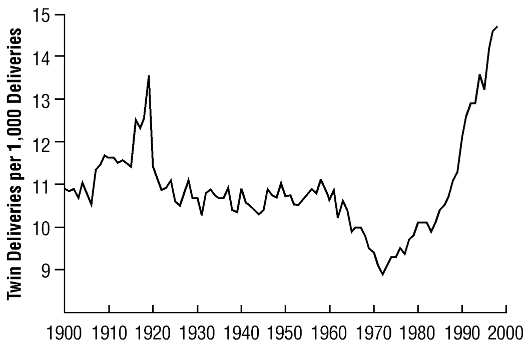
Fraternal and identical twins thus correspond to two distinct biological processes, and their incidence depends on different factors.

The Twinning Rate

The twinning rate is the proportion of twin deliveries in the total number of deliveries.

FIGURE 1

Twinning Rate in France, 1900–1998



SOURCE: Pison (2000).

Identical twin deliveries occur at the rate of 3.5 to 4 per 1,000, regardless of the mother's age, birth order, or ethnic or geographic origin. The same proportion has been observed among all mammals, except for some armadillos that systematically give birth to monozygotic quadruplets or octuplets. All women seem to run the same risk of having identical twins, whether or not they have previously given birth to twins.

In contrast to identical twin births, the proportion of fraternal twin births is extremely variable. The main factors influencing these variations are as follows.

Age of the mother. Beginning with a near zero level at puberty, the proportion steadily increases up to age 37, where it reaches its maximum level, then rapidly decreases back to zero level by the time of menopause. This variation corresponds to that of the Follicle Stimulating Hormone (FSH), which ensures the development of the ova. (The drop in the fraternal twin rate after the age of 37 could be due to weaker ovarian function and to the higher mortality of fertilized eggs as menopause draws nearer.)

Order of birth. Controlling for age of mother, the fraternal twinning rate increases with every childbirth. Birth order is nevertheless less influential than age.

Geographic or ethnic origin. The same variations by mother's age and order of birth are observed everywhere, but the frequency of twinning differs by region. Controlling for age and birth order, the fraternal twinning rate in sub-Saharan Africa is two times higher than in Europe, and four to five times higher than in China or Japan. These differences are partly linked to hormonal differences of genetic origin. Hence, for example, the twinning rate of African-Americans in the United States lies between the European and the African rates.

Individual and family characteristics. Some women may have several sets of fraternal twins; this predisposition to twin pregnancies is partly genetic and can be observed among the sisters and daughters of women who have had twins.

The Influence of Sterility Treatments

In France, in the first half of the twentieth century, the incidence of twin deliveries was about 11 per 1,000, a proportion which did not significantly vary, except during World War I, when the twinning rate temporarily rose. (See Figure 1.) In the 1960s, the proportion of twin deliveries declined, reaching a low 8.9 per 1,000 in 1972. The rate then began to climb again and by 1987, it had risen back to the level of the first half of the century. However, the upward trend did not stop there, and even gained momentum: By 1998, the twinning rate had reached 14.7 per 1,000, a 65 percent increase from 1972. The same downward and upward trends were observed in most developed countries.

A partial explanation for these trends is variation in the mean age of mothers. In France in the 1950s, for example, the mean age was close to 28; it fell to 26.5 in 1977. A rapid increase followed and, by the end of the 1990s, it exceeded 29. However, the most important factor in the steep rise in twinning rates since the 1970s has been the expanded use of sterility treatments. Twinning rates rose especially in developed countries, where such treatments are most available, and particularly among older women, who are more likely to utilize them.

French physicians began to prescribe hormones to stimulate ovulation in 1967. The treatments became so popular that by 2000 some 400,000 menstrual cycles were being stimulated each year. By comparison, the total number of births in France in 2000 was 780,000. In addition, at the beginning of the twenty-first century some 40,000 in vitro fertilization (IVF) procedures are performed per year. In order to improve the likelihood of IVF success, physicians often implant several ova or several embryos at once—2.5 on average in 1997—resulting in a high probability of multiple births. Almost one out of four IVF pregnancies leads to the birth of twins, as opposed to one in 100 for natural pregnancies.

Mortality of Twins

In all parts of the world, the mortality rate of twin babies is much higher than that of singletons, due to their often low birth weight, their tendency to be premature, and more frequent complications at birth. The risk of giving birth to a stillborn twin is three to four times as high as that for a singleton. The mortality rate of twins born alive is also higher than that of singletons. In the first month following birth, the mortality rate for a twin is five to seven times higher than for a singleton, both in countries where infant mortality rates are high and in countries where the rate is low. After the first month, the gap decreases, but, regardless of the overall level of mortality, the mortality rate of twins remains two to three times that of singletons through the first year of life and continues to exceed that of singletons throughout childhood.

See also: *Reproductive Technologies: Modern Methods.*

BIBLIOGRAPHY

Bulmer, M. G. 1970. *The Biology of Twinning in Man.* Oxford: Clarendon Press.

FIVNAT. 1995. "Grossesses Multiples." *Contraception Fertilité Sexualité* 23(7–8): 494–497.

FIVNAT. 1997. "Bilan Général Fivnat, 1997." *Contraception Fertilité Sexualité* 26(7–8): 463–465.

Institut National de la Statistique et des Études Économiques (INSEE). Various years. *La Situation Démographique.* Paris: INSEE.

Office for National Statistics, Great Britain. 1995. *Mortality Statistics in England and Wales. Childhood, Infant and Perinatal.* London: The Stationery Office.

Pison, Gilles. 1992. "Twins in Sub-Saharan Africa: Frequency, Social Status and Mortality." In *Mortality and Society in Sub-Saharan Africa,* ed. Etienne van de Walle, Gilles Pison, and Mpembele Sala-Diakanda. Oxford: Clarendon Press.

INTERNET RESOURCE.

Pison, Gilles. 2000. "Nearly Half of the World's Twins Are Born in Africa." *Population et Sociétés* 360: 1–4. <http://www.ined.fr/englishversion/publications/pop_et_soc/index html>.

Gilles Pison

MULTISTATE DEMOGRAPHY

Multistate demography is the study of populations stratified by age, sex, and one or several attributes, such as region of residence, marital status, number of children, living arrangement, employment status, occupation, and health status. A population that is stratified is a multistate population, and people who occupy the same state constitute a subpopulation. The dynamics of multistate populations are governed by differential fertility and mortality, the transfer of individuals between subpopulations.

A Brief History

Multistate demography was pioneered by Andrei Rogers in the 1960s and 1970s. Rogers's aim was to generalize classical demographic models—the life table, population projection models, the stable population model—from two states (alive and dead) to multiple states of existence. As a specialist in urban and regional planning, Rogers's interest was mainly in regional population dynamics and migration, and the generalization was to a system of regions: a multiregional system. His first results appeared in *Demography* in 1966 and in book form in 1975. The book covers the multiregional life table, the continuous and discrete models of multiregional demographic growth (the Lotka and Leslie models), and the estimation of multiregional demographic measures from incomplete data. Rogers demonstrated that the generalization of demographic techniques to multiple states is relatively straightforward. Changes in multiregional populations are described by systems of simultaneous linear equations, conveniently represented in matrix notation. The broadening of multiregional demography into multistate demography was triggered by Robert Schoen's treatment of a population stratified by marital status (Schoen 1975).

In England, the geographer Philip Rees developed an accounting system for multiregional populations, pursuing some ideas from Rogers and having been influenced by earlier work of the economist Richard Stone (1913–1991), who initiated economic and social accounting in the early 1960s (Rees and Wilson, 1977). Accounts—in this case comprising population stocks and flows—have a great advantage: They must balance. Differences in data type, inconsistencies, and other data problems are easily identified.

From their beginning, multistate models followed the accounting tradition prevailing in demography and the actuarial sciences. Multistate models, and in particular the multistate life table, however, could also be viewed as applications of mathematical statistics, based in probability theory. Supporters of this perspective—Jan M. Hoem, Michael T. Hannan, and others—identified common features of the questions demographers try to answer using the life table and those addressed in the fields of survival analysis and event-history analysis with their focus on models of duration dependence. Age is viewed as a duration variable. The two distinct traditions persist (see Bogue et al. 1993, Chapters 21-22 for an accessible introduction).

Multistate Models

At any point in time, an individual occupies a state, and the distribution of people over the various states determines the population structure. State occupancies change over time as a result of (1) interstate transitions people experience—for example, from being single to being married, from being diseased to being healthy, or from being a resident of one region to being a resident of another region, and (2) differential entries from and exits to the rest of the world. The multistate life table describes how the size and composition of a (synthetic) cohort change over time. Multistate projection models describe how the population structure (stock) at a given time depends on the initial population and the transitions people make (flows).

The dynamics of a multistate population—a cohort or an age-graded population—are based on transition rates and transition probabilities. Rates relate the number of transitions people make to the *duration* at risk of a transition. Probabilities relate transitions to the *population* at risk at the beginning of an interval.

Transition rates and transition probabilities are estimated from the data. The estimation of probabilities directly from the data is complicated in the presence of censoring (i.e., if individuals enter or leave the population during the period of observation for a reason unrelated to the transitions being studied). In survival analysis, the concept of *risk set* has been introduced to distinguish the population at risk of experiencing an event during an interval from the population present at the beginning of that interval. The estimation of rates does not present that problem since the transitions are related to the time spent in the origin state during the interval. In this approach, people may enter and/or leave a state during an interval. Transition rates must be converted into probabilities. The task is straightforward if the rates vary between age intervals but not within age intervals, or when the transitions that occur during an interval are uniformly distributed.

Applications

Early applications considered populations stratified by age and region of residence. The life table was used to estimate the regional distribution of members of a synthetic cohort and the number of years spent in the different regions. For example, using data from the 1980 census and vital statistics, Rogers (1995, p. 91) found that a person born in New York and subjected to migration and mortality patterns of the late 1970s, may expect to live 74 years, of which 18 years are in the South including 3 years in Florida. The period in the South is concentrated at higher ages. The life table also gives the number of migrations cohort members may experience in a lifetime. Rogers and Frans Willekens (1986) present multiregional life tables for several countries. Multiregional population projections are used widely because regional populations change more in response to migration than to fertility or mortality. A multiregional model is the only one that considers migration by origin and destination.

Another popular area of application is family and household demography. The life table produces indicators such as the probability that a marriage ends in a divorce, the mean age at divorce, the expected duration of marriage at divorce, and the expected number of divorces in a lifetime. It also reports the probability that a married woman at a given age, 32 (for example), will experience a divorce within 10 years and the probability that she will be divorced at age 60 (for example). The multistate life tables follow women and men through their marital careers. The text *Family Demography* (1987), edited by John Bongaarts, Thomas Burch, and Kenneth

Wachter, which includes descriptions of the marital careers of American women, children's experiences with different types of families, and the family types generated over the life course of a cohort, has stimulated the development and application of multistate models. Multistate projection models allow researchers to move beyond the widely used headship rate method and to consider changes in the number and types of families and households in terms of the demographic events people experience and the transitions they make to new family or household types.

Epidemiology and public health are other important areas of application of the multistate models. The state space distinguishes states of health and may consider specific diseases, impairments, disability or handicaps. The life table estimates the probability that a person of a given age develops a disease over a period of 5 years, 10 years, or a lifetime, and adds the probability of recovery if data permit. It also yields estimates of expected duration of the disease. Kenneth Manton and Eric Stallard (1988) developed multistate life tables for chronic diseases. Historically, multistate models have been applied and further developed in epidemiology and public health, in particular to assess the length of healthy life and the effect of risk factors on morbidity and mortality. A review by D. Commenges (1999) reveals, however, that many studies using multistate models do not stratify the population by age and do not use a multistate life table. Commenges concludes that "the strong effect of age is not very well taken into account" (1999, p. 332). The situation is changing, however, age is becoming a significant time scale in epidemiology and is leading to the new subfield of life-course epidemiology. A paper on the cardiovascular life course by Anna Peeters and others (2002) illustrates how the multistate life table may be used to describe a particular disease history of a cohort and how the life table may be used to improve the estimates of lifetime risk of the disease and years with the disease attributable to risk factors.

As the area of application is extending into new fields of research, the multistate life table is developing into a technique that moves beyond the description of a (synthetic) cohort into a method that accounts for intra-cohort variation. Two developments are currently under way. The first considers the effect of covariates on transition rates and probabilities. The multistate life table with covariates generalizes the semiparametric Cox model and parametric duration models to multiple and transient states. This change is a movement toward the construction of synthetic individual biographies rather than cohort biographies. That action requires techniques of microsimulation to produce samples of individual life histories on the computer that are consistent with the empirical evidence on life histories. The second development results in probabilistic multistate life tables that account for the effects of sampling variation. The most modern procedure is to produce probabilistic life tables using bootstrapping.

The prediction of individual life histories combining data on the individual and on people with similar characteristics, and accounting for the uncertainties involved, may initiate a new era in which the multistate life table becomes an instrument for life planning and contingency analysis.

See also: *Event-History Analysis; Life Tables; Migration Models; Renewal Theory and the Stable Population Model; Stochastic Population Theory.*

BIBLIOGRAPHY

Bogue, Donald J., Eduardo E. Arriaga, and Douglas L. Anderton, eds. 1993. *Readings in Population Research Methodology.* Chapter 21: "Survival and Event History Methods"; Chapter 22: "Multistate Methods." Chicago: Published for the United Nations Population Fund by Social Development Center.

Bongaarts, J., T. Burch, and K. Wachter, eds. 1987. *Family Demography.* Oxford: Clarendon Press.

Commenges, D. 1999. "Multi-state Models in Epidemiology." *Lifetime Data Analysis* 5: 315–327.

Hannan, Michael T. 1984. "Multistate Demography and Event History Analysis." In *Stochastic Modeling of Social Processes,* ed. A. Diekmann and P. Mitter. Orlando, FL: Academic Press.

Hoem, Jan M., and U. F. Jensen. 1982. "Multistate Life Table Methodology: A Probabilist Critique." In *Multidimensional Mathematical Demography,* ed. K. C. Land and A. Rogers. New York: Academic Press.

Manton, K. G., and E. Stallard. 1988. *Chronic Disease Modelling: Measurement and Evaluation of the Risks of Chronic Disease Processes.* London: Charles Griffin.

Peeters, A., A. A. Mamun, F. Willenkens, and L. Bonneux. 2002. "A Cardiovascular Life History:

A Life Course Analysis of the Original Framingham Heart Study Cohort." *European Heart Journal* 23: 458–466.

Rees, Philip, and A. Wilson. 1977. *Spatial Population Analysis.* London: Edward Arnold.

Rogers, Andrei. 1975. *Introduction to Multiregional Mathematical Demography.* New York: Wiley.

———. 1995. *Multiregional Demography: Principles, Methods, and Extensions.* New York: Wiley.

Rogers, Andrei, and F. Willekens, eds. 1986. *Migration and Settlement: A Multiregional Comparative Study.* Dordrecht, Netherlands: Reidel.

Schoen, Robert. 1975. "Constructing Increment-Decrement Life Tables." *Demography* 12: 313–324.

———. 1988. *Modeling Multigroup Populations.* New York: Plenum Press.

Frans Willekens

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NATIONAL SECURITY AND POPULATION

National security issues can be defined narrowly as immediate threats of violence to a society—terrorism, war, revolution, ethnic/religious/regional conflicts. National security issues can also be defined more broadly to include diffuse and non-violent threats to the well-being of a society, such as damage to the environment, problems of disease and public health, and reductions in present or future economic welfare. Demography is relevant to both kinds of national security. Under certain conditions, as Myron Weiner and Sharon Stanton Russell (2001) have shown, demographic changes can increase both the risks of violence, and the degree of diffuse and non-violent threats to well-being.

Demographic Variables and National Security

Scholars such as Thomas Homer-Dixon and Jessica Blitt (1998) have pointed to a number of demographic variables as relevant to issues of national security. These include the size and density of a country's population and its rate of growth; the proportion of population that is urban and the urban growth rate; the age structure of the population; the rates of internal and international migration; the internal composition of the population with regard to ethnicity, regional identity, or religion; the rates of social mobility, literacy, and education; infant mortality and life expectancy; and the distribution of income.

However, few of these variables have simple, uniform effects on national security across time and space. To understand their impact requires careful examination of how they interact with, or exacerbate, other factors leading to violent conflict or diffuse harm.

Violent Environmental and Demographic Security Threats

Because populations must exist in a physical space, from which they draw the resources to survive and reproduce, the effects of demographic structure and change in any population are inextricably bound up with the conditions of the environment, particularly the flows and stocks of renewable and non-renewable resources available either within the national boundaries of the population in question or through exchanges with other populations. Changes in population that affect the ratios of population (or population segments) to key resources generally have impacts on national security, as do changes in key resources on which the population (or population segments) depends. The term "environmental and demographic security threats" recognizes this intertwining.

Violent environmental and demographic security threats (VEDS) arise when the relationship between a population (or populations) and its environment increases the risks of war, revolution, terrorism, and ethnic or other violent conflicts. A number of demographic variables seem to be correlated with such conflicts. Countries with larger and denser populations appear to have more civil conflicts and greater involvement in international wars. In addition, the proportion of men aged 15 to 24 in the total population aged 15 and above correlates with the frequency and magnitude of war conflicts. Countries with higher rates of infant mortality also appear to have a higher rate of revolutions and ethnic/religious/regional conflicts.

However, many of these relationships are simple correlations—that is, there is a relationship between demographic conditions and violence, but that relationship could be due to other combinations of factors than simply population characteristics. For example, if some of the world's most populous countries (e.g., China, India, Indonesia, Nigeria, Pakistan) are also very poor, and poor countries have more conflict, then cross-national studies would show a correlation between population size and conflict, even though that relationship may actually be due to another causal relationship. To test such relationships, political scientists have subjected VEDS issues to multivariate analysis.

So far, multivariate studies such as those by Nils Petter Gleditsch (1998) and by Wenche Hauge and Tanja Ellingsen (1998) have tended to undermine most of the claims made for the importance of VEDS threats. Population pressure on resources does *not,* in general, lead to war or other violent conflicts. For example, one of the most obvious needs of populations is for fresh water, and there are many areas in the world where large populations in arid or semi-arid regions seem poised to clash over control of river basins. Yet as Aaron Wolf (1999) has pointed out, examining numerous cases of potential water-related conflicts, wars over water have almost never occurred. Rather, countries find it preferable to negotiate water rights rather than engage in costly military strife, simply because the costs of water conservation and negotiated agreement are almost always far less than the costs of armed conflict.

In addition, population size, density, growth rates, and age-structure have been shown in some studies, such as that of Jack Goldstone and colleagues (2000), to have no effect on the risks of violent internal conflicts when one controls for such other factors as regime type, involvement in international trade, and the presence of conflicts in neighboring countries. Such studies have shown that whether or not conflicts have "pass[ed] the threshold of violence definitely depends on *sociopolitical* factors and not on the degree of environmental degradation as such" (Baechler 1998, p. 32; emphasis in original).

Thus, there are no simple and direct effects of population characteristics on violence. Nonetheless, under certain conditions, demographic considerations do affect violence. This depends on the degree to which political elites use demographic factors as a basis for mobilizing populations for conflict.

Political violence is rarely a simple response to poverty or religious or ethnic differences. Such violence is the result of the inability of government institutions to diffuse and channel conflicts into constructive efforts for change, and more specifically the result of a choice by elites to mobilize populations or particular groups for organized violence against others. Where demographic factors produce violence, it is through their impact on state capacity, and on elite interests and choices. The demographic and political characteristics and the related material interest of elites are important elements in conflict, as are conditions that affect the opportunities for elites to mobilize followers for violence.

The ability of the state to manage growing populations is a key factor. Where a country's population grows faster than the government's revenues, administration and welfare provision become increasingly difficult. Criticism of the state is likely to mount along with state debts, and elites are more prone to oppose a decaying government. Among elites, if their numbers are growing rapidly relative to the growth of the economy, and hence of jobs suitable for elites, they are more likely to become polarized and initiate violent conflicts over control of the government and resources. In addition, where elites are drawn from all major ethnic or religious groups in a society, there seems to be less violence. However, where elites are concentrated in one dominant ethnic or religious grouping that excludes and discriminates against other groups, violent conflict is a greater risk. Finally, countries with greater material deprivation (as indicated by higher rates of infant mortality, or scarcity of land or jobs for peasants and workers) often have large populations that can readily be tempted by elite promises of better material conditions in return for enlisting in campaigns of violence. This is especially true in societies with larger proportions of urban population, and of young men, as such societies have potentially more people who are concentrated and easily mobilized for group violence. Goldstone (1991) has shown how these effects contributed to numerous rebellions and revolutions throughout history, including the English and French Revolutions, and the Taiping Rebellion in China.

Because certain demographic conditions can create opportunities favorable for elites to mobilize populations for violence, researchers examining particular cases of conflict often find demographic preconditions such as rapid population increase, high rates of urban growth, and large youth cohorts. However, this does not mean that *in general* such conditions conduce to violence. Rather, population growth can lead to violence where state revenues, economic growth, and the expansion of elite positions fall behind the demands created by population increase. Countries with fiscally sound governments, strong economic growth, and stable elites can avoid violent conflicts regardless of demographic conditions.

It is also notable that several of the demographic conditions often associated with violence—mass migrations, poverty, and religious/ethnic concentrations—are more often the *result* of violent conflicts than their cause.

Non-violent Environmental and Demographic Security Threats

In contrast to violence, the range of non-violent environmental and demographic security (NEDS) threats is widespread; but doubts about the severity of these problems remains high. Damage to the atmosphere—mainly in regard to ozone destruction and global warming—has led to extensive international negotiations and treaties, although thus far these have only been effective with regard to controlling ozone depletion. Debates on the magnitude of the threat to global well-being from climate changes due to human activity continue to hamper political agreements. Other areas of international conflict and negotiations over environmental and demographic threats noted by Goldstone (2001) include concerns over the extinction of species; loss of tropical and temperate forests; the generation of acid rain or particulates; over-fishing of oceans or estuaries that depletes fish stocks; the spread of harmful biological agents, such as pathogens or perhaps undesirable genetic elements from genetically-modified biota; and environmental damage to agrarian regions or other population/resource imbalances that lead to large and unexpected international migrations.

All of these NEDS threats are affected by changes in the size, density and geographic distribution of populations. In particular, larger populations, dispersed over larger areas, generally increase their use of energy for production and transportation, and destroy habitat and spread pathogens. Population changes thus tend to increase NEDS threats if their consequences are not appropriately controlled.

However, control of such threats is often difficult because actions and events in one country can create NEDS threats in others. Acid rain and particulates are carried thousands of kilometers by high altitude winds; over-fishing affects all countries that exploit a given fishery; carbon emissions or forest destruction affect global and not just local atmospheric and weather conditions. Efforts to deal with NEDS threats often stumble on the need to build complex international agreements that meet the needs of countries at vastly different levels of economic development and with very different degrees of responsibility for the creation of such threats.

In sum, the relationships between demographic variables and national security are varied and complex. Simple and direct relationships are absent; rather, contingent and indirect relationships dominate. In the area of VEDS threats, demographic conditions generally facilitate, rather than cause, political violence, creating more or less fertile ground for elites to mobilize groups for violent action. Yet elite conditions and motivations, and the political institutions that regulate elite interaction, are the key factors that determine whether violence will arise. For the more diffuse NEDS threats, dealing with the impact of population growth and dispersion seems critical. However, political factors again are key, for the international agreements that seem necessary to regulate NEDS threats have been difficult to achieve, given the varied goals and prospects of different countries.

See also: *Ethnic Cleansing; Forced Migration; Geopolitics; Lebensraum; Refugees, Demography of; War, Demographic Consequences of.*

BIBLIOGRAPHY

Baechler, Günther. 1998. "Why Environmental Transformation Causes Violence: A Synthesis." *Environmental Change and Security Project Report of the Woodrow Wilson Center* 4: 24–44.

Gleditsch, Nils Petter. 1998. "Armed Conflict and the Environment." *Journal of Peace Research* 35: 381–400.

Goldstone, Jack A. 1991. *Revolution and Rebellion in the Early Modern World.* Berkeley: University of California Press.

———. 2001. "Demography, Environment, and Security." In *Environmental Security,* ed. Paul Diehl and Nils Petter Gleditsch. Boulder, CO: Westview Press.

Goldstone, Jack A., Ted Robert Gurr, Barbara Harff, Monty Marshall, Robert Bates, Tom Parris, Colin Kahl, and Marc Levy. 2000. *State Failure Task Force Report: Phase III Findings.* McLean, VA: Science Applications International Corporation.

Hauge, Wenche, and Tanja Ellingsen. 1998. "Causal Pathways to Conflict." *Journal of Peace Research* 35: 299–317.

Homer-Dixon, Thomas, and Jessica Blitt. 1998. *Ecoviolence: Links Among Environment, Population, and Security.* Lanham, MD: Rowman & Littlefield.

Weiner, Myron, and Sharon Stanton Russell. 2001. *Demography and Security.* Oxford: Berghahn Books.

Wolf, Aaron T. 1999. "'Water Wars' and Water Reality." In *Environmental Change, Adaptation, and Human Security,* ed. Steve Lonergan. Dordrecht, Netherlands: Kluwer.

JACK A. GOLDSTONE

NATURAL FERTILITY

The concept of natural fertility was first defined by the French demographer Louis Henry (1911–1991) in the 1953 study, "Fondements théoriques des mesures de la fécondité naturelle," to refer to the fertility of a population not practicing any form of birth control. In 1961, he gave a more precise definition in two papers. In "Some Data on Natural Fertility," published in *Eugenics Quarterly,* and frequently quoted, Henry stated clearly that he preferred the qualifier *natural* to *physiological* or *biological* because "social factors may also play a part—sexual taboos, for example, during lactation" (Henry 1961, p. 81). He also suggested a simple means for separating controlled fertility from natural fertility: "control can be said to exist when the behavior of a couple [at a given age or marriage duration] is bound to the number of children already born and is modified when this number reaches the maximum which the couple does not want to exceed" (p. 81).

The role of marriage—a typical non-biological variable—was implicit in this definition because Henry was in fact interested in marital fertility: Out-of-wedlock births were rare in the France of the *ancien régime* (the fifteenth through eighteenth centuries). Even with this restriction, the levels of natural fertility that he found exhibited a wide range, varying by a factor of two. The highest recorded total fertility in a population is around ten children per woman; but in some parts of seventeeth-century France fertility—also taken to be natural—was below five children per woman. This variation is due to both behavioral factors (age of marriage, sexual behavior, duration of breastfeeding) and biological factors (fecundability, the post-partum non-susceptible period, the rate of fetal wastage—which vary both among individuals and among populations). It has been estimated that a woman who is continuously in a sexual union between the ages of 15 and 50 years, not breastfeeding her children, and not practicing any form of birth control, would bear 15 children on average.

Although age-specific marital fertility rates may vary among natural-fertility populations, the age profile of these rates is characteristic. This property has been used to develop models of fertility (for example, the Coale-Trussell model) which, fitted to the observed fertility schedule from any given population, can give an indication of how far the observed rates are from the standard profile, and thus how far fertility in that population is from a natural regime. The widely-used decomposition of fertility into its proximate determinants, the framework developed by John Bongaarts, also owes much to the scheme developed by Henry.

The concept of natural fertility is explicitly based on the absence of attempts by couples to *limit* the number of their children, not on the absence of efforts to *space* them. Strictly speaking, spacing behavior that was independent of the number of children born could not be detected. It is however, very unlikely that a population would develop an effective form of spacing behavior that was independent of any limiting intentions. Breastfeeding could be construed to be such a practice. However, its primary aim is to help the child survive and grow; it is impossible to separate this purpose from a possible attempt by the mother to space her births as a way of controlling their final number.

See also: *Fecundity; Fertility, Proximate Determinants of; Fertility Control, Indirect Measurement of; Henry, Louis.*

BIBLIOGRAPHY

Coale, Ansley J., and James Trussell. 1974. "Model Fertility Schedules: Variations in the Age-Structure of Childbearing in Human Populations." *Population Index* 40(2): 185–258.

Henry, Louis. 1953. "Fondements théoriques des mesures de la fécondité naturelle." *Revue IIS* 21(3): 135–151.

———. 1961. "Some Data on Natural Fertility." *Eugenics Quarterly* 8(2): 81–91.

Leridon, Henri. 1989. "Fécondité naturelle et espacement des naissances."*Annales de démographie historique 1988,* pp. 21–34.

Leridon, Henri, and Jane Menken, eds. 1979. *Natural Fertility/Fécondité Naturelle.* Liège, Belgium: Ordina.

Henri Leridon

NATURAL RESOURCES AND POPULATION

Human survival in places with clement climate requires only a constant supply of oxygen and drinkable water and digestible food; no more was available to human's earliest hominin ancestors. Subsequent evolutionary processes, marked by extraordinary increase of brain capacity and resulting in the worldwide radiation of human species, extended the human need for natural resources to phytomass and zoomass (poles, branches, leaves, fibers, skin, sinews, furs, bones) used to construct simple shelters, clothes, and tools. Transition from migratory foraging to sedentary existence based on permanent agriculture expanded the requirements to a much greater variety of resources that were increasingly subjected to some kind of processing—relatively simple milling and fermenting of grains, more complicated firing of clays to produce bricks and ceramics, or elaborate smelting and forging of a growing array of metals.

Acquisition and Use of Resources

This trend of widening resource acquisition and more sophisticated processing has been accelerating since the mid-nineteenth century. It has become difficult to think about any part of the Earth's natural capital that is not either already exploited or seen as a potentially useful input into some process or service. And human ingenuity keeps creating new resources even from the oldest and simplest materials. Sand (silica dioxide) got its first upgrade more than 2 millennia ago when the Roman engineers began using it to make concrete. The second, unheralded, elevation of sand came in 1918 when Jan Czochralski discovered how to grow large silicon crystals. Half a century later his process was deployed on an industrial scale to produce thin semiconductor wafers for photovoltaic cells that power satellites and that may, within a few generations, produce a large share of electricity.

Determining the Magnitude of Resource Bases

Resource base is the totality of a commodity present in the biosphere and in the Earth's crust. Although this changes naturally only over long periods of evolution, measuring it is seldom easy. Resource base quantification is relatively straightforward only for such entities as the total volume of surface water, the area of potentially arable land, or the aggregate volume of wood in a particular forest biome. In contrast, it is very difficult to measure not just minerals in the Earth's crust but also such diffuse and mobile living resources as ocean fish and marine mammals. Not surprisingly, these uncertainties lead to recurrent disputes about the ultimate amounts of globally recoverable fossil fuels and ores (engendering periodic "running out" scares) and make the management of ocean fisheries or conservation of endangered marine mammals a matter of continuing controversy (American estimates of whale numbers are much below Japanese estimates).

Renewable and Nonrenewable Resources

Moreover, the distinction between renewable and nonrenewable resources is not as clear as it may seem at first. Clearcutting of forests on steep slopes, overgrazing of pastures, and improper agronomic procedures are among common malpractices that open the way for excessive soil erosion, loss of organic matter and plant nutrients, decline in soil's moisture-storing capacity, and, in arid areas, an often irreversible desertification. These environmental changes may make it impossible to restore the forest or to sustain highly productive grazing and crop cultivation. Similarly, excessive withdrawals of surface water for irrigation and industrial and urban uses can eliminate (entirely or seasonally) previously copious river flows; neither the Colorado River nor the Huanghe (Yellow River) now reach, respectively, Baja California and Bohai Bay for most of the year. They can also deplete aquifers—such as the great Ogallalla reservoir that underlies the croplands of the Great Plains or the huge aquifers under the Saudi Arabian sands whose water irrigates wheat in the midst of a desert—at rates far exceeding the pace of their slow natural recharge.

Historical Debates on Resource Scarcity

Concerns about the balance between human numbers and natural resources have exisited ever since the beginning of modern industrial expansion when, in 1798, they were eloquently formulated by T. R. Malthus (1766–1834) in the first edition of his *An Essay on the Principle of Population.* Malthus's pessimistic conclusions—that "the power of population is indefinitely greater than the power in the earth to produce subsistence for man" and that "this natural inequality . . . appears insurmountable in the way to the perfectability of society"—have been surely among the most cited sentences of the nineteenth and twentieth centuries. In the second (1803) and subsequent editions of the essay, however, Malthus was more sanguine. In fact, the true Malthusian bequest is not a message of despair but a judicious mixture of understandable concern about the human future and confident hope for progressive solutions, a judgement that continues to be vindicated by gradual improvements of the human condition.

The economist David Ricardo (1772–1823) raised another concern regarding agricultural resources in *The Principles of Political Economy and Taxation,* published in 1817. He argued that the new land brought into cultivation as population grows will be steadily less fertile, and thus its produce increasingly costly. Within a few generations these worries had receded, thanks to the unprecedented availability of extrasomatic energies. Massive flows of fuels and electricity that are used to produce and to power the field and processing machinery and to synthesize agricultural chemicals have virtually eliminated hard physical labor in modern food production and turned the farmers in affluent countries into mere controllers of inanimate energy flows. The same process is underway in all rapidly modernizing low-income countries.

A third kind of worry was about running out of mineral resources. In 1865 William Stanley Jevons (1835–1882), one of the leading economists of the Victorian era, published *The Coal Question,* in which he rightly connected the rise of British power with the widespread use of coal converted to the mechanical energy of steam but wrongly concluded that coal's exhaustion must spell an inevitable demise of national greatness. In forecasting coal demand he made the two perennial errors of long-range forecasting by vastly exaggerating future demand for the fuel and grossly underestimating human inventiveness. After examining all supposed substitutes for coal (wind, water, tides, atmospheric electricity, peat, and petroleum) he concluded that it is "of course . . . useless to think of substituting any other kind of fuel for coal" and that future advances in science "will tend to increase the supremacy of steam and coal."

As it turned out, his worries were groundless. During the first years of the twenty-first century, rapidly dwindling numbers of British miners are extracting less coal every year than does Colombia or Turkey, not because the United Kingdom has no coal left (its remaining reserves are a hefty 1.5 billion tons), but because the country has little need for it as it has become the world's ninth largest producer of crude oil and the fourth largest producer of natural gas and a substantial exporter of both of these hydrocarbons.

Future Resource Supplies

But these realities do not mean that concerns about the scarcity of natural resources and about their role in economic growth have disappeared; they receded during the last decades of the nineteenth and during the first half of the twentieth century, but its second half was punctuated by flare-ups of such worries even as the costs of all basic commodities were steadily declining or, at worst, remained fairly stable. These apprehensions ranged from the 1952 warning by the Paley Commission that the United States does not have all of the material resources necessary for its development to the latest round of predictions about an imminent peak (before 2010) of global oil extraction and the subsequent inexorable decline of world oil supplies. Most famously, in 1973 the modeling study *Limits to Growth* predicted that, according to its "standard" world model run, the global economy and the Earth's population will collapse "because of nonrenewable resource depletion" and an unbearable spike in environmental degradation well before the end of the twenty-first century.

New discoveries, resource substitutions, technical innovation, economic adjustments, and extensive global trade in relatively scarce commodities have repeatedly turned these catastrophically framed scenarios into yet another set of failed forecasts. Britain's experience is an excellent example of a universal trend of resource substitutions evident not only in transitions to new sources of energy (the post-1850 sequence being wood, coal, crude oil, natural gas, new renewables) but also in shifts in using structural materials (in machine construction: wood, iron, steel, aluminum, composites; in buildings: wood and stone, bricks, concrete, steel and glass) or in the ways people communicate across long distances (running messengers, horse riders, wired telegraphy, wireless broadcasting). The last sequence is a perfect example of dematerialization, a broad civilizational trend toward using smaller specific amounts of resources.

Evidence of this admirable trend is everywhere, whether measured in macroeconomic terms (e.g., consumption of primary energy or basic metals per unit of GDP) or expressed as resource needs for particular products or services (engine mass/installed automobile power; gasoline consumed/distance; irrigation water or nitrogen fertilizer per unit of crop yield). And in some instances the need for a particular resource has entirely disappeared; reserves of copper ore deposits and the price of the metal used to be a recurrent worry for a society depending on highly conductive wires—but they are of little concern for cellular telephony, satellite TV, and the Internet. Innovative substitutions have not been the only means of dematerialization and of allaying concerns about the exhaustion of mineral resources: higher efficiencies of resource use and increasing rates of recycling have extended the available supplies and helped to lower the cost of virtually every mineral resource.

As a result, and in spite of growing populations and advancing economies, national and global consumption of some key resources has actually declined in absolute terms. Perhaps the most surprising example in this category has been the decline in water withdrawals in the United States; between 1980 and 1995 the U.S. GDP expanded by nearly 55 percent (in real terms) while the country's total water use fell by 10 percent. However, for many resources, from aluminium to urea, the trend of relative dematerialization has been going hand in hand with increasing rates of absolute consumption.

Even so, there have been hardly any exceptions to the long-term secular decline of inflation-adjusted commodity prices. No insurmountable shortages of nonrenewable resources are foreseen during the twenty-first century, which should be marked by the necessarily slow but epochal transition to renewable sources of energy and by a slow shift toward many bioengineered materials.

The main resource challenges of the twenty-first century will be concerned with environmental impacts of resource use rather than with resource availability. The most intractable global concern is the loss of those natural resources that are critical for maintaining irreplaceable environmental services. Destruction of tropical and marine biodiversity and large-scale transformation of remaining natural ecosystems due to human interference in grand biospheric cycles are high on this list of worries. Combustion of fossil fuels and deforestation alter the global carbon cycle; applications of nitrogen fertilizers and emissions of nitrogen oxides from combustion introduce large amounts of reactive nitrogen into the biosphere; sulfur, and nitrogen, oxides are the principal cause of acidifying deposition. A dire but conceivable environmental scenario would have the biosphere experiencing more pronounced and faster global warming than at any time during the last 1 million years.

Regional Resource Scarcities

There are justifiable local and regional concerns about the future availability of some key resources. The most acute of these is the availability of water in some 40 arid African and Asian countries extending from Mali to Iran. As with nearly every other perceived resource scarcity, a large part of the solution to water shortages lies not in tapping new sources but in reducing considerable waste (caused by low and subsidized prices and by poor efficiencies of water use due to improper irrigation, outdated industrial processes, and leaky urban distribution) and by deploying available techniques that allow for virtually perfect water recycling.

Another effective solution to these local and national resource scarcities is through trade based on comparative advantage. As production of a kilogram of grain needs more than 1000 kilograms of water, rainy and fertile places have an obvious comparative advantage in grain production. In a rational world there would be no wheat produced in Saudi Arabia, nor any alfalfa in California. Unfortunately, extensive government subsidies (amounting globally to more than $1 billion per day for agricultural production alone) lead to an enormous misallocation and waste of resources. Even a very conservative appraisal of the world's natural resources cannot find any reasons why they could not support dignified life for a population that may be finally approaching the global plateau and that may avoid yet another doubling. But given the naturally uneven geographic distribution of every major resource it would be impossible to achieve that goal through national and regional autarky.

Cornucopians and Catastrophists

Cornucopian dismissal of any concerns about the quantity and quality of the world's natural resources derives from the record of indisputably admirable innovation, technical fixes and socioeconomic adjustments that have been able, so far, to prove all modern Cassandras wrong. Indicators that matter point in the right direction as resources have been able to support a higher quality of life for larger populations: infant mortality is down, life expectancy, income, and schooling rates are up. In contrast, catastrophists see the emerging scarcities of some natural resources, and equally indisputable examples of worldwide environmental change and degradation, as harbingers of worse things to come. Some important indicators that matter point in the wrong direction: the Earth's biodiversity is declining, simplification and homogenization of ecosystems is progressing, and the signs that the biosphere is in trouble can be found anywhere from the rapidly rising incidence of childhood asthma to the fact that the 1990s were the warmest decade since the beginning of instrumental records.

Both the cornucopians and the catastrophists are right—and they are both wrong. The historical record is both inspiring and discouraging; the future looks very promising but also quite perilous. The civilization of the early twenty-first century would not be the first whose mismanagement of resources (as opposed to their actual availability) would be the cause of its decline or even of its demise. But our innovative drive, our technical prowess, and our understanding of how the biosphere works gives us the capacity to avoid that fate. The outcome is not preordained one way or the other but will be determined by our choices.

See also: *Carrying Capacity; Deforestation; Ecological Perspectives on Population; Energy and Population; Food Supply and Population; Land Use; Limits to Growth; Sustainable Development; Water and Population.*

BIBLIOGRAPHY

Coyne, Mark S., and Craig W. Allin, eds. 1998. *Natural Resources.* Pasadena, CA: Salem Press.

Dahlberg, Kenneth A., and John W. Bennett, eds. 1986. *Natural Resources and People: Conceptual Issues in Interdisciplinary Research.* Boulder, CO: Westview.

McLaren, Digby J., and Brian J. Skinner, eds. 1987. *Resources and World Development.* Chichester, Eng.: Wiley.

Simon, Julian L., ed. 1995. *The State of Humanity.* Oxford: Blackwell.

Smil, Vaclav. 1994. *Global Ecology.* London: Routledge.

———. 2002. *The Earth's Biosphere: Evolution, Dynamics, and Change.* Cambridge, MA: MIT Press.

Vaclav Smil

NITROGEN CYCLE

Only three elements cycled through the biosphere form stable compounds that can be transported both in water and air: carbon, sulfur, and nitrogen (N). The N cycle is peculiar, not only because the element's largest biospheric reservoir (nitrogen gas, N_2, in the atmosphere) exists in an unreactive form, but also because it is largely mediated by bacterial metabolism. A small number of bacterial species are the only organisms that can fix N—that is, convert it from inert N_2 to reactive ammonia (NH_3). Bacteria also convert NH_3 to soluble nitrates (nitrification), which are the main source of the nutrient for plants; decompose organic matter (ammonification); and close the N cycle by reducing nitrates back into N_2 (denitrification). N, together with phosphorus and potassium, is one of the three plant macronutrients and its shortages were the most common cause of low crop yields in all pre-industrial agricultures. N is also a key constituent of amino acids, the building blocks of proteins, adequate intake of which is essential for human growth and health.

Traditional farmers could supply the nutrient by either recycling organic materials (crop residues, manures, human waste) or by planting leguminous crops, which contain symbiotic *Rhizobium* bacteria, and can break down the inert atmospheric N_2 and synthesize reactive ammonia, NH_3. However, even the most assiduous recycling of organic wastes and the highest practicable planting of legumes in climates that allow year-round cultivation would result in crop yields that could support no more than five or six persons per hectare on an almost totally vegetarian diet. Guano and Chilean nitrate, commercially introduced after 1840, offered only a limited expansion of supply of reactive N.

The barrier to agricultural productivity growth, and hence to population carrying capacity, imposed by limits on the availability of nitrogen was broken by German chemist Fritz Haber's discovery of the synthesis of NH_3 from its elements (in 1909) and its speedy conversion to a large-scale industrial process by the BASF (Badische Anilin & Soda Fabrik) chemical company under the leadership of German industrial chemist Carl Bosch (in 1913). Thereafter, production of synthetic nitrogenous fertilizer became a major worldwide industry. Widespread use of N fertilizer accelerated after the mid-1960s with the introduction of new high-yield varieties of wheat and rice. American agronomist Norman Borlaug, one of the key architects of this Green Revolution, concluded that N fertilizer was responsible for its forward movement.

In the early twenty-first century, nearly 90 million tons of nitrogen are applied to crops each year, mostly to cereals and other annuals. In affluent nations, these applications help to produce an excess of food in general, and of animal foods in particular, and they boost agricultural exports. At least one-third of the world's population is alive at the beginning of the twenty-first century because of the additional food produced by application of N fertilizers—the nitrogen in the world's population dietary proteins comes from inorganic fertilizers. Moreover, given the balance of population numbers and cultivable land, and disregarding food imports from other countries, most of the anticipated future population growth in Asia could not take place without proteins synthesized by using N from urea, the world's leading N fertilizer.

The rising dependence on inorganic N represents the most pronounced human interference in the biospheric N cycle. More than half of all N fertilizer leaches into waters, volatilizes as NH_3, or is denitrified before it can be assimilated by plants. Environmental consequences of these losses include eutrophication of both aquatic and terrestrial ecosystems, contamination of waters with nitrates, and generation of nitrous oxide, a potent greenhouse gas, from imperfect denitrification. These effects can be reduced by adopting appropriate agronomic practices, as well as by more efficient feeding of animals, proper treatment of urban sewage, and reduction of the intake of animal foods.

See also: *Food Supply and Population; Land Use; Sustainable Development.*

BIBLIOGRAPHY

Smil, Vaclav. 2000. *Cycles of Life.* New York: Scientific American Library.

Vaclav Smil

NOMADS

Nomads are people who move in order to survive. True nomads have mobile housing and no settlements, although many mobile populations group together for parts of the year and many have some form of fixed settlement. There are three main types of nomads: hunter-gatherers, livestock herders, and travelers (Roma, or gypsies). Few demographic data are available for any of these groups for a variety of reasons: They are often despised minorities, their mobility hinders demographic data collection, they usually live in low-density remote areas, and they frequently refuse to provide information.

Nomads are found throughout the Old World. It is impossible to quantify their numbers past or present, although these populations probably decreased substantially throughout the twentieth century as a result of forced (e.g., Iran, Mongolia, China) or voluntary (Middle East, Africa) sedentarization. Many nomads still live in central Asia and Africa, with a few reindeer herders living above the Arctic circle and a few Bedouin residing in the Middle East.

Pastoral nomadism, whatever the animal species kept, is highly specialized and, at least in more recent decades, usually exploits environments that are unsuitable for agriculture. However, all pastoralist populations depend substantially on mutual exchanges with agricultural and urban communities, and the boundaries between them are often blurred; this hinders the study of the demography of nomads. People and communities may slip in and out of nomadic lifestyles, depending on particular political, economic, or climatic situations.

African Pastoral Nomads

This article focuses on African pastoral nomads, the only populations for which reasonable demographic data are available. African pastoralists move throughout the year, as the essential resources required for their herds fluctuate over time and space. A range of theories have been developed about the demography of African pastoral nomads, and this may explain the relative wealth of data on them.

Colonial administrators were interested in the demography of their subject populations as sources of labor and for purposes of taxation. That colonial understanding of nomad demography continues to influence perceptions of nomads' demographic behavior. Nomads were thought to have low fertility, high mortality, and often a high prevalence of sexually transmitted diseases. These ideas were rarely based on reliable data and reflected a mistrust of these populations, with their uncontrollable mobile lifestyle. The belief that nomads had low fertility probably was a result of colonial administrators' inability to find and count mobile people; however, the perception of low nomad fertility and relatively low population growth rates persists today.

Traditional pastoral nomads have decreased in number over recent decades, although mobility remains an integral part of survival strategies for many groups. The nomadic proportion of the population has declined as a consequence of sedentarization, diversification out of pastoralism, government pressure, droughts, war, and impoverishment. With the exception of Mauritania and Somalia, African pastoral nomads are national minorities and are usually both politically and spatially marginal, living far from capital cities in low-population-density environments where the provision of public services is poor. Low educational opportunities and participation have reinforced their marginalization. Largely untouched by family planning and health interventions, they represent some of the few "natural fertility" regimes left in the world.

This marginalization has repercussions for researchers understanding of their demography, as nomadic populations are frequently excluded from demographic sample surveys: Sampling frames for them are difficult to establish, and interviewing is expensive. Census data on nomads are also poor. For example, in Mali most nomads live in the northern regions of the country, which have been omitted or only fractionally covered in all principal demographic surveys since 1963. In Kenya the 1998 Demographic and Health Survey excluded the seven districts dominated by nomadic pastoralists. Demographic data for these nomadic and seminomadic pastoralist groups usually come from small community studies.

Environment and Mobility

Contemporary African nomadic pastoralists generally live in semiarid areas that are unsuitable for agricultural production and have extreme seasonal variation. This spatial peripheralization has been exacerbated in the last half of the twentieth century by population growth and expansion of agricultural areas, pushing nomadic pastoralists farther toward arid areas where extensive livestock production is the only way of exploiting the erratic rainfall.

The disease burden might be expected to be low because of low population density, fewer problems of fecal disposal, less water-borne disease (especially malaria), and population groups of insufficient size to maintain disease epidemics. That may have been the case in the past. However, because of scant investment in health, education, and transport infrastructure, most nomadic populations in the early twenty-first century are severely disadvantaged in terms of health and related services relative to countrywide averages, and this is likely to be reflected in their morbidity and mortality. Strong seasonal variation in energy balance (nutritional intake and energy expenditure) has a substantial impact on conception rates of the Turkana (Kenya) and the nutritional status of the WoDaaBe (Niger). R. A. Henin (1968) suggests that the physical demands of mobility may lead to an increased incidence of miscarriages.

Constraints of a Pastoral Economy

Unlike subsistence agriculture, pastoralism can achieve substantial economies of scale; therefore, there may be few economic benefits to having many children, although this depends on both herd composition and herding strategies. A nomadic pastoral economy has to balance human population growth with herd growth; this is difficult to achieve when animals reproduce relatively slowly and are subject to rapid fluctuations in a risky environment. Various strategies for coping with this problem have been documented: maintaining low fertility through delayed marriage and social acceptance of many divorcees and widows (Tuareg, Maure, Rendille, Baggara), although other regimes appear to maximize fertility (Turkana, Maasai); out-migration; and economic transformation and sedentarization of surplus population (Tuareg, Rendille, Turkana, Fulani, WoDaaBe, Maasai). Out-migration or economic transformation can provide immediate responses to population—resource imbalances; fertility reduction is a longer-run adjustment. Until recently some West African low-fertility pastoral nomads (Tuareg, Maures) had substantial dependent slave populations who provided labor that otherwise might have been performed by children. In subsistence crises slaves could be jettisoned.

Fertility and Mortality

Aside from the questionable colonial reports mentioned above, there is little evidence that East African nomads have low fertility. Data from 1998 for the Maasai in Kenya and Tanzania show very high levels of fertility (total fertility rates of 8.2 and 6.4, respectively). In Kenya the more nomadic pastoral Maasai had higher fertility than did the sedentary agropastoral Maasai; the opposite was true in Tanzania. Completed fertility for the Turkana, another Kenyan nomadic group, in the 1980s was around 6.6, with substantial variation according to whether the population was going through a good (high fertility) or a poor (low fertility) climatic period. In East Africa nomadic pastoral production is relatively labor-intensive and women contribute substantially to the household economy, and there are economic advantages to men in having many wives and offspring. Among Sudanese and some West African nomadic pastoralists fertility may be lower. However, the few studies that allow a comparison of the fertility of nomadic and nonnomadic groups of the same ethnic origins show inconsistent patterns; for example, the nomadic Fulani of Burkina Faso had higher fertility (completed parity 8.0 compared to 6 to 7 in sedentary groups), whereas the Sudanese Baggara and Khawalha nomads had lower fertility than did the corresponding sedentary groups.

Nomadic pastoralists' nuptiality regimes often have a significant fertility-reducing impact. Tuareg and Maures have relatively high proportions of women who never marry and substantial numbers of widowed and divorced women at reproductive ages. In the Rendille traditional marriage system one-third of women are not permitted to marry and reproduce until all their brothers are married, a practice that is rationalized in terms of herd management and raiding but that has long-term consequences for population growth. In contrast, Maasai marriage patterns maximize the time women spend reproducing.

Comparatively little is known about nomads' mortality. Data problems are compounded by the fact that many nomadic groups, particularly Maasai and Samburu, have strong taboos against discussing dead people. Paul Rada Dyson-Hudson and Peggy Fry (1999) put together a series of estimates (direct and indirect) of child mortality in East and West African pastoral populations spanning 40 years, finding probabilities of death up to age 5 (${}_5q_0$) ranging from 0.21 (for Turkana and Rendille in the 1990s) to 0.48 (FulBe in the Malian inner delta, an exceptionally unhealthy environment). In Burkina Faso overall Fulani ${}_5q_0$ was about 0.23 in the 1990s, but that of the more nomadic population was substantially lower than that of the sedentary. Recent studies of previously nomadic Tuareg in Mali suggest that ${}_5q_0$ declined substantially from about 0.35 in the 1970s to around 0.2 in the late 1990s. This variability indicates that there is not a single nomadic mortality regime but context-specific mortality, a conclusion confirmed by the existence of substantial mortality differentials by Tuareg social class.

Data are even scarcer for adult mortality. Indirect estimates from 1981–1982 data based on orphanhood proportions show extremely high adult mortality for Tuareg (Mali) men and women compared to neighboring sedentary populations but with substantial differences both within and between Tuareg groups. A later restudy (2001) of the same Tuareg population suggests little improvement in adult female mortality in the interim and an estimated lifetime risk of dying from maternal causes of one in eight.

Despite limited and low-quality data, the picture of African nomad demography is one of "natural fertility" populations in which nuptiality is the main factor constraining fertility. As would be expected in isolated populations with little formal education and limited access to health services, mortality is relatively high. The substantial variation between and within nomadic populations suggests that this is not a consequence of nomadism per se, although a contributory factor is the fact that a nomadic economy in the early twenty-first century is possible only in marginal isolated zones.

See also: *Hunter-Gatherers; Indigenous Peoples.*

BIBLIOGRAPHY

Hampshire, Kate, and Sara Randall. 2000. "Pastoralists, Agropastoralists and Cultivators: Interactions between Fertility and Mobility in Northern Burkina Faso." *Population Studies* 54(4): 247–261.

Henin, Roushdi A. 1968. "Fertility Differences in the Sudan." *Population Studies* 22(1): 147–164.

Little, Michael A., and Paul W. Leslie, eds. 1999. *Turkana Herders of the Dry Season Savanna.* Oxford: Oxford University Press.

Muhsam, H. V. 1966. *Beduin of the Negev: Eight Demographic Studies.* Jerusalem: Academic Press.

Randall, Sara. 1993. "Issues in the Demography of Mongolian Nomadic Pastoralism." *Nomadic Peoples* 33: 209–230.

Randall, Sara C. 1994. "Are Pastoralists Demographically Different from Sedentary Agriculturalists?" In *Environment and Population Change,* ed. B. Zaba and J. Clarke. Liège, Belgium: Ordina editions.

Sara Randall

NOTESTEIN, FRANK W.

(1902–1983)

Frank Notestein was born in Alma, Michigan, the son of the Dean of Alma College. He attended Wooster College in Ohio, graduating with a degree in economics. He received a Ph.D. in social statistics from Cornell University in 1927, where he was a student of Walter Willcox, one of America's leading demographers. After a brief stint in Europe studying occupational mortality, Notestein took a position as a research associate at the Milbank Memorial Fund in 1928. The Fund, formerly interested primarily in public health issues, was expanding its focus to general population concerns, especially fertility trends. Notestein spent his eight years at the Fund studying class differences in fertility and the role played by birth control in inducing fertility decline. He was present at the establishment of the Population Association of America in 1931, being one of its charter members. His research on birth control culminated in the publication of *Controlled Fertility* (1940), coauthored with Regine Stix, which concluded that fertility declined when the motivation to have children underwent a change. They found that an increased desire for small families stimulated the desire for more contraceptive use and better contraceptives, not the reverse.

In 1936 Frederick Osborn, convinced of the need for a formal training center in demography, persuaded Albert G. Milbank to fund the establishment of the Office of Population Research at Princeton University. Notestein became the director of this first center at a major U.S. university offering graduate training in demography. His recruitment of Irene Taeuber, Frank Lorimer, Dudley Kirk, Kingsley Davis, Ansley Coale, Wilbert Moore, John Hajnal, Robert Potter, and Charles Westoff over the early years as staff members or associates provided demography with an entree into the academy that helped establish it as an accepted academic discipline. Notestein's initial research agenda at Princeton was the study of Europe's interwar population trends, undertaken at the request of the League of Nations—later extended, at the instigation of the State Department, to Asia. In the course of projecting future European demographic trends, the Princeton demographers observed that the population dynamics of Eastern and Southern Europe were similar to those of Western and Northern Europe at an earlier time, and Notestein argued that a "vital revolution" was sweeping Europe. (Adolphe Landry had earlier used essentially the same term.) In 1945 Notestein made this revolution worldwide in his classic elaboration of transition theory, "Population: the long view." "High growth potential" populations would become "transition growth" ones as modernization began to affect their fertility. When industrialization and urbanization became commonplace fertility would reach low levels and the population would enter into the stage of "incipient decline." At the time Notestein clearly foresaw the possibility that not all "high growth potential" populations would experience the entire vital revolution, especially those under colonial domination. Many of these populations were experiencing public health advances and improved agricultural productivity that lowered their mortality, but not the urbanization and industrialization that would lower their fertility. Notestein suggested that their period of population expansion could end in catastrophes and increased mortality. He directed his scholarly and practical energies over the rest of his career to preventing such an eventuality.

Partly at Notestein's initiative, one of the early offices established by the United Nations Secretariat, in 1946, was a Population Division, and he became its first director. He set the division on the path of objective, informed documentation and analysis of demographic trends that it has subsequently followed.

In 1948 John D. Rockefeller 3rd invited Notestein to be part of a four-person team to travel to six East Asian countries and appraise their population problems. The team reported that birth rates were "resistant to change" and were producing a situation where the gains in production were being consumed by increasing numbers. Although the political sensitivities surrounding the birth control issue prevented the conservative Rockefeller Foundation from acting on this report at the time, it induced Rockefeller to sponsor a conference on population problems in 1952 that resulted in the establishment of the Population Council. Notestein was one of the original four trustees of this unique non-profit organization focused on population issues, and became its third president in 1959. Under Notestein's leadership the Council conducted biomedical and demographic research and sponsored graduate training in these fields; it also became the key organization offering technical assistance to developing countries wishing to establish family planning programs well before the United States and the United Nations began offering such assistance. He retired in 1968.

A bibliography of Notestein's writings appears in Population Index, 49 (Spring 1983), pp. 7–12.

See also: *Demographic Transition; Demography, History of; Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY FRANK W. NOTESTEIN.

Notestein, Frank W. 1936. "Class Differences in Fertility." *Annals of the American Academy of Political and Social Science* 188: 26–36.

———. 1943. "Some Implications of Population Change for Post-War Europe." *Proceedings of the American Philosophical Society* 87, no. 2 (August): 165–174.

———. 1945. "Population—The Long View," In *Food for the World,* ed. Theodore W. Schultz. Chicago: University of Chicago Press.

———. 1964. "Population Growth and Economic Development." Colombo. Reprinted in *Population and Development Review* 9 (1983): 345–360.

———. 1967. "The Population Crisis: Reasons for Hope." *Foreign Affairs* 46(1): 167–180.

———. 1982. "Demography in the United States: A Partial Account of the Development of the Field." *Population and Development Review* 8: 651–687.

Stix, Regine K., and Frank W. Notestein. 1940. *Controlled Fertility: An Evaluation of Clinic Service.* Baltimore: Williams and Wilkins.

SELECTED WORKS ABOUT FRANK W. NOTESTEIN.

Coale, Ansley J. 1979. "Notestein, Frank W." In *International Encyclopedia of the Social Sciences:*

Biographical Supplement, ed. David L. Sills. New York: Free Press. Reprinted in *Population Index* 49(1), 1983.

Ryder, Norman B. 1984. "Obituary: Frank Notestein (1902–1983)." *Population Studies* 38(1): 5–20.

Dennis Hodgson

NUPTIALITY

See *Marriage*

NUTRITION AND CALORIE CONSUMPTION

Net nutrition (diet in relation to claims made on food intake by basal metabolism, physical activity, and disease) is an important influence on overall health. Poor nourishment impairs child growth and development, which in turn increases the risk of mortality, raises morbidity, and reduces physical capacity. These consequences are not limited to the growing years, and adversely affect adults who had poor nutritional experiences as children. Numerous debates and controversies surround the study of nutrition. These controversies historically have been fed by a lack of scientific knowledge, by varying goals and methods for studying nutritional needs, and by the confusion arising from simplifying complex material for a wide audience.

Dietary Standards

A brief history of the evolution of approaches to calibrating requirements for human nutrition can illuminate some of the central issues around dietary standards. The nutritional values of certain foods—such as limes in combating scurvy—have been known for over two centuries, but it was food shortages associated with World War I that established the need for dietary standards in planning food shipments. In the 1930s the League of Nations issued a series of reports on nutrient needs according to age, sex, and activity patterns; these were later drawn on in responding to the food crises created by World War II. Beginning in the late 1940s the United Nations, the League's successor, coordinated a program of nutritional requirement reports produced by individual countries. These reports were often local adaptations of Food and Agriculture Organization/World Health Organization recommendations, but they varied widely on some components.

Research on dietary standards began with tabulations of average intakes of nutrients thought essential to life among "healthy" people. Over time this list expanded from items such as energy and carbon to include protein, iron, zinc, and a host of other ingredients. Scientific studies that varied or observed these intakes across people, looking for readily observable effects on health (such as growth failure or specific signs of disease), found both systematic patterns and also considerable differences in individual needs. Biochemical markers later provided a means to identify subclinical deficiencies.

An important question to ask of dietary recommendations is how they are to be used. The standards may differ widely depending on whether they are used to implement a program of organizing food shipments to address a crisis; to protect against obvious deficiency diseases in the vast majority of a population that is relatively sedentary; or to insure against any subclinical deficiencies for all people in a physically active group.

Assessment Strategies

Another area of concern in the field of nutrition is assessment, or measuring dietary intake in relation to dietary standards. Several approaches historically have been used, but each has limitations. Under the "disappearance" method, human consumption is a residual calculated as the supply of food (production, plus beginning stocks, plus imports) minus utilization (the sum of exports, ending stocks, nonfood uses, feed, spoilage, and seed). This method ignores the unequal distribution of food across regions, families, and individuals, and so malnutrition may exist even though per capita amounts are adequate. In addition, methods of preservation and cooking affect food's nutritional value. These changes are not acknowledged by the disappearance method of nutritional assessment.

Surveys are another method of assessment. While much has been learned through dietary surveys, one may question their accuracy as they are affected by the limited window of time during which food intakes are observed. Because diets vary by season, it is desirable to gather information throughout the year, but this takes time and imposes high costs. Moreover, even well constructed studies across seasons cannot detect annual fluctuations. Surveys conducted through recall methods may undercount or misreport consumption. This can be remedied in principle by placing an observer in the household; however, the family may then try to impress the observer by preparing unusually good meals (a situation that is analogous to the Heisenberg principle).

Anthropometric Measures

Anthropometric approaches to measuring nutritional status have the virtue of accounting for biological individuality while simultaneously measuring net nutrition, or dietary intake minus claims made by work and by disease. Disease is too seldom recognized as a factor in nutritional status. A person's need for iron in the diet, for example, is very much a function of exposure to hookworm and other parasites. Similarly, gastrointestinal diseases may divert dietary intake, resulting in malnutrition even though disappearance methods or dietary surveys would indicate that food supplies or intake were adequate. Anthropometric measures consider biological performance or failure to thrive as motivating principles.

Numerous studies of height and weight of healthy groups around the world suggest that a wide variety of human populations have a similar potential for growth. Therefore, if a particular group falls substantially below standard, one may infer that components of net nutrition are inadequate. The two most widely used anthropometric measures are height and weight-for-height (sometimes expressed as the body mass index, which is weight in kilograms divided by the square of height in meters). Height is an indicator of a person's net nutrition from conception through the growing years, which if poor, results in "stunting." Weight-for-height is a measure of recent nutritional status, which if poor, results in "wasting." If it can be established that a particular group's potential for growth differs from commonly used norms, it may be appropriate to utilize other standards.

A significant advantage of anthropometric measures is their low cost of collection. They are also broad-spectrum measures, incorporating a wide variety of factors that affect height and weight. This has the advantage of reflecting all variables that affect growth, but complicates the analysis of results. Simply identifying groups that fail to grow adequately does not provide information on causes or remedies. Other detective work (and expense) may be required.

Under- and Overnutrition

Historically a major challenge facing humans has been acquiring enough food. In the early twenty-first century, however, the world faces two food problems: undernutrition and overnutrition. The first is primarily, but not exclusively, an issue for poor countries, many of which have low agricultural productivity yet limited capacities to pay for food imports. Nutritional problems can be made worse by policies that artificially reduce prices received by farmers, thereby discouraging production and agricultural innovation. Wars and rivalries within and across countries can be significant in interrupting the delivery of food that would alleviate malnutrition. The largest regions of contemporary nutritional distress are found in Africa and Asia. Pockets of malnutrition are widely distributed and can be found throughout the world, even among some subpopulations in industrialized countries.

Obesity is a growing problem in developed countries, and is especially noteworthy in the United States. In more recent years, some children in some developing countries also have acquired this "disease." Two causes are widely cited: the declining cost of food and sedentary lifestyles. Rapid increases in agricultural productivity have occurred since the 1950s, and the price of food has fallen relative to income and many other commercial goods, which tempts people to consume more. Evidence for sedentary lifestyles is less well established, in part because energy expenditure is difficult and expensive to measure. But the growing use of automobiles to replace walking or cycling, falling demand for manual labor, and a host of household conveniences do make a case for reduction in calorie expenditures. Against this one may cite growth of health clubs and the rise of recreational sports played by a segment of the population. If these trends continue, the populations within industrialized countries may become divided increasingly on the basis of weight and physical fitness.

See also: *Anthropometry; Food Supply and Population.*

BIBLIOGRAPHY

Beaton, George H. 1999. "Recommended Dietary Intakes: Individuals and Populations." In *Modern Nutrition in Health and Disease,* 9th edition, ed. Maurice E. Shils, James A. Olson, Moshe Shike, and A. Catharine Ross. Baltimore, MD: Williams and Wilkins.

Eveleth, Phyllis B., and J. M. Tanner. 1990. *Worldwide Variation in Human Growth,* 2nd edition. Cambridge, Eng.: Cambridge University Press.

Steckel, Richard H. 1995. "Stature and the Standard of Living." *Journal of Economic Literature* 33: 1903–1940.

Richard H. Steckel

O

OCCUPATION AND INDUSTRY

Occupation and industry are key variables needed to describe and analyze the world of work experienced by men, women, and sometimes children in nations around the world and the changes that occur in this experience over time. These variables are also indispensable in describing the structure of national economies and their temporal dynamics. Briefly, occupation describes the type of work a person does and industry describes the main activity of the establishment in which the work is done (e.g., *rice farmer* in *agriculture*). Statistics on occupation and industry are usually collected by the official statistical organizations of individual countries through censuses or surveys designed to meet national needs for monitoring the economy and shaping economic policies. The range of activities defined as work affects the scope of statistics that will be collected by these organizations. Coverage of such statistics is typically limited to persons who were employed during some reference period, such as the week preceding the census or survey, although usual occupation is sometimes reported for the unemployed. Occupations of persons who are employed intermittently (such as poll workers on election days), are temporarily out of the labor force, or are producing goods and services for their own consumption only usually will not be included. These persons are often disproportionately women.

National statistical organizations in many countries have collected industry and occupation data in censuses and surveys for many years. In the United States decennial census, for example, questions on industry date back to 1820 and regarding occupation to 1850.

Industry and Occupation Classification

Once the agencies have collected information about the industry in which respondents work and the occupations they report, they must classify these responses into industry and occupational categories. While the industry and occupation classifications adopted are necessarily country-specific, there has been considerable progress over the last 50 years toward also ensuring international comparability of such statistics.

Industry

An industry category is designed to describe the activity of the establishment in which employed or self-employed persons worked during a specified reference period. It describes what the establishment does rather than what the individual does while employed there. Industry statistics have been collected in censuses and employment surveys in many countries, usually in response to questions regarding where a person works (including name and address of the establishment), or what the main products or functions of the establishment are. In order to facilitate comparisons of different data sources and data from different countries, it is desirable to have an internationally comparable industry classification. This type of classification scheme has been in existence since 1948 and is periodically revised. The United Nations Statistics Division recommends that countries code and tabulate industry data ". . . according to the most recent revision of the International Standard Industrial Classification (ISIC) of All Economic Activities" (United Nations, Principles and Recommendations for Population and Housing Censuses, Revision 1.1998, p. 86). Many other classification schemes exist, however.

TABLE 1

United States Civilian Labor Force in 2000, by Industry

Industry	Number (thousands)	Percent Female
Total Employed	135,208	46.5
Agriculture	3,305	26.4
Mining	521	13.7
Construction	9,433	9.7
Manufacturing	19,940	32.5
Transportation, communication, and other public utilities	9,740	28.7
Wholesale and retail trade	27,832	47.2
Wholesale trade	5,421	30.4
Retail trade	22,411	51.2
Financial, insurance, real estate	8,727	58.5
Services	49,695	62.1
Business and repair services	9,661	37.4
Advertising	280	55.2
Services to dwellings and buildings	862	51.6
Personnel supply services	1,063	59.9
Computer and data processing	2,496	31.8
Detective/protective services	574	25.6
Automobile services	1,626	14.9
Personal services	4,515	70.0
Private households	894	92.1
Hotels and lodging places	1,443	57.9
Entertainment and recreation	2,582	42.3
Professional and related services	32,784	70.0
Hospitals	5,028	76.3
Health services, except hospitals	6,569	79.7
Elementary, secondary schools	7,629	76.0
Colleges and universities	2,903	54.3
Social services	3,519	81.9
Legal services	1,362	58.5
Public administration	6,015	44.9

SOURCE: U. S. Census Bureau (2001).

The North American Industry Classification System (NAICS) was adopted by the United States, Canada, and Mexico, and used in their 2000 round of censuses. The overall structure of the classification is the same in all three countries, though the details differ. The United States version of NAICS, used to code Census 2000 industry responses, is a complete revision of the 1990 census classification and differs from the ISIC. The 1990 census published data under 13 major industry groups and 243 detailed industries; for Census 2000 there are 15 major groups and 265 detailed industry categories.

Occupation

In any complex economy, people work in a wide variety of occupations. A classification scheme for occupations, similar to that devised for industries, must be adopted. The many existing schemes used by different governments all seek to organize the actual jobs people do into clearly defined groups, according to the tasks performed and/or the skills required. They provide guidelines as to how the jobs people report are to be classified into detailed occupational groups and how these detailed groups are to be aggregated into broader groups. Many national classifications are designed to be similar to or comparable with the International Standard Classification of Occupations (ISCO).

The version of ISCO employed in the early twenty-first century, ISCO-88, was developed by the Fourteenth International Conference of Labor Statisticians in 1987 and adopted by the International Labor Organization (ILO) in 1988. It consists of four levels of aggregation: 10 major groups; 28 sub-major groups; 116 minor groups, and 390 detailed occupational unit groups. The ILO, as custodian of ISCO-88, provides advice and assistance to countries in developing common classifications based on that classification system. The UN Statistics Division recommends that countries prepare tabulations of census data in accordance with ISCO-88 to facilitate international comparisons and communication among users of the data.

Full international comparability has not yet been achieved. An ILO review of 1990 census-round practices in 115 countries found that 65 countries could link their occupational data to ISCO-88, and another 33 to an earlier version of that system; others used national classification systems which were not comparable. In the 2000 round of censuses, many countries still used occupational classifications that were not directly comparable with ISCO-88.

In the United States until the 1970s, government agencies, notably the Department of Labor (and its Bureau of Labor Statistics) and the Census Bureau, used different and noncomparable occupational classifications. The 1980 U.S. Standard Occupational Classification (SOC) was developed concurrently with the 1980 Census Occupational Classification with the expectation that it would be phased in and used by all agencies. A secondary consideration in its development was comparability with ISCO-68. A major revision of the SOC was undertaken prior to the 2000 census, with many occupational categories added, deleted, or changed. There are now over 800 detailed categories. In the final Census 2000 Occupational Index these were aggregated into 509 detailed occupations, which are not directly comparable with those in the 1990 census or with ISCO-88.

History of Industry and Occupation Statistics

Statistics on industry and occupation are needed to monitor social and economic trends and to inform related policies. In the United States the census was mandated primarily to establish the basis for apportioning the House of Representatives. Yet, as early as the first census in 1790, the debates about its content reflected a view that governments at all levels need more detailed knowledge about the social and economic characteristics of the population. Several proposals on industry/occupation categories were made, including some by the future presidents James Madison and Thomas Jefferson. Eventually, a three-way classification was adopted, and applied in the census of 1820: agriculture, commerce, and manufactures. Today these would be viewed as industrial classifications. No occupational information was collected in 1830 but the question was included again in 1840. By this time the number of categories had been extended to seven: mining; agriculture; commerce; manufactures and traders; ocean navigation; navigation of canals, lakes, and rivers; and learned professions and engineers. While these categories gave a fuller depiction of the work people were doing than did the previous three, the categories still combined industry and occupation and omitted servants, government officials, clerks, and others.

The increasing division of labor in American society can be observed by noting the occupational classifications of each progressive census. The census of 1850 shifted from family to individual enumeration and separate schedules were provided for free persons and slaves. Information on occupation was acquired only for free males over 15 years old but greater occupational detail was collected. In 1850, 323 specific occupational categories were created under ten headings. In 1860 women as well as men over 15 years old were asked their occupations and the increasing complexity of the economy was reflected in the list of 584 possible choices. Between 1870 and 1930, persons ten years old and over were included in the occupational inquiry, reflecting the prevalence of child labor in the United States. In 1940 and later the age limit was 14 years old and over, reflecting the effect of child labor laws enacted in the early part of the century that prohibited or limited the paid work of children. Separate questions on occupation and industry were introduced in 1910, and the number of occupational categories changed each decade: 303 in 1900, 469 in 1950, 509 in 2000.

TABLE 2

Percent Distribution of the Civilian Labor Force by Industry in Selected High-Income Countries, 2000

Industry	US	Australia	Japan	Germany	Italy
Agriculture, forestry, fishing	3	5	5	3	6
Mining and construction	7	8	10	10	8
Manufacturing	15	13	21	24	25
Services	75	74	64	64	62
Total	100	100	100	100	100

SOURCE: U. S. Census Bureau (2001).

Trends in Occupation and Industry Composition

These changes in coverage and in occupational categories reflected an expanding economy, greater division of labor, emergence of new jobs, and shifts in broad occupational areas, as well as major changes in the status of women and African Americans. In 1790, the nation was predominantly agricultural. By the mid-twentieth century, it had become predominately industrial and commercial. At the end of the twentieth century it was largely a service economy.

The census occupational data reveal a number of other striking changes over the course of the twentieth century. In addition to the movement from farm to non-farm work, the composition of non-farm work changed: The number of laborers declined, operatives and craftsmen increased, as did those in the service trades. The most significant twentieth century increase was observed in "white-collar" occupations, which went from about 18 percent of workers in 1900 to over 40 percent by 1980. According to the U.S. Department of Commerce in 2001, figures indicated that by 2000, white collar workers represented about 59 percent of the total employed.

Occupational trends were usually described in detail only for men until the last several decades when the increasing participation of women in the labor force required attention to their roles also. Trends in the distribution of occupations for women differed somewhat from men. There was a notable drop in private household workers throughout the twentieth century and significant declines in the operatives category as well. In contrast, trends for women were similar to those for men with respect to the number of farm workers and other types of manual work. Some convergence in occupational distributions was evident by 1980 although many more women were still in clerical and service work whereas men predominated in managerial and craft occupations. The convergence continued through 2000, though a substantial degree of occupational clustering by sex remains a characteristic of the labor force.

Industry Composition in 2000

In 2000 the total U.S. population was 281 million. Of this, the civilian non-institutional population aged 16 years and older was 209.7 million: 100.7 million males and 109 million females. The total number of employed persons was 135.2 million, or 64.5 percent of the total, of which 72.3 million were males and 62.9 million were females. A concise description of the industrial composition of the 135.2 million figure just cited is presented in Table 1. For each category, the proportion of females is also shown.

As Table 1 shows, by the beginning of the twenty-first century, the proportion of people employed in agriculture was only 2.4 percent of total employment—considerably less, for example, than persons employed in hospitals, 3.7 percent. Women had a share of employment that ranged from less than 10 percent in construction to 81.9 percent in social services—an industry in which total employment was also larger than the total employment in agriculture.

The radical transformation of the industrial-occupational structure away from agriculture, first toward manufacturing and then from manufacturing toward service industries, is also reflected in the statistics of other high-income countries, although to a lesser degree than in the United States. Table 2 presents the broad distribution of the civilian labor force by major industrial sectors in selected high-income countries.

See also: *Census; Labor Force.*

BIBLIOGRAPHY

Bradley, Dana and Katharine Earle. 2001. "Developing and Explaining the Crosswalk between Census 1990 and 2000 Industry and Occupation Codes." *Proceedings of the Annual Meeting of the American Statistical Association* August 5–9, 2001. American Statistical Association.

International Labour Office. 1990. *International Standard Classification of Occupations: ISCO–88.* Geneva, Switzerland: International Labour Office.

International Labour Office. 1996. "Sources and Methods: Labour Statistics." *Total and Economically Active Population, Employment and Unemployment,* 2nd edition. Geneva, Switzerland: International Labour Office.

International Labour Office. 2001. "Asking Questions on Economic Characteristics in a Population Census." *STAT Working Papers, No. 2001–1* pp. 4–48. Prepared by R. Gilbert. Geneva, Switzerland: International Labour Office, Bureau of Statistics.

Nam, Charles B. and Mary G. Powers. 1983. *The Socioeconomic Approach to Status Measurement.* Houston, TX: Cap and Gown Press.

United Nations. 1998. *Principles and Recommendations for Population and Housing Censuses,* revision l. Statistical Papers. Series M No. 67. New York: United Nations.

U. S. Census Bureau. 2001. *Statistical Abstract of the United States: 2001* Washington, D.C.: U.S. Government Printing Office.

Mary G. Powers

OLDEST OLD

The term "oldest old" refers to persons at the upper segment of the age pyramid. By a conventional demographic definition those age 80 years and older are included in the oldest-old population, although, as noted below, alternative definitions are also in use. Since the end of World War II, in most countries the oldest old has been the fastest growing component of the population at large. This trend will almost certainly continue in the decades to come, with improving survival rates at very high ages.

The relationship between indicators of average lifespan, such as life expectancy at birth, and the age structure of populations is often misunderstood by statisticians, policymakers, journalists, and other users of demographic data. Increases in life expectancy are welcomed as a sign of progress and improvement in living conditions. The countries that are most advanced in the demographic transition are proud that their life expectancy at birth exceeds 80 years, at least among women (who, especially in low-mortality countries, enjoy an appreciable advantage over men). This was the case by the end of the twentieth century in Japan (the country which in the period from 1995 to 2000 had the highest female life expectancy at birth: 83.8 years) and in Hong Kong; in Finland, Norway, and Sweden; in most countries of southern and western Europe; and in Canada and Australia. (In the United States, female life expectancy during the period from 1995 to 2000 was, at 79.4 years, slightly short of this mark.) On the other hand, increases in the numbers of nonagenarians and even octogenarians are often viewed with alarm, as portending an increase in the burden of health care and old-age support. Most people, of course, do not die in the years narrowly bracketing the average life expectancy at birth.

The increasing number of old people is not a new phenomenon, although some still find it surprising. One reason for this is the way in which a final open-ended age group is used in tabulating age distributions and mortality rates: in the past, 65 years and over; now, 85 years and over. But 65 years and over or 85 and over tends to be popularly interpreted as approximately 65 years and approximately 85 years, not age brackets ranging from 65 or 85 to 100 or 110 years. The upper end of the distribution, the oldest-old population, is thus incorrectly visualized.

The Problem of Definition

The oldest old as an identifiable category within human populations always existed even if its definition in terms of biological, social, or chronological age was varying and fuzzy. During the seventeenth century, the absence of a concept of the oldest old was not very important because with life expectancy at birth at levels of 30 to 35 years, only a small minority—about 10 to 15 percent—of the population reached the age of 70.

The three great ages of humankind—youth, adulthood, and old age—correspond to the history of life from a biological point of view, with youth a phase of growth and development, adulthood a phase of reproduction and childrearing, and old age a phase of physical decline, beyond the selective pressures of evolution. The division also corresponds to the economic and social organization of the industrialized countries during the twentieth century around school, work, and retirement, reflected in the three broad age ranges of many statistical tables: 0 to 14 years; 15 to 64 years; 65 and over. But these socioeconomic ages have little reality for most developing countries, where very few old people enjoy retirement. And in the developed countries furthest advanced in the demographic transition, the period of old age, as defined by lessened or no economic activity, lengthens at both ends—as labor force participation tends to decline above the age 50 and as life expectancy at age 65 increases. This explains the logic of dividing old age into two parts: the "young old" and the "oldest old."

But on what criteria? Chronological age is a rather crude marker here. Everyone can agree that those aged 60 to 70 are "young old" and that those over 85 are oldest old, but what about those between 70 and 85? Criteria other than age might be considered.

Biodemographic approach. A simple biodemographic classification would consist of numbered generations or "ages": a child belongs to the first age, parents to the second age, grandparents to the third age, and great-grandparents (the oldest old in this scheme) to the fourth age. But this simple classification presumes reproductive success and a high degree of uniformity in the reproductive life cycle.

Functional approach. An approach largely popularized by the historical demographer Peter Laslett (1996) is that the fourth age—the age of the oldest old—starts when a person becomes physically dependent on another. Thus the third age starts when the person is released from the constraints of adulthood (paid work and education of children) and finishes when the loss of physical independence begins, without precise age limits. Indeed, the concept of loss of autonomy of old people is not easily pinned down as it involves three main criteria: physical dependence—the need for the assistance of another to perform the activities of daily life; cognitive autonomy—the capacity to make decisions for oneself; and social integration—the capacity to remain integrated in a community. Three indicators of life expectancy by health status (active life expectancy, dementia-free life expectancy, and institution-free life expectancy) are helpful in defining the boundary of the fourth age congruent with this approach.

Gerontological approach. In their model of successful aging, John Rowe and Robert Kahn (1997) distinguish four states, namely the absence of appreciable risk of degenerative disease or disability, the presence of risk, the presence of actual degenerative disease, and the presence of disability. Successful aging would imply prolongation of the period without accumulation of the risk of developing a degenerative disease or becoming disabled. The third age is generally associated with successful aging and the fourth age with unsuccessful aging. The fourth age would begin with the accumulation of risks of degenerative diseases and disability. The risk of "unsuccessful" aging is an important concept in gerontology, drawing on the concept of frailty.

Demographic approach. A definition of oldest old based on loss of autonomy faces the difficulty that a large minority of older people will never lose their autonomy. Demarcating the category of oldest old by setting a plausible if necessarily arbitrary age when persons are thought to enter it, such as age 80 or 85, is an approach commonly used by demographers. It should be remembered, of course, that an arbitrarily selected advanced age does not have the same connotations in the early twenty-first century as it did in the past when attainment of that age was exceptional. Nor does it have the same meaning for men as for women. Other demographic definitions of the oldest old, or the fourth age, would be in terms of the proportion of survivors—the highest age reached by at least 25 percent of the population; or in terms of life expectancy—the age at which there remains ten years of expected life. The nominal ages corresponding to these criteria, however, would vary depending on the level and pattern of mortality; hence, they differ from one country to another and from one time to another.

Numbers and Trends

In virtually all countries the populations at ages beyond 80 years—the oldest old—have strongly increased in size since 1950. This is a consequence of declining mortality and also of the fact that as time passes the oldest old consist of survivors of increasingly larger birth cohorts (groups of individuals born at the same time). The proportions of the oldest old within the overall population have also been increasing, in part as a result of declining fertility, which narrows the base of the age pyramid. Thus, for example, in the 15 countries of the European Union the proportion at ages 80 and older was 1.2 percent in 1950 and 3.8 percent in 2000 (more than tripling). In the United States the corresponding percentages were 1.1 and 3.2.

TABLE 1

The Oldest-Old Population by Age Group and Proportions Aged 80 and Over, Selected Countries, 2000 and 2050 (Nunbers in Thousands)

Age	United States	European Union (15 countries)	India	China
		Year 2000		
80–84	4,900	6,997	4,264	7,826
85–89	2,673	4,865	1,472	2,818
90–94	1,160	1,847	328	743
95–99	371	376	44	127
100+	75	37	3	12
All ages	283,230	376,502	1,008,937	1,275,133
Ages 80+	9,179	14,122	6,111	11,526
Percent 80+	3.2	3.8	0.6	0.9
		Year 2050		
80–84	12,676	18,152	28,313	56,986
85–89	9,662	12,740	13,881	28,214
90–94	5,377	6,423	4,783	10,201
95–99	1,969	2,331	1,039	3,286
100+	473	534	142	471
All ages	397,063	339,314	1,572,055	1,462,058
Ages 80+	30,157	40,180	48,158	99,158
Percent 80+	7.6	11.8	3.1	6.7

SOURCE: United Nations (2001). Estimates and medium-variant projections.

Within the oldest old, the number and proportion in the higher ages increased especially rapidly. In 1995 James W. Vaupel and Bernard Jeune showed that in Western countries the number of centenarians doubled approximately every ten years starting in 1950; the doubling time for the number of people 105 years old was just a little shorter. Of course, in 1950, although the numbers of those over 80 were already numerous, few were over 90, very few were centenarians, and almost none had reached 105. In the lowest-mortality countries, such as France and Japan, in the early twenty-first century, the fall in mortality at old ages appears to be accelerating and the "centenarian doubling time" is becoming shorter. As a consequence of these changes, the maximum reported age at death has been strongly increasing. The longest reliably recorded human lifespan (for the French woman Jeanne Calment, who died in 1997) is 122 years.

These trends are likely to continue in the coming decades. Table 1 shows the size of the oldest-old population in 2000 in the three most populous countries of the world and in the 15-nation European Union and the proportions of the oldest old within the total population. The table also includes anticipated figures of the oldest old in the year 2050, as projected by the United Nations (UN) on rather conservative assumptions as to the future evolution of mortality. Note that the absolute numbers of the oldest old in 2050 are affected only by mortality (and to a degree also by future international migration), because those aged 80 years and older will be survivors of persons already alive (survivors of those aged 30 years or older in 2000). The future proportions of the oldest old within the total population are of course affected by future fertility as well as mortality. The projected proportions shown in the table are based on the UN's "medium fertility" assumptions.

As the table indicates, the rapid expansion of the oldest-old population is not limited to the Western world. Developing countries are also faced with greatly increased numbers over age 80. In China, for example, during the first half of the twenty-first century the number of oldest old is expected to grow nearly ninefold, in contrast to a 15 percent increase of the total population. By 2050, the oldest-old population of China is expected to be some 99 million. As a proportion of the total population that number would represent 6.7 percent—well above the corresponding proportions in 2000 in the United States or in the European Union.

Women invariably represent a high percentage of the oldest old. For example, in the United States in 2000, some 67 percent of those above age 80 were women. And among centenarians, women accounted for 87 percent of the total. In these conditions, further calculations of health expectancies (for example, active life expectancy and disability-free life expectancy) are more and more relevant. They suggest an increase in healthy life expectancy in some — but not all — countries such as the United States and France. In Austria, for instance, life expectancy in good perceived health at age 80 increased by 1.3 years between 1978 and 1998, going up from 2.8 to 4.3 years.

See also: *Aging and Longevity, Biology of; Aging of Population; Disability, Demography of; Health Transition; Life Span; Mortality Decline.*

BIBLIOGRAPHY

Doblhammer, Gabriele, and Josef Kytir. 2001. "Compression or Expansion of Morbidity? Trends in Healthy-life Expectancy in the Elderly Austrian Population between 1978 and 1998." *Social Science and Medicine* 52: 385–391.

Laslett, Peter. 1996. *A Fresh Map of Life,* 2nd edition. Houndmills, Basingstoke, Eng.: Macmillan.

Robine, Jean-Marie, Isabelle Romieu, and Emmanuelle Cambois. 1999. "Health Expectancy Indicators." *Bulletin of the World Health Organization* 77: 181–185.

Rowe, John W., and Robert L. Kahn. 1997. "Successful Aging." *Gerontologist* 37: 433–440.

Thatcher, A. Roger. 2001. "The Demography of Centenarians in England and Wales." *Population* 13(1): 139–156.

United Nations. 2001. *World Population Prospects: The 2000 Revision,* Vol. II: *Sex and Age.* New York: United Nations.

Vaupel, James W., and Bernard Jeune. 1995. "The Emergence and Proliferation of Centenarians." In *Exceptional Longevity: From Prehistory to the Present,* ed. Bernard Jeune and James W. Vaupel. Odense, Denmark: Odense University Press.

JEAN-MARIE ROBINE

ONE-CHILD POLICY

The People's Republic of China (PRC) is the world's most populous country, comprising 21 percent of the global population. After almost three decades of radical Maoist Communism and nearly a decade of increasingly compulsory family planning, China, in 1978, launched both its market-oriented economic reform era and its unique one-child policy. These two plans appear to be contradictory in that the economic reforms loosen the prior meticulous government controls on people's lives under the planned economy, while the one-child policy micro-manages the most intimate parts of marital and family life. Yet China's political leaders and its educated elite generally saw both economic reform and the one-child policy as important, even essential, means toward the goal of rapidly raising per capita living standards in China. Market reforms partially unleashed the previously suppressed and frustrated entrepreneurial, ambitious spirit in Chinese culture, bringing about the world's most rapid macroeconomic growth, while the one-child policy sharply reduced population growth. Very rapid economic growth and unusually slow population growth in combination have yielded the remarkable upsurge in per capita income that China has experienced.

Origin of the One-Child Policy

Mao Zedong had suppressed the field of demography—and population studies in general—from the time of the founding of the PRC in 1949. In the late 1970s, after China tried to impose a two-child limit, a team of natural scientists (non-demographers) prepared a population projection showing, correctly, that China's population would continue to grow rapidly for decades even if all couples had no more than two children. This result shocked China's political leaders, who wanted to stop population growth immediately; they quickly announced a one-child limit for all urban and rural couples, except for the six percent of the population in non-Han Chinese minority groups. At the time, the leadership and scholars apparently were unaware that successful implementation of the one-child policy would speed the emergence of a new problem, the rapid aging of China's population structure.

Implementation of the One-Child Policy

The one-child policy was imposed in 1979 and was carried out with increasing coercion in urban and rural areas. The stated policy was (and, generally speaking, remained) that after one child, a woman was required to have an intrauterine device (IUD) inserted; if the couple already had two children, the woman (or, infrequently, the man) was required to be sterilized; and all pregnancies that had not received prior official approval were to be aborted. Coercive mass campaigns became widespread in the early 1980s and recorded their worst abuses in 1983. Statistics on birth control operations showed a sharp peak in sterilizations (1982: 5 million; 1983: 21 million), abortions (1981: 8.7 million; 1982: 12.4 million; 1983: 14.4 million), and IUD insertions (1981: 10.3 million; 1982: 14.1 million; 1983: 17.8 million) that year.

The one-child policy, from its inception, has also included *disincentives* for births beyond the approved number. Disincentives vary by place and can include severe fines, appropriation or destruction of family homes or possessions, political or physical harassment, work penalties or loss of employment, and the required adoption of officially controllable and long-term birth control techniques. The one-child policy has also always included *incentives* reserved for couples who agree to stop childbearing after one child and who sign a *one-child pledge.* The incentives can take the form of regular payments to the couple for the single child's benefit, priority in access to health services and public childcare and education, hiring priority in desired job categories for the parents and single child, and political praise. However, penalties strongly overshadow incentives in the enforcement of birth restrictions in China.

The one-child policy remained in force in the early twenty-first century. The PRC government, in March 2000, issued a document mandating that there be no change in the overall population targets, fertility controls, or means of enforcement. In December 2001, the National People's Congress passed a law on population and birth planning, thus creating, after much delay, a formal legal basis for the policy.

Compliance and Non-Compliance

At the time the one-child policy was adopted in 1978, the urban population of China had been living with a strict two-child policy since the mid-1960s. Urban conditions such as overcrowding and the greater autonomy of women encouraged voluntary low fertility. In addition, the urban social safety net (allocated housing, free or inexpensive medical care, pensions, subsidies) made families less dependent on their children for old-age support than rural couples. Thus, the one-child policy, aggressively implemented throughout urban China, was successful from its inception. A large proportion of urban couples in childbearing ages sign the one-child pledge, even though China's urban couples, like their rural counterparts, usually say they would prefer two or more children if this were an option. The urban total fertility rate (TFR) is only 1.4 births per woman or lower, well below replacement level. The urban population constitutes 36 percent of the total population of the PRC.

Rural China has consistently resisted the one-child policy, because there is essentially no social support system for rural families to substitute for the support of children, and especially sons, when they are grown. Daughters marry out of their villages (the marriage system is patrilocal), while sons continue to live with or near their parents and each son brings in a wife who helps him support his parents in their old age. Accordingly, preference for male progeny remains strong. Given peasant resistance, the government modified the one-child policy for rural China starting in 1984. In 18 provinces (more than half the total), rural couples are allowed to bear a second child if the firstborn is a girl, but remain subject to the one-child policy if the firstborn is a boy. Five provinces allow all rural couples to have two children and the provinces with populations dominated by minority groups allow rural couples two or three children. The four province-level municipalities and also Jiangsu and Sichuan provinces continue the one-child limit for all urban and rural Han couples. China's exact rural TFR is not known, but it is estimated to be about 2.0 births per woman, slightly below replacement level or lower.

Effects of the One-Child Policy

China's one-child policy has held both urban and rural fertility down to levels well below what they would otherwise have been during the decades since 1978. This has reduced China's population growth rate and, all else being equal, has increased per capita income. Such low fertility has also reduced the number of pregnancies and births per woman, and thereby helped to reduce maternal mortality. The one-child policy has greatly changed family structure and raised the perceived value of each child as the number of children per couple has declined. In cities, the one-child policy may have helped elevate the status of daughters, because almost half the time an only child is a girl. But elsewhere, the one-child policy or its modifications have exacerbated life-threatening discrimination against female infants and very young girls, and brought about a worsening problem of sex-selective abortion of female fetuses. In addition, reproductive rights have been largely denied to China's women who, in most of the country, continue to bear the burden of required use of IUDs, frequent inspections to confirm that the IUD is still in place, required abortions of noncompliant pregnancies, compulsory sterilization, and often, harm to their marriages and family relations if they do not bear a son. Finally, the strong contraction of fertility has distorted China's age structure and set in motion a process of rapid and extreme population aging. China's one-child policy is, therefore, partly beneficial and partly detrimental to the quality of life of China's people.

See also: *Communism, Population Aspects of; Population Policy.*

BIBLIOGRAPHY

Aird, John S. 1996. "Family Planning, Women, and Human Rights in the People's Republic of China." In *International Conference on Demography and the Family in Asia and Oceania, September 1995, Proceedings.* Taipei: Franciscan Gabriel Printing Company.

Banister, Judith. 1987. *China's Changing Population.* Stanford, CA: University Press.

Chinese Communist Party, Central Committee. 2000. *Document No. 8: Decision of the Central Committee of the Communist Party of China and the State Council on Enhancing Population Work and Ensuring Stable and Low Levels of Births.*

Croll, Elisabeth, Delia Davin, and Penny Kane, eds. 1985. *China's One-child Family Policy.* New York: St. Martin's Press.

Feeney, Griffith, et al. 1989. "Recent Fertility Dynamics in China: Results from the 1987 One Percent Population Survey." *Population and Development Review* 15(2): 297–322.

Greenhalgh, Susan. 1986. "Shifts in China's Population Policy, 1984–86: Views From the Central, Provincial, and Local Levels." *Population and Development Review* 12: 491–515.

Hardee-Cleveland, Karen, and Judith Banister. 1988. "Fertility Policy and Implementation in China, 1986–88." *Population and Development Review* 14(2): 245–286.

Short, Susan E., and Zhai Fengying. 1998. "Looking Locally at China's One-Child Policy." *Studies in Family Planning* 29(4): 373–387.

Wang Feng. 1996. "A Decade of the One-child Policy: Achievements and Implications." In *China: The Many Facets of Demographic Change,* ed. Alice Goldstein and Wang Feng. Boulder, CO: Westview Press.

Winkler, Edwin A. 2002. "Chinese Reproductive Policy at the Turn of the Millennium: Dynamic Stability." *Population and Development Review* 28: 379–418.

Xie Zhenming. 2000. "Population Policy and the Family Planning Program." In *The Changing Population of China,* ed. Peng Xizhe with Guo Zhigang. Oxford: Blackwell.

JUDITH BANISTER

OPTIMUM POPULATION

In casual discourse it seems obvious that a population of some geographically delimited entity—a village, a city, a country, the world—can be too small or too large. People can be too few to sustain a productive economy or creative culture; or so many that congestion effects and environmental degradation detract from present and future well being. Hence, there must be some intermediate population (or population range) that is in some sense *best* or optimal. Unfortunately, translating this simple idea into a coherent and useful concept has proved elusive—to the extent that in the early twenty-first century the term is rarely used in writings on demography or population policy. Some of the difficulties encountered are discussed in this article.

Increasing and Diminishing Returns

The idea that there was some size of population under which, other things being equal, per capita economic wellbeing was maximized, was implicit in the writings of the classical economists in the nineteenth century, particularly John Stuart Mill (1806–1873). Economic (at the time meaning agrarian) output per head was seen as determined by the offsetting forces of diminishing returns to labor (as more labor was applied to the same amount of land) and technological progress. At a given technological level, as the number of workers increased, the output per worker might initially rise, for example, as a result of the division of labor. But as more workers were added, output would ultimately fall. The labor input at the point of peak average productivity corresponded to what came to be called the optimum population.

In more complex economies it is possible to make an analogous argument, although the diminished significance of natural resources and the options for trade and other factor flows make it much less cogent. The pervasiveness of technological change as a source of economic growth undermines the usefulness of the stipulation that other things are equal, which is needed to define an optimum. There was a period of enthusiasm for the concept of an optimum population in the early decades of the twentieth century, starting with English economist Edwin Cannan (1861–1935), which dissipated as its difficulties became apparent. French demographer Alfred Sauvy (1898–1990) made some use of the term, and defined a *power optimum* as distinct from the economic optimum.

The Social Welfare Function

The simplest economic growth models take income per capita as the measure of wellbeing. A straightforward generalization would add numerous other components to the welfare criterion aside from income. Some ethicists (including Peter Singer)—and a few economists (including the Nobelist James Meade)—have argued, following English philosopher Jeremy Bentham (1748–1832), that a more appropriate measure of social wellbeing is average wellbeing multiplied by the size of population. This is called the total welfare or Benthamite criterion. Under it, if everyone in a society enjoyed a given level of happiness, overall wellbeing would be improved by having more people to enjoy it. An optimum population under the Benthamite criterion would be much larger than under the per capita welfare criterion. Most people, however, strongly prefer the per-capita form. This issue is treated at length by the philosopher Derek Parfit. Related theoretical concerns are discussed in a literature in welfare economics on what may be called normative population theory—for example, by economists such as Partha Dasgupta and Charles Blackorby.

If the welfare criterion attaches a strong value to preservation of the natural environment the optimum population may be substantially diminished. This is the basis of the call by some environmentalists for a reduction of world population. However, global averages have little meaning for most such calculations in view of the great diversity of country and local situations. In more constricted regions, the disamenities that may be associated with continued population growth are clearer. For example, various modeling exercises have sought to calculate optimum city sizes under welfare criteria that take into account density and congestion costs. Purely qualitative assessments of diminution of the quality of urban environmental amenity as population increases are also frequently made, albeit confounding the effects of scale with those of public expenditure and aesthetic standards.

No reasonable welfare function should be timeless. Conditions change, and researchers know at least some things about the directions of change. Hence, the welfare function that is to be maximized is usually expressed formally as an integral over time:

$$\int_0^\infty e^{-rt} U(c,t)\, dt ,$$

where $U(c,t)$ is the level of welfare at time t, c is a vector of components of wellbeing, and e^{-rt} is a discounting factor to reflect a bias toward the near term by downweighting future welfare at a rate of r (a necessity if one is to ensure that the integral converges). A plausible welfare function might include the population growth rate or the age structure among its arguments as well as population size: People might reasonably prefer not to live in an excessively elderly population that would eventually be produced by very low fertility. Thus, there may be a conflict between a population size goal and an age-structure (hence population growth) goal, calling for specification of preferred trade-offs between them.

Optimal Population Trajectories

Population growth and economic growth are interrelated, and the combined system can be modeled. The models can be extremely simple, like the Solow neoclassical model, or extremely elaborate, like the large-scale economic-demographic planning models in vogue in the 1970s. The models could have been (although usually they were not) optimized over alternative feasible population trajectories—either analytically or numerically. Incorporating a cost of control is mathematically straightforward. Optimal steady-state solutions for simple classical and neoclassical growth models with age-structured populations are discussed in a 1977 article by W. Brian Arthur and Geoffrey McNicoll. Other formulations are examined by Paul A. Samuelson and Klaus F. Zimmermann.

A striking real-world application of optimal control theory to population lay behind the design of China's radical one-child policy that was introduced in 1979. In work done during the 1970s, Song Jian and his colleagues, systems engineers by training, calculated that the long-run sustainable population of the country was 700 million. They then formulated the population policy problem in control-theory terms: How should fertility evolve if the population is eventually to stabilize at 700 million, the peak population is not to exceed 1.2 billion, there are pre-set constraints on the acceptable lower bound of total fertility (a one-child average) and the upper bound of old-age dependency, and there is to be a smooth transition to the target population while minimizing the total person-years lived in excess of 700 million per year? The resulting optimized policy called for fertility to be quickly brought down to the allowable minimum, held there for 50 years (producing negative population growth), then allowed to rise back to replacement level. Notably not a part of the technical deliberations—or of the actual policy that was adopted—was consideration of the human costs that attainment of such a trajectory would entail.

Central planning has deservedly lost favor in the economic realm, *a fortiori* in the demographic. But the general issue of achieving balance between human population numbers and the natural world remains relevant, as does the issue of striking a balance between the benefits to a society of a desired demographic outcome and the costs to the society of achieving it. But before these matters can be usefully expressed in the language of optimization, there are important surrounding problems of values, levels of analysis, and delimitation of boundaries to be resolved—areas where most of the meat of the issue is likely to be found. Real-world population policy easily eludes formal characterization.

See also: *Cannan, Edwin; Carrying Capacity; Limits to Growth; Mill, John Stuart; Population Policy.*

BIBLIOGRAPHY

Arthur, W. Brian, and Geoffrey McNicoll. 1977. "Optimal Growth with Age Dependence: A Theory of Population Policy." *Review of Economic Studies* 44(1): 111–123.

Blackorby, Charles, Walter Bossert, and David Donaldson. 1995. "Intertemporal Population Ethics: Critical-level Utilitarian Principles." *Econometrica* 63: 1,303–1,320.

Meade, James. 1955. *Trade and Welfare.* New York: Oxford University Press.

Parfit, Derek. 1984. *Reasons and Persons.* Oxford: Clarendon Press.

Robbins, Lionel. 1927. "The Optimum Theory of Population." In *London Essays in Economics in Honour of Edwin Cannan,* ed. T. E. Gregory and Hugh Dalton. London: Routledge.

Samuelson, Paul A. 1975. "The Optimum Growth Rate for Population." *International Economic Review* 16: 531–538.

Sauvy, Alfred. 1969. *General Theory of Population,* trans. Christophe Campos. New York: Basic Books.

Song, Jian, Chi-Hsien Tuan, and Jing-Yuan Yu. 1985. *Population Control in China: Theory and Applications.* New York: Praeger.

Zimmermann, Klaus F., ed. 1989. *Economic Theory of Optimal Population.* Berlin: Springer-Verlag.

Geoffrey McNicoll

ORGANIZATIONS, DEMOGRAPHY OF

Research on organizations (for example, firms, voluntary associations, political movements) has become increasingly more focussed on demographics and ecology. The research strategy of organizational demography has several noteworthy features that resonate with practice in the study of human demography. This research examines the *full* histories of organizational populations, because early events have been shown to have lasting consequences for population dynamics. It also gathers life history data on all organizations in the population(s), including the large and famous as well as the small and insignificant—this is crucial for avoiding problems of selectivity bias. Organizational demography records detailed information about the ways in which organizations enter and leave and investigates organizational populations. Finally, it uses event-history methods to estimate the effects of characteristics of organizations, populations, and environments on vital rates in populations of organizations.

Differences between Human and Organizational Demography

The fact that organizations are constructed social entities, not biological organisms, has major implications for their demography. In 2000 sociologists Glenn R. Carroll and Michael T. Hannan enumerated several important differences between organizational and human demography. First, organizations come into existence and disappear due to a wider range of events including founding, merger, spinout, and secession. Their lives as independent corporate actors can end by dissolution, acquisition, or merger. Second, an organization can exist long after its initial members have departed; it is not unreasonable to characterize organizations as, potentially, *immortal.* Third, organizations often do not have obvious parents. Therefore, organizational demography treats the *population of organizations* as the unit at risk of experiencing entries. Fourth, organizations can have multilayered structures, each level of which might operate relatively autonomously. These structures range from establishments (physical sites) to business groups such as the Korean *chaebol.* Many other possible configurations lie between these extremes. Most research, in this area, focuses on the autonomous organization. Fifth, organizational populations generally possess great heterogeneity in size and other characteristics.

Density Dependence

A major discovery of organizational demography is a regular pattern of density dependence in rates of founding and disbanding. As the number of organizations in a population (density) rises, founding rates first rise and then fall as density increases and mortality rates fall initially and then begin to rise. The standard explanation for this pattern is based on the opposing effects of legitimation (taken-for-grantedness) and diffuse competition, each of which depends upon density, but in characteristically different ways. Several parametric models of these relationships are well established from research on many diverse populations. In their 2000 book Carroll and Hannan review this evidence.

Several important variations on the basic pattern have been identified. First, density has a "delayed" effect, as was noted by human demographer P. H. Leslie in his analysis of cohort differences in mortality in human populations. The population density at time of entry has a persistent positive effect on an organization's mortality hazard. Second, density-dependent competition is generally more localized than density-dependent legitimation, presumably because cultural information diffuses more readily.

Resource Partitioning

Another major focus of organizational demography has been endogenous processes of segmentation in organizational populations. The best developed research program builds on resource-partitioning theory, developed by Glenn R. Carroll in 1985, which concerns the relationship between increasing market concentration and increasing proliferation of specialist organizations in mature industries with heterogeneous consumers. Specialist organizations are those that focus on narrow, homogeneous targets, whereas generalist organizations aim at broad, heterogeneous targets. If there is an advantage of scale (in production, marketing, or distribution), then competition is most intense in a resource-dense center, which generally becomes dominated by large generalist organizations. The failures of smaller generalists free some resources near the center, but large generalists can rarely secure all of the newly freed resources due to constraints imposed by organizational identities. Therefore, as concentration (the share of the market held by the largest firms) rises, the viability of specialist organizations increases as well: Founding rates rise and mortality rates fall.

Age and Size Dependence

In 1965 sociologist Arthur L. Stinchcombe observed that organizations experience a liability of newness, that age dependence in the mortality hazard is negative. A great deal of early research confirms this pattern. Some later research found a liability of adolescence: The hazard rises during the early portion of the lifespan—that is, while initial stocks of endowments are being exhausted—before declining. Much of this latter research did not control for age-varying organizational size, which is important because age and size are correlated and mortality hazards fall sharply with increases in size. More recent research, using designs that measure age-varying organizational size, has produced mixed evidence in favor of *positive* age dependence. Two interpretations of this pattern have been proposed. If inertial forces are strong, then the possibility of adapting to changing environments is limited and older cohorts of organizations have lower fitness—there is a liability of obsolescence. Alternatively, the accumulation of rules and routines impedes adjustment to environmental change—the liability is one of senescence. Theoretical research by logician László Pólos and Michael T. Hannan has sought to unify these seemingly irreconcilable theory fragments.

Inertia and Selection

Important inspiration for developing a demography and ecology of organizations comes from Stinchcombe's 1965 conjecture that new organizations get *imprinted* by their environments. Because entrants get tested against taken-for-granted assumptions that vary over time, organizations that pass such tests reflect the social structure of the time of entry. Imprinting requires both a mapping of environmental conditions onto organizations and inertia in the imprinted characteristics.

Organizational demography and ecology emphasizes inertial forces. According to structural-inertia theory, inertia prevails as an inadvertent by-product of a selection process that favors the properties of reliability (low variance in the quality of performance) and accountability (the ability to construct rational accounts for actions). Achieving these properties depends on structures being reproduced faithfully over time. Yet, high reproducibility means that structures resist transformation. Therefore, this selection process inadvertently favors corporate actors with strong inertial tendencies.

Fundamental change in technologies and environments presumably diminishes reliability and accountability. Old loses value, and new processes must be learned. Vestiges of the old system conflict with the emerging new one. Thus, even if fundamental change has long-term benefits (the new form might be better aligned with environments and internal processes), change might increase mortality hazards over the short term. If this is indeed the case, reorganization-prone organizations have a lower probability of representation in future populations.

Substantial research has tested the implications of this argument. Most well designed studies have determined that changing core structures increases the hazard of mortality in the short term, often substantially. Moreover, the magnitude of this effect increases with organizational age.

See also: *Event-History Analysis; Human Ecology.*

BIBLIOGRAPHY

Carroll, Glenn R. 1985. "Concentration and Specialization: Dynamics of Niche Width in Organizational Populations." *American Journal of Sociology* 90:1,262–1,283.

Carroll, Glenn R., and Michael T. Hannan. 2000. *The Demography of Corporations and Industries.* Princeton, NJ: Princeton University Press.

Carroll, Glenn R., and Anand Swaminathan. 2000. "Why the Microbrewery Movement? Organizational Dynamics of Resource Partitioning in the U.S. Brewing Industry." *American Journal of Sociology* 106: 715–762.

Hannan Michael T., and John Freeman. 1989. *Organizational Ecology.* Cambridge, MA: Harvard University Press.

Leslie, P. H. 1959. "The Properties of a Certain Lag Type of Population Growth and the Influence of an External Random Factor on the Number of Such Populations." *Physiological Zoölogy.* 3:151–159.

Pólos, László, and Michael T. Hannan. 2002. "Reasoning with Partial Knowledge." *Sociological Methodology 2002.* ed. Ross M. Stolzenberg. Cambridge, Eng.: Blackwell.

Stinchcombe, Arthur L. 1965. "Social Structure and Organizations." *Handbook of Organizations,* ed. James G. March. Chicago: Rand McNally.

MICHAEL T. HANNAN

OUTER SPACE, COLONIZATION OF

Human beings have established settlements in places as varied as the frigid and dry arctic tundra of northern Canada and the hot and wet Amazon rain forest. Clearly, humans are remarkable creatures. But can humans extend the frontier of settlement into an even less hospitable place, the cold vacuum of outer space? More than forty years after the launch of *Sputnik,* how far off is the colonization of outer space?

Low Earth Orbit

The first human went into space in the early 1960s. From then until the 1990s, a few astronauts—or, to use the even more grandiose Russian label, cosmonauts—episodically "populated" near-Earth space. Groups of such travelers rocketed into space, stayed a few days or months, and then returned to Earth. In the 1990s the space station Mir, assembled by the Soviet Union and operated by Russia, was continuously inhabited for several years by rotating crews of cosmonauts. The station aged and was abandoned in 1998 after Russia, the United States, and many other international partners began work on the International Space Station.

A demographic regime in space may have begun on October 31, 2000, when the three-person crew of *Expedition 1* began its four-month stay in orbit on the space station. The U.S. National Aeronautics and Space Administration (NASA) claims that there will always be a crew in the space station. If this turns out to be right, then the dawn of the third millennium will mark the beginning of a permanent space population, a milestone in space similar to that for Antarctica marked by the International Geophysical Year of 1957.

Water—The Liquid of Life

Are Mir and the International Space Station the first steps toward the human colonization of the solar system? Russian space pioneer Konstantin Tsiolkovsky (1857–1935) wrote that "the Earth is the cradle of humanity, but one cannot live in the cradle forever." It is hard for human beings to leave their literal cradles for the Earth beyond them, because the Earth contains what is needed to sustain life: air, food, and water. Outer space is airless, foodless, and most importantly, waterless.

A single human being needs about eight pounds of water per day, including wash water, to live. It takes a ton of water to sustain an eight-person space station for a month if each drop of water is used by a human being only once. On earth, all of this water is recycled, filtered, and purified by the water cycle. In existing space stations, aerospace engineers have made some progress in closing the water loop, by recycling cabin moisture into drinking water. If large-scale, free-floating space colonies—like those proposed by the Princeton physicist Gerard K. O'Neill (1927–1992) in the 1970s—were to become real, 100 percent of the water, including urine, has to be recycled.

In the past few years space enthusiasts have looked more to the planets as possible future homes for humanity. The discoveries of substantial amounts of water on the planet Mars and on Jupiter's satellite Europa have suggested that it might be more feasible to consider colonizing these places, instead of dealing with the tough (though technically solvable) water problem of space stations. Just as settlers in the American West followed great rivers like the Missouri westward, humans may follow the trail of water, which probably would lead to the surface of Mars. And planets like Mars can not only supply space travelers with water to drink; Martian materials can also provide rocket fuel for the trip home. American engineer Robert Zubrin incorporates the use of Martian materials into his revolutionary and important "Mars Direct" plan, proposed in 1996, which cuts the travel time to Mars from nine months to six and permits astronauts to spend much more time on the Martian surface.

Terraforming Mars

Could humans establish a colony on Mars? The Red Planet is far from being Earthlike. Could it be *terraformed,* or altered in order to make it habitable by humans? Scholars Joseph A. Burns, Martin Harwit, and Carl Sagan were the first to suggest terraforming in a mainstream scientific journal in 1973. In broad terms, to terraform Mars, colonists would need to darken the surface so it absorbs more sunlight, and find a way to release the water and carbon dioxide that exists underground so that the atmosphere will become thicker and will trap solar heat by the greenhouse effect.

Thirty years after its initial suggestion, the idea of terraforming is still intellectually alive. It has been discussed in mainstream scientific reviews by such writers as Martyn J. Fogg (1998), as well as in science fiction novels that occasionally delve quite deeply into scientific issues, such as Kim Stanley Robinson's 1994 novel *Green Mars.* But the obstacles to terraforming Mars are formidable. Once enough volatile material (like water and dry ice) is found to create a massive atmosphere, there is still a need to get the gas mixture right. Scuba divers occasionally experiment with breathing oxygen-rich or nitrogen-poor air, and have established that humans need something close to the 4:1 mix of nitrogen to oxygen that humans breathe on Earth. So it may be that nitrogen, the "inert" ingredient in Earth's atmosphere, will limit humans' ability to terraform Mars.

Beyond the Solar System

For a species which has just stuck its toes in the oceans of space, humans have a wonderful capacity to dream. A surprisingly large literature deals with interstellar space flight. *Interstellar Migration and the Human Experience,* a remarkable book edited by Ben R. Finney and Eric M. Jones (1986), provides an inspiring introduction. Perhaps the most visionary of thinkers is the physicist Freeman Dyson, who suggested in 1979 that very advanced civilizations could construct spherical absorbers that would permit them to harness 100 percent of the energy output from an individual star. Can human beings or other intelligent creatures move from one star to another? While the technical challenges are extreme, it is not impossible.

Whether any such dreams will turn into reality is a matter for the future. Some writers like Dyson and Zubrin believe that the allure of the space frontier by itself is enough to propel humanity—in significant numbers—toward the stars. Others, like Harry L. Shipman and many of the authors in *Interstellar Migration and the Human Experience,* take a more cautious approach, suggesting that some kind of return on investment, whether it be through space industrialization or space tourism, must provide a political and economic push. Whatever the future brings, space colonization is a fun and mind-expanding concept to dream about.

Will space colonization ever reach a scale at which number of colonizers could make a significant difference to demographic trends on Earth? It seems unlikely in the foreseeable future. Even Antarctica, where there is a large supply of water (in the form of ice) and air, can only support a year-round population of a few hundred. The most optimistic visions of space colonies, whether free-floating or Martian, postulate populations of tens of thousands. A significant effect on terrestrial population requires space for at least a few tenths of a billion inhabitants. Although outer space is vast, the environment may not be entirely hospitable.

See also: *Extinction, Human; Literature, Population in.*

BIBLIOGRAPHY

Burns, Joseph A., and Harwit, Martin. 1973. "Towards a More Habitable Mars, or The Coming Martian Spring." *Icarus* 19: 126.

Dyson, Freeman J. 1979. *Disturbing the Universe.* New York: Harper and Row.

Finney, Ben R., and Jones, Eric M., eds. 1985. *Interstellar Migration and the Human Experience.* Berkeley: University of California Press.

Fogg, Martyn J. 1998. "Terraforming Mars: A Review of Current Research." *Advances in Space Research* 22(3): 415–420.

Freeman, Marsha. 2000. *Challenges of Human Space Exploration.* Berlin: Springer-Praxis.

O'Neill, Gerard K. 1982. *The High Frontier: Human Colonies in Space.* Garden City, NY: Anchor Books.

Robinson, Kim Stanley. 1994. *Green Mars.* New York: Bantam.

Sagan, Carl. 1973. "Planetary Engineering on Mars." *Icarus* 20: 513.

Shipman, Harry L. 1989. *Humans in Space: 21st Century Frontiers.* New York: Plenum.

Zubrin, Robert, and Wagner, Richard. 1996. *The Case for Mars: The Plan to Settle the Red Planet and Why We Must.* New York: Simon and Schuster Touchstone.

INTERNET RESOURCES.

British Interplanetary Society. 2002. <http://www.bis-spaceflight.com>.

Fogg, Martyn J. 2002. "The Terraforming Information Page." <http://www.users.globalnet.co.uk/~mfogg/index.htm>.

National Aeronautics and Space Administration. 2002. <http://science.ksc.nasa.gov/history/A97>.

Robinson, Kim Stanley. "The Red, Green, and Blue Maps Site." 2002. <http://www.xs4all.nl/~fwb/rgbmars.html>.

HARRY L. SHIPMAN

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PALEODEMOGRAPHY

Paleodemography attempts to reconstruct past population structure using samples of human skeletons, either freshly excavated or stored in museum collections, from archaeological sites. Its chief claim to legitimacy is that it provides demographic information—albeit of a limited, indirect, and uncertain sort—about the many human populations in the past that left no written records. In principle, paleodemography also allows the reconstruction of demographic trends over time spans that are unattainable by any other branch of population science. Because of persistent methodological problems, however, paleodemographic analysis has achieved only limited credibility among mainstream demographers. Yet while it is fair to say that past paleodemographic analyses were often too crude to be believable, it is also true that recent methodological advances, not yet known to most demographers, have moved paleodemography to a firmer scientific footing. The most important such advances have been in the areas of age estimation, mortality analysis, and adjustments for the effects of demographic non-stationarity on skeletal age-at-death distributions.

Age Estimation

Osteologists have made great progress in identifying reliable skeletal markers of age. Information on age at death is provided by skeletal features such as dental development, annual increments in dental cementum, closure of long-bone epiphyses and cranial sutures, and changes in the articular surfaces of the pelvis. Ages based on such features are subject to differing degrees of error arising from the inherent variability of the underlying processes of maturation and senescence. The age of juveniles can be estimated much more reliably than that of adults, and younger adults more reliably than older adults. But all paleodemographic age estimates are inherently error-prone and always will be. However much osteologists work to reduce these errors and identify new age indicators, a large degree of aging error will always be a part of paleodemography.

The most difficult problems of paleodemographic age estimation are statistical rather than purely osteological. In addition to a *target sample* (the archaeological skeletons whose ages are to be estimated), the paleodemographer needs access to a *reference sample* of skeletons whose ages at death are known. Several well-known reference samples—for example, the Hamman-Todd and Terry Collections—provide reasonably accurate data on the joint distribution of c and a, where c is a vector of skeletal traits that provide information on age and a is age itself. For the target sample, however, researchers know only the marginal distribution of c, from which they hope to estimate the marginal distribution $\Pr(a)$ of ages at death. One of several parametric or non-parametric methods can be applied to data from the reference sample to estimate the conditional probability density or mass function $\Pr(c \mid a)$. If these estimates are to be used in estimating ages of archaeological skeletons, one needs to make an "invariance assumption" that the joint distribution of c and a is identical in the two populations from which the reference and target samples were drawn. It is by no means clear that this assumption is warranted for many skeletal traits, and an ongoing goal of paleodemography is to identify indicators that are both informative about age and reasonably invariant across human populations.

Insofar as the invariance assumption is correct, it would seem to make sense to combine data on Pr(c) in the target sample and the joint distribution of a and c in the reference sample to estimate Pr(a | c) for each individual skeleton. But according to Bayes' theorem:

$$\Pr(a\,|\,c) = \frac{\Pr(c|a)\ \Pr(a)}{\int_0^\infty \Pr(c\,|\,x)\ \Pr(x)dx}$$

where Pr(a) is the age-at-death distribution in the *target* sample, which is unknown.

A procedure for estimating Pr(a) was recently developed by Hans-Georg Müller and his colleagues (2002). Briefly, Pr(a) is specified as a Gompertz-Makeham or similar parametric model, Pr(a | θ), with parameters θ which can be estimated from the reference sample using a maximum-likelihood technique. Once the parameters of Pr(a | θ) have been estimated, the expected ages of individual skeletons can be found by a straightforward application of Bayes's theorem. This approach to age estimation is called the *Rostock protocol* because it grew out of a series of workshops held at the Max Planck Institute for Demographic Research in Rostock, Germany.

It will seem strange to orthodox paleodemographers that they need to estimate the entire age-at-death distribution before they can estimate individual ages—the reverse of their usual procedure. But the Rostock protocol actually solves a number of problems that have long plagued paleodemography, including the "age mimicry" problem first noted by Jean-Pierre Bocquet-Appel and Claude Masset in 1982. In addition, the method can be used to obtain not just point or interval estimates of age, but the entire error structure of the age estimates. Important statistical problems remain to be solved, such as whether to use discrete categories or "staged" traits versus more continuous age indicators, and how best to use multivariate skeletal data when traits are correlated in their age trajectories. But these problems can all be attacked within the framework of the Rostock protocol.

Mortality Analysis

For years paleodemographers have used skeletal age-at-death data to compute life tables based on some simple modifications of conventional life-table techniques originally developed by the Hungarian demographer and archeologist Gy. Acsádi and J. Nemeskéri. Though this approach is still a common one, the paleodemographic use of life tables can be criticized on several grounds. First, paleodemographic studies do not produce the kinds of data needed to compute life-table mortality rates using standard methods—specifically, paleodemographers lack the numbers of deaths among people at each (known) age and the number of person-years of exposure to the risk of death at that age during some well-defined reference period. Second, the use of fixed age intervals in the life table implies that the ages of all skeletons are known within the same margin of error, including those of fragmentary skeletons that exhibit only a few unreliable indicators of age. Third, the life table is a wasteful way to use the small samples typical of paleodemographic studies—samples that are often on the order of a few dozen or a few hundred skeletons. In computing a life table demographers need to estimate one parameter (an age-specific mortality rate) for every age category by sex in the table. Few paleodemographic samples will support such a data-hungry approach to estimation.

The Rostock protocol supports an alternative approach to paleodemographic mortality analysis. If unbiased estimates of the parameters of Pr(a | θ) can be obtained for the target population of interest—and if the effects of demographic non-stationarity can be removed (see below)—the parameter estimates can be used to derive the survival function, the age-specific probability of death, life-expectancies, and anything else one might hope to learn from life-table analysis.

Demographic Non-stationarity

Another shortcoming of traditional paleodemographic life-table analysis is that it assumes that the population under investigation was stationary: that it was closed to migration, and had an intrinsic rate of increase equal to zero, age-specific schedules of fertility and mortality that were unchanging over time, and a balanced age distribution generated by those age-specific birth and death rates. Only in this special case is the empirical age distribution of skeletons expected to have a simple, straightforward relationship to the cohort age-at-death column in the life table. This problem was recognized by Larry Angel, one of the early practitioners of paleodemography, and remains a concern.

As demographers have long realized, the age structure of a non-stationary population—and thus the number of its members at risk of death at each age—is more sensitive to the level of fertility than to the level of mortality. Thus, age-at-death distributions from different populations are at least as likely to reflect fertility differences as genuine differences in mortality. This incontrovertible fact of demography has given rise to the odd notion that paleodemographic age-at-death estimates are more informative about fertility than mortality. In fact all demographers can ever hope to estimate about fertility from such data is the crude birth rate, which is scarcely a measure of fertility at all. But if paleodemographers could correct for demographic non-stationarity, they could extract quite a bit of information about age-specific mortality from skeletons, and perhaps even estimate the population's growth rate.

Let $f_0(a)$ be the expected age-at-death distribution for a single birth cohort in the target population. If the target population was stationary, the same distribution holds for all deaths occurring in the population. But even if the population cannot be assumed to have been stationary, it may be reasonable to assume that it was *stable.* That is, demographers may be able to make all the assumptions listed above for the stationary population, with the exception that they should allow for the possibility of a non-zero growth rate. (The assumption of stability is much less restrictive than that of stationarity: even when fertility and mortality rates are changing and migration is occurring, most human populations still closely approximate a stable age distribution at any given time.) In a stable but non-stationary population, the age-at-death distribution is only partly a function of age-specific mortality; it is also influenced by the number of living individuals at risk of death at each age, which is influenced in turn by population growth. More precisely, the probability density function for ages at death in a stable population with growth rate r, $f_r(a)$, can be expressed in terms of the target population age-at-death distribution, $f_0(a)$, by:

$$f_r(a) = f_0(a)e^{-ra} \bigg/ \int_0^\infty f_0(x)e^{-rx}\,dx$$

As David Asch showed in 1976, this expression also applies to all the skeletons accumulated by a stable population over some more or less extended span of time—for example, the period over which skeletons were deposited in a cemetery. In principle, then, $f_r(a)$ can be treated as the $\Pr(a \mid \theta)$ function in the Rostock protocol, and r can be estimated as an additional parameter of the model, if the population can be assumed to be stable. And if it was *not* stable, at least approximately, paleodemographers have probably reached the limits of what they can ever hope to learn about age-specific mortality from skeletal samples.

Prospects

The most important recent developments in paleodemography from the perspective of the early twenty-first century have been methodological, not substantive. But now that paleodemographic methods have become more sophisticated, there is every reason to expect that important empirical results will be forthcoming. It is likely, too, that the findings of paleodemography will be strengthened by the study of DNA extracted from ancient bones—a field that is already starting to provide insights into the ancestry and kinship structure of past populations, as well as the pathogens that infected them. There is also a new and encouraging movement to bring archaeological settlement studies, long an established approach to past population dynamics, into the purview of paleodemography. Another useful development has been the study of historical graveyards where cemetery records or parish registers exist to cross-check the osteological results. While mainstream demographers were once justified in dismissing the field of paleodemography, it may be time for them to rethink their skepticism.

See also: *Archaeogenetics; Evolutionary Demography; Prehistoric Populations.*

BIBLIOGRAPHY

Acsádi, G., and J. Nemeskéri. 1970. *History of Human Life Span and Mortality.* Budapest: Akadémiai Kiadó.

Angel, J. L. 1969. "The Bases of Paleodemography." *American Journal of Physical Anthropology* 30: 427–438.

Asch, D. L. 1976. *The Middle Woodland Population of the Lower Illinois Valley: A Study in Paleode-*

mographic Methods. Evanston, IL: Northwestern University Press.

Bocquet-Appel, J. P., and C. Masset. 1982. "Farewell to Paleodemography." *Journal of Human Evolution* 11: 321–333.

Hoppa, R. D., and J. W. Vaupel, eds. 2002. *Paleodemography: Age Distributions from Skeletal Samples.* Cambridge: Cambridge University Press.

Horowitz, S., G. Armelagos, and K. Wachter. 1988. "On Generating Birth Rates from Skeletal Samples." *American Journal of Physical Anthropology* 76: 189–196.

Iscan, M. Y., ed. 1989. *Age Markers in the Human Skeleton.* Springfield, IL: C. C. Thomas.

Kolman, C. J., and N. Tuross. 2000. "Ancient DNA Analysis of Human Populations." *American Journal of Physical Anthropology* 111: 5–23.

Konigsberg, L. W., and S. R. Frankenberg. 1992. "Estimation of Age Structure in Anthropological Demography." *American Journal of Physical Anthropology* 89: 235–256.

Konigsberg, L. W., and S. R. Frankenberg. 1994. "Paleodemography: 'Not Quite Dead.'" *Evolutionary Anthropology* 3: 92–105.

Meindl, R. S., and K. F. Russell. 1998. "Recent Advances in Method and Theory in Paleodemography." *Annual Review of Anthropology* 27: 375–399.

Milner, G. R., J. W. Wood, and J. L. Boldsen. 2000. "Paleodemography." In *Biological Anthropology of the Human Skeleton,* ed. M. A. Katzenberg and S. R. Saunders. New York: Wiley-Liss.

Müller, H. G., B. Love, and R. D. Hoppa. 2002. "Semiparametric Method for Estimating Paleodemographic Profiles from Age Indicator Data." *American Journal of Physical Anthropology* 117: 1–14.

Paine, R. R., ed. 1997. *Integrating Archaeological Demography: Multidisciplinary Approaches to Prehistoric Population.* Carbondale: Southern Illinois University Press.

Sattenspiel, L., and H. C. Harpending. 1983. "Stable Populations and Skeletal Age." *American Antiquity* 48: 489–498.

Stone, A. C. 2000. "Ancient DNA from Skeletal Remains." In *Biological Anthropology of the Human Skeleton,* ed. M. A. Katzenberg and S. R. Saunders. New York: Wiley-Liss.

Wood, J. W., G. R. Milner, H. C. Harpending, and K. M. Weiss. 1992. "The Osteological Paradox." *Current Anthropology* 33: 343–370.

James W. Wood

PARENTHOOD

Throughout history, pregnancy and parenthood were uncontrollable hazards of life for sexually active women. This changed from the 1960s onwards, as the contraceptive revolution allowed sexual activity to be divorced from reproduction. For women, the most important technical innovation of the twentieth century was the contraceptive revolution: the development of coitus-independent and reliable methods of contraception that can be controlled, or chosen, by women themselves. The three principal methods are the contraceptive pill, the IUD or coil, and sterilization. These modern methods of contraception give women control over their own fertility. For the first time in history, parenthood became a voluntary act, rather than the inevitable outcome of marriage. In countries where women can choose if, and when, to become parents, fertility levels have declined sharply, making it clear that the high fertility levels observed in the past were not entirely chosen, even if accepted by couples.

Social Impact of the Contraceptive Revolution

The contraceptive revolution produced two social developments in modern societies: the rise of voluntary childlessness, and the polarization of lifestyles between couples with and without children. In the past, childlessness was generally due to infertility of one or both partners, and childless couples were pitied. Childless women were often stigmatized as social and physical failures, or as unnatural. In countries where the contraceptive revolution has been fully implemented, voluntary childlessness typically rises to around 20 percent of the adult population. People in this group have a distinctive lifestyle, focused on careers, leisure, and intensive consumption. In contrast, couples with children invest a substantial proportion of their resources in the education and socialization of their offspring. Smaller numbers of children mean that greater effort is put into the care and education of each child. The total volume of parenting work thus grows even though the number of children per family declines. In countries where child mortality remains high, parents have less incentive to invest substantial resources in any individual child. Public concern over child labor, child abuse, and children's education are characteristic of societies where family sizes and child mortality are low.

Economics of Parenthood

The nature of parenting changes as the economic relationship between parents and offspring changes. In less developed countries, children are important contributors of labor to the family enterprise, or they contribute earnings from independent jobs, from an early age. Parents also rely on their offspring for financial and social support when they become infirm or old. In effect, the family provides mutual welfare services, and within-family transfers between generations are balanced. Parenting is thus an economic investment with a clear long-term benefit. In modern societies, the principal within-family income transfer is from the older generation to the younger generation, from parents to their offspring, so that children become consumption goods. It is in this sense that having children becomes a lifestyle choice in modern societies, rather than being an absolute necessity for parents' own survival.

The cost of children, as consumption goods, rises steadily as their dependence on their parents is extended beyond early adolescence—initially to late adolescence, then into early adulthood, then into prime adult age, due to the gradual prolongation of full-time education. In 1999 the average age of leaving the parental home in the European Union was 23 for women and 25 for men. However it was markedly higher in southern Europe: 27 for women and 30 for men in Italy, 28 for women and 29 for men in Spain. In prosperous modern societies, parenting is no longer concentrated exclusively on the early years of a child's life.

Parenting Work

Throughout history, mothers have always worked. Survival depended on it. The non-working wife (or concubine) in a single-earner family has always been an indicator of prosperity and higher social status, in all societies. For most women, productive and remunerative work had to be combined with childcare and other family work. For the space of less than 100 years, in the nineteenth and twentieth centuries, women were "domesticated": western European and north American societies promoted the idea of the single earner model of the family as the ideal to aim for in all social classes. Many achieved the goal of one full-time homemaker, for at least part of the family life-cycle. By the end of the twentieth century, women had returned to the labor market in most modern societies, and the dual-earner family was being re-established as the dominant pattern. Nonetheless, mothers retain a much greater attachment to their children, especially during early childhood, which some claim to be the result of evolutionary development rather than the childbearing process.

The majority of mothers in modern societies thus reduce their involvement in paid work when their children are very young. Some women abandon their jobs to become full-time mothers and homemakers on a permanent basis. Sociologist Catherine Hakim (2000) estimates this choice is made by one-fifth of all adult women. Another minority (about one-fifth) contracts out virtually all parenting work—either to state nurseries and schools, or to private nannies and boarding schools. Most women are able to combine childcare with some type of involvement in paid work. The most popular arrangement is the part-time job, which leaves plenty of time for parenting and family work. Seasonal work, term-time work, and temporary jobs are also used to fit paid work around mothers' parenting responsibilities. In countries where part-time jobs are in short supply (such as the United States and southern Europe), mothers are obliged to choose between a full-time job and no paid work at all. Mothers who choose full-time jobs then complain about their "double shift" as sociologist Arlie Hochschild (1990) described it.

In modern societies, many parenting activities are transferred from families to the state. The most obvious example is the formal education and socialization of children. In many countries, the state also provides informal socialization, through clubs and associations, free or subsidised sporting facilities, and cultural activities. The one enduring and irreplaceable contribution of parents seems to be the emotional and social development of young children. Children deprived of one or both parents are more likely to develop antisocial attitudes and behaviors, and be less successful in adult life. There is, apparently, no substitute for parental love and care in the early years. In the early twenty-first century, this seems to be the permanent obstacle to the mass-production of humans outside the family envisaged by Aldous Huxley in his classic novel *Brave New World.*

See also: *Childlessness; Cost of Children; Family Life Cycle; Family Policy; Grandparenthood.*

BIBLIOGRAPHY

Hakim, Catherine. 2000. *Work-Lifestyle Choices in the 21st Century: Preference Theory.* Oxford: Oxford University Press.

Hochschild, Arlie. 1990. *The Second Shift: Working Parents and the Revolution at Home.* London: Piatkus.

Huxley, Aldous. 1932 (1994). *Brave New World.* London: Flamingo.

Rogers, Barbara. 1981. *The Domestication of Women: Discrimination in Developing Societies,* London: Tavistock.

Westoff, Charles F., and Ryder, Norman B. 1977. *The Contraceptive Revolution.* Princeton NJ: Princeton University Press.

Catherine Hakim

PARETO, VILFREDO

(1848–1923)

Italian economist and sociologist Vilfredo Pareto was classified by Joseph A. Schumpeter, the development economist who integrated sociological understanding into economic theory, as one of the great economists. In 1893, Pareto became Professor of Political Economy at the University of Lausanne, occupying the chair formerly held by Léon Walras, the founder of modern theory of general economic equilibrium. He used his background in mathematics and engineering to study human society, adapting the principles of the physical sciences to economic theory. He understood the latter as a science of people's *logical actions* in the use of means for achieving particular ends.

In Pareto's general system of economic equilibrium, the demographic component is the first variable considered. It is the subject of the lengthy first chapter of volume 1 of his *Cours d'économie politique* (1897), entitled "Personal Capital." His statement that, "Political economics must first of all take into account the composition of the population," was an unusual emphasis to find in an economic text (Pareto, p.96 in the Italian edition: *Corso di economia politica, Giulio Einaudi Editore, Torino,* 1949.). According to Pareto (and also English economist T. R. Malthus [1766–1834], from whom Pareto distanced himself by assessing social organization to be much more important in influencing behavior than the principle of moral restraint), the equilibrium between population and subsistence is caused by the mutual interaction between the two components, in much the same way that the movement of a planet is the result of the combined action of the centrifugal force, which tends to drag it away from its orbit, and the centripetal force, pulling it toward the sun. Analogously, a population would tend to grow constantly, under the effect of the *generative force,* were it not restricted by subsistence: hence an equilibrium caused by two disequilibria. Pareto analyzed the state and movement of populations using the formal paradigms of Luigi Perozzo, Italian mathematical demographer, and Wilhelm Lexis, German statistician, and explored the effects of economic factors (particularly those linked to class differences) on natality and mortality.

There is also a demographic element to Pareto's view of sociology, that was considered as a science of humanity's non-logical actions. Pareto's theory maintains that, in an ideal society, a continued and regular change of the ruling class is a necessary condition for a dynamic equilibrium: This is his theory of the circulation of elites, or more accurately, the downward social mobility of less able members of the upper classes, compensated by the rise of lower class members.

See also: *Social Mobility*

BIBLIOGRAPHY

SELECTED WORKS BY VILFREDO PARETO.

Pareto, Vilfredo. 1893. "La mortalità infantile e il costo dell'uomo." *Giornale degli Economisti* (November): 451–456.

———. 1897. *Cours d'économie politique.* Lausanne, Switzerland: F. Rouge.

———. 1906. *Manuale di Economia Politica* [Manual of political economy]. Milan: Societa Editrice. English translation. 1971. New York: A. M. Kelley.

———. 1916. *Trattato di Sociologia Generale* [The mind and society: A treatise on general sociology]. 4 Vols. Florence, Italy: G. Barbèra. English translation. 1935. New York: Harcourt Brace.

———. 1966. *Sociological Writings,* Selected and Introduced by S. E. Finer. New York: Praeger.

———. 1966. *Sociological Writings,* The Robert J. Le Fevre Collection. Selected and Intro. S. E. Finer, trans. Derick Mirfin. New York: Praeger.

———. 1968. *Rise and Fall of the Elites: An Application of Theoretical Sociology.* Totowa, NJ: Bedminster Press.

SELECTED WORKS ABOUT VILFREDO PARETO.

Schumpeter, Joseph A. 1951. *Ten Great Economists, from Marx to Keynes.* New York: Oxford University Press.

Spengler, Joseph J. 1972. "Pareto on Population." In *Population Economics.* Durham, NC: Duke University Press.

Italo Scardovi

PARTNER CHOICE

There are many systems of partner choice, but all tend to produce a high degree of "assortative mating," that is a pattern in which individuals choose partners who are similar to themselves. This pattern also has been called *homogamy* and has been described as "like marries like." Assortative mating has been observed in a wide range of societies, though numerous exceptions have always been found.

Several theories have been advanced to explain the origins of assortative mating. The most common view starts from a rational actor/exchange perspective in which individuals search among potential partners and seek to maximize their gains from an alliance. Because each individual is likely to reject anyone with characteristics less desirable than his or her own, all are likely to wind up with individuals very much like themselves. An alternative view stresses the noneconomic aspects of status and sees the process as a search for a partner with the same culture and values. In both perspectives assortative mating links individuals who are similar on a number of ascribed (i.e., determined by birth) and achieved characteristics and thus perpetuates the prevailing system of social stratification.

The numerous exceptions to assortative mating also require explanation. Limitations imposed by the pool of possible partners are a potentially important factor. A second factor is that individuals typically have personal, emotional, and idiosyncratic partner preferences. Still, there is good reason to believe that many exceptions to homogamy reflect social structural factors.

Traditionally, women have sought men who can fulfill a breadwinner role, and in contemporary Western societies a man's steady job is still very important. Although women's employment outside the home is growing in importance in many societies, men traditionally have emphasized a woman's social characteristics: poise, charm, attractiveness, and other noneconomic attributes. As a result, mutually beneficial exchanges can occur between a man's economic characteristics (e.g., education, income, and occupation) and a woman's noneconomic characteristics (including age and race/ethnicity). A classic explanation along those lines is that most (two-thirds or more) black-white marriages in the United States involve black men and white women because they represent an exchange between a black man's greater economic resources and a white woman's superior social status.

Although the significance of exchanges in the overall context of partner choice remains a matter of dispute, exchanges involving a number of female noneconomic and male economic characteristics have been found in analyses of marriage data. Marriages that cross major social divisions also reflect the social distance between those groups. When dominant and subordinate groups are involved, such intermarriages are simultaneously a reflection of the acceptance of the subordinate group and a threat to that group's cohesion and distinctiveness.

One characteristic of Western and some non-Western societies since the mid-twentieth century is a trend toward a greater emphasis on achieved characteristics and a deemphasis of ascribed traits. For example, in the United States educational homogamy has grown in importance while religious homogamy has declined. The rise of cohabitation in many Western societies raises additional issues because if cohabitation is a distinct institutional form, patterns of partner choice could differ. There is some evidence that compared with marriages, cohabitations are more assortative in regard to achieved characteristics and less in regard to ascribed ones. Cohabitations are less permanent than marriages and thus are less likely to emphasize long-term, familistic considerations. However, since cohabitation is frequently a prelude to marriage, the increased frequency of cohabitation may accentuate the shift away from ascribed characteristics. Little is known about the nature of assortative mating in same-sex unions.

As societies change their institutional forms and beliefs, the criteria that guide mate selection are transformed. However, despite much individual variation, partner choice has always reflected the prevailing social structures and values.

See also: *Cohabitation; Family Bargaining; Marriage.*

BIBLIOGRAPHY

Davis, Kingsley. 1941. "Intermarriage in Caste Societies." *American Anthropologist* 43: 376–395.

DiMaggio, Paul, and John Mohr. 1985. "Cultural Capital, Educational Attainment, and Marital Selection." *American Journal of Sociology* 90: 1,231–1,261.

Edwards, John N. 1969. "Familial Behavior as Social Exchange." *Journal of Marriage and the Family* 31: 518–526.

Gordon, Milton M. 1964. *Assimilation in American Life.* New York: Oxford University Press.

Schoen, Robert, and Robin M. Weinick. 1993. "Partner Choice in Marriages and Cohabitations." *Journal of Marriage and the Family* 55: 408–414.

Schoen, Robert, and John Wooldredge. 1989. "Marriage Choices in North Carolina and Virginia, 1969–1971 and 1979–1981." *Journal of Marriage and the Family* 51: 465–481.

Robert Schoen

PEARL, RAYMOND

(1879–1940)

Raymond Pearl was an American biologist, geneticist, biometrician, and eugenicist. He was also a professor of Biometry and Vital Statistics at Johns Hopkins University (1918–1940) and the first president of the International Union for the Scientific Investigation of Population Problems (IUSSP's predecessor). Pearl studied under the statistician Karl Pearson (1857–1936) in London and subsequently applied statistical methods to the analysis of human populations, concentrating on longevity, fertility, and the patterns of population growth. The value used in the medical sciences to rate the effectiveness of a birth control method bears his name (*Pearl Index*). Following the lead of the eugenicist Francis Galton and Pearson, Pearl tried to create a new branch of mathematical biology—the "biology of groups"—based on the population as the unit of analysis.

Under the influence of Pearson, Pearl started out as a strong advocate of eugenics. However, in the course of his active life, he relaxed his views, arguing against the class bias that pervaded the eugenics movement. Much to the chagrin of the eugenicists he asserted that the higher reproduction rate of the lower classes need not be feared: the lower classes often produced superior individuals who, given the opportunity for social mobility, would become valuable members of society.

In 1920 Pearl, together with Lowell J. Reed, rediscovered the "logistic curve" of population growth, which had been first formulated by the Belgian mathematician Pierre-François Verhulst in 1838. Initially, Pearl tended to interpret the logistic curve in a deterministic way as a general biological "law," holding for both human and non-human populations. In his view the theoretical basis for this was to be found in natural causes—biological, physical or chemical. The relevance of the logistic curve as a theory of population growth was widely questioned by those who thought that such growth depended largely upon cultural, social, and economic changes. Later, Pearl moved away from determinism.

Both Pearl and his law of logistic population growth were prominent at the World Population Conference in Geneva in 1927. Throughout the 1920s the merits of the logistic curve as a tool for estimating and projecting population growth were debated and juxtaposed with those of the cohort component approach then being introduced. The latter method was favored by most European statisticians and economists, and subsequently became the dominant mode of population forecasting. In 1932 Alfred Lotka reconciled the two approaches by constructing a unified formal model that integrated the logistic and cohort-component characteristics of population growth.

See also: *Demography, History of; Lotka, Alfred; Projections and Forecasts, Population; Verhulst, Pierre-François.*

BIBLIOGRAPHY

SELECTED WORKS BY RAYMOND PEARL.

Pearl, Raymond. 1924. *Studies in Human Biology* Baltimore, MD: Williams & Wilkins.

———. 1926. *The Biology of Population Growth.* London, Williams and Norgate.

———. 1928. *The Rate of Living: Being an Account of Some Experimental Studies on the Biology of Life Duration.* New York: Alfred A. Knopf.

———. 1939. *The Natural History of Population.* New York: Oxford University Press.

Pearl, Raymond, and Lowell J. Reed. 1930. *The Logistic Curve and the Census Count of 1930.* New York: Science Press.

SELECTED WORKS ABOUT RAYMOND PEARL.

De Gans, Henk A. 2002. "Law or Speculation? A Debate on the Method of Forecasting Future Population Size in the 1920s." *Population* 57(1): 83–108.

Kingsland, Sharon. 1988. "Evolution and Debates Over Human Progress from Darwin to Sociobiology." In *Population and Resources in Western Intellectual Traditions,* ed. Michael S. Teitelbaum and Jay M. Winter. Supplement to *Population and Development Review,* Vol. 14, pp. 167–189.

Lotka, Alfred J. 1932. "The Structure of a Growing Population." In *Problems of Population.* London: George Allen and Unwin Ltd.

HENK A. DE GANS

PEOPLING OF THE CONTINENTS

From Africa, humans migrated to Asia and Europe and, later, settled the Pacific islands and the Americas. Successive waves of migration have covered the habitable world with self-sustaining settlements. The geographical patterns of peopling are the result of two closely related processes: migration and endogenous growth associated with contextual living conditions. Robust endogenous growth is seldom found in isolated and sparse settlements unless the population reaches critical levels of density that make the division of roles and functions and the emergence of agriculture possible. With the neolithic revolution—about 10,000 years ago in the Middle East and China, and later in the Americas—endogenous growth accelerated, providing an additional impetus for successive waves of settlement in empty or sparsely settled regions of the world. As early as 2000 years ago, with a total population of between 250 and 350 million, most regions of the world were well settled with populations expanding by natural growth rather than by migration.

The growth performances of the various continents and regions have differed widely during the last two millennia. In approximately 1500, the population of Europe was double that of Sub-Saharan Africa; in 1900 it was four times larger; and in 2000 the populations were nearly equal. In 1500 the Americas—according to William Denevan's 1992 estimate—had approximately the same population as Africa; in 1800 it was one-half Africa's size; and in 1900 it was larger than Africa's population by 50 percent. Migration flows and differential natural growth are the proximate determinants of these highly varied performances, but the remote determinants are much more complex and rooted in differential command of technology and knowledge, resilience of social texture, and environmental characteristics.

Africa

Oddly enough, Africa, the continent of humanity's origin, has the least understood demographic history. Over the last millennium, the population growth of sub-Saharan Africa was associated with the expansion of Bantu populations, sustained by the use of iron, and by the extension and intensification of agriculture in the tropical forests of Central Africa and in the savannas of East and Southern Africa. Coinciding with this expansion was the southward movement of Nilo-Saharan populations from the eastern part of the continent. The population of North Africa, which at the peak of Roman power matched the size of that in the Sub-Saharan region, fell to perhaps one-fourth of that amount by the middle of the last millennium.

There is a great deal of information available about the slave trade and the forced abduction of millions of Africans, who were taken mainly from the west coast of the continent and transported, in major part, to the Americas, beginning in the late-fifteenth century. The total number of people who were forcibly moved to the Americas is believed to be about 8 million between 1500 and the end of the trade in the mid-nineteenth century. Another flow, of lesser magnitude, followed Arab trading routes to the north. It is generally thought that the slave trade had little or no effect on the growth of Africa's population, which was approaching 50 million at the beginning of the relevant period. A strict Malthusian interpretation of these events is that the population drain might have improved the chance of survival of those remaining behind by lessening the pressure on resources, while the revenues of the slave trade improved the standard of living. But this view must be balanced by the fact that slaves were typically in the prime productive years of their lives, families were separated, and communities were deeply wounded. The negative demographic effects on the areas from which the slaves came must have been considerable.

The Americas

The size of the population of the Americas at the time of the first European contact is a matter of controversy, with many ideological connotations. Influential estimates made by scholars in the last 50 years vary between a low level of 13 million by Angel Rosenblat in 1954 to a high of 113 million by Henry F. Dobyns in 1966, with more recent reassessments taking a middle course: 54 million according to William M. Denevan in 1992. However, the negative impact of contact and conquest is not in dispute: By the early seventeenth century the population had declined to just above 10 million and a sustained recovery took place only during the eighteenth century with the contribution of European and African immigration.

The steep decline in the century after the European arrival has been traditionally explained by the violent shift of power that ensued and the consequences of wars, forced labor, displacement, and violence. These were the ingredients of the *black legend* of the Conquest, first discussed in the writings of the settler-turned-Dominican friar, Bartolomé de Las Casas (1484–1566), and expanded to include anti-Spanish and anti-Catholic attitudes by later writers. Later revisionism, while raising the initial estimates of the indigenous population, attributes the main cause of the demographic catastrophe to diseases—such as smallpox, measles, or influenza—imported from Europe into a population with no immunity. However, the epidemiological explanation fails to take into account the complexity of the changes brought about by the European conquest and settlement. To assess the mix of factors that led to population decline or outright depopulation calls for careful analysis of each area and society. In the Greater Antilles, for example, local Taino Indians had almost disappeared by the mid-sixteenth century and were already much reduced in numbers by 1518 when the first epidemic of smallpox reached the New World from Europe. Earlier negative effects on survival and fertility may be traced to the economic displacement and confiscation of labor by the new masters, which eroded the standard of living in the local subsistence economy, the disruption of traditional social hierarchies, the fragmentation of families and clans, and the absorption of Taino women into the European reproductive pool. In other places, and particularly in the areas of densest settlement, it is likely that imported diseases were the principal cause of population decline.

Some population historians, including Sherburne Cook and Woodrow Borah, demonstrated that population decline was more severe in the areas with low density—for instance, in the coastal lowlands of the Gulf of Mexico—than in the more densely-settled plateaus and highlands—such as those making up the core of the Aztec empire. This argument, if correct, is at odds with the epidemiological explanation: The transmission of new pathologies would have been easier, and would have had deadlier effect, where the population was densely settled. Another nonepidemiological factor in depopulation must have been the displacement of native populations under the pressure of European settlement, as happened, for instance, along the coast of Brazil.

European populations thrived everywhere. The population of French origin in Québec in 1800, was seven times larger than the total inflow of immigrants from France up to that time; the population of Iberian and British origin was three to four times the cumulated immigration from their areas of origin. Compare this pattern of growth with the mere doubling of the European population from 1500 to 1800. European settlers had ample access to land; they found favorable climatic conditions and a more benign pathological environment; and plants and livestock imported from Europe flourished.

In the Americas as a whole, a cumulative total of some two million European immigrants, who had arrived by 1800, had grown into a population (not counting *mestizos*) of around seven million, equally divided between north and south. The population of European origin approached the size of the indigenous population, the descendants of the estimated 54 million of 1500. In contrast with the European immigration, the population of African origin (slave and nonslave) suffered heavy losses due to adverse living and working conditions, restrained family formation, and other consequences of slavery. In 1800 the African population in the Caribbean was perhaps 50 percent of the total inflow of enslaved people that arrived from Africa, while in Brazil the same population approximated the cumulated inflow. These two destinations accounted for 80 percent of the slave trade. A continuous inflow of slaves was needed in order to compensate the negative natural growth of the African population.

In the following century and a half, the population of the Americas increased rapidly due to the pressure of mass European immigration pushing the frontier of settlement westward and southward. Between 1840 and 1940, immigration accounted for 60 percent of natural growth in Argentina, 40 percent in the United States, and 20 percent in Brazil and Canada. Mexico, by far the most populous country of the Americas up to the eighteenth century, was the destination of only modest inflows of immigrants and slaves; Mexico was surpassed in population size by the U.S. in 1800 and by Brazil in around 1850.

Europe

The peopling of Europe is relatively well understood. In prehistoric times agriculturists from Asia Minor progressively migrated northwest into Europe, bringing new settlements and cultivation techniques and causing, or at least encouraging, the neolithic revolution there. The great blending of populations caused by migration from outside the continent increased with the fall of the Roman Empire and continued until the end of the ninth century when nomadic people, today's Hungarians, coming from the Euro-Asian steppes settled in the Carpathian Basin. Immigration continued to the open areas in the east of the continent and with the ebb and flow of Turks in the Balkans. Nevertheless, major immigration into Europe basically ended by the end of the Middle Ages.

The early centuries of the second millennium saw sustained population movement to the east of the continent, a settlement process that continued, in spite of the demographic decline caused by the Black Death in the fourteenth century, with varying rhythm until the nineteenth century. Much of this movement consisted of Germanic groups that gradually settled in territories east of the river Oder, which had been occupied by ethnic Slavs during the preceding millennium, and later in the southeast in territories taken back from the receding Ottoman Empire. The numbers of migrants were relatively small (perhaps a few hundred thousand), but improved technology, good organization and planning, and abundant land created conditions that both favored the natural growth of settlers and generated new waves of migration. In addition to this major eastern thrust, there were also lesser migrations in other directions: Spaniards and Portuguese toward the south, following the Reconquista of the Iberian peninsula (the fifteenth century expulsion of the Arabs); northward by the Scandinavians; and Slavs southward in Russia in search of more stable borders.

After two centuries of moderate but significant migration from Europe to the Americas, Iberian and British imperialists had established the political, economic, and demographic basis for mass migration. The availability of land in the Americas and to a lesser degree in Oceania, combined with an expanding demand for labor in these new societies, created the conditions for massive outflow from Europe. The industrial revolution and the acceleration of population growth in Europe pushed an increasing number of peasants out of their traditional occupations, making them candidates for emigration. Between 1846 and World War II, over 60 million Europeans emigrated, 50 percent of them from the British Isles and Italy; 60 percent of this flow went to North America, and another 25 percent to Latin America. (Many emigrants eventually returned to their home countries.) Another steady outflow—exceeding five million in total—was from European Russia to Siberia and Central Asia in the second half of the nineteenth century and the first half of the twentieth century.

In the first 15 years of the twentieth century the annual rate of European emigration exceeded three per thousand, one-third of the rate of natural increase. In spite of this drain, Europe accounted for about one-fourth of the world population by the onset of World War I, as compared to less than one-fifth in 1750. In part because of this drain, the Americas's share of the world population increased from 2.3 percent in 1750 to 11 percent in 1914.

Asia

The population of Asia is so large that growth of the largest countries has been mainly endogenous, migration playing only a minor role, at least in modern times. In China, with the Ming dynasty replacing the Mongol dynasty in the fourteenth century, the depopulated north was the destination of substantial migration from the Yangtze area. In the nineteenth century and at the beginning of the twentieth century, Chinese migrants went to other southeast-Asian countries—Malaysia, Indonesia, Indochina, Thailand—as well as to the Americas. Indian labor, after the end of the slave system, emigrated to places such as Natal in South Africa, Mauritius, and Trinidad. But the quantitative impact of these flows on the populations of origin was very small, and the decreased weight of Asia on world population, from around 66 percent in 1800 to 55 percent in 1900, is due to natural increase in Asia that was lower than was then prevailing in the rest of the world. Over the same period, the combined weight of Europe and of the Americas on world population increased from 23 to 36 percent, while that of Africa declined from 11 to 8 percent. During this period the West, in full demographic transition, reached the zenith of its weight in world population.

The Twentieth Century

In the twentieth century waves of migration were important locally but, with the steep drop in European emigration in the third decade of the century, changes in the distribution of population among the continents and regions of the world were mainly due to differences in natural increase. This rate declined in the West, with the nearing completion of its demographic transition, and soared in the other continents with the mid-century onset of their respective transitions. For the world as a whole, the number of migrants in relation to the total population has become relatively small: in the second half of the twentieth century the foreign born made up little more than 2 percent of the total population. By 2000, the weight of Europe had declined to 13 percent, about half the level it reached in 1900.

See also: *Prehistoric Populations; Trans-Atlantic Migration; World Population Growth.*

BIBLIOGRAPHY

Biraben, Jean-Noël. 1979. "Essai sur l'évolution du nombre des hommes." *Population* 34(1): 13–25.

Cavalli-Sforza, Luca Luigi, Paolo Menozzi, and Alberto Piazza. 1994. *The History and Geography of Human Genes.* Princeton: Princeton University Press.

Cook, Sherburne, and Woodrow Borah. 1971. *Essay in Population History: Mexico and the Caribbean.* Berkeley: University of California Press.

Curtin, Philip D. 1969. *The Atlantic Slave Trade. A Census.* Madison: University of Wisconsin Press.

Denevan, William M. 1992. *The Native Population of the Americas in 1492.* Madison: The Wisconsin University Press.

Dobyns, Henry F. 1966. "Estimating Aboriginal American Population: An Appraisal of Techniques with a New Hemispheric Estimate." *Current Anthropology* 7(4): 395–416.

Durand, John D. 1977. "Historical Estimates of World Population." *Population and Development Review* 3(3): 253–296.

Livi-Bacci, Massimo. 2000. *The Population of Europe: A History.* Oxford: Blackwell.

———. 2001. *A Concise History of World Population.* Oxford: Blackwell.

Maddison, Angus. 2001. *The World Economy: A Millennial Perspective.* Paris: OECD.

McEvedy, Colin, and Richard Jones. 1978. *Atlas of World Population History.* Harmondsworth, NY: Penguin.

Reinhardt, Marcel, André Armengaud, and Jacques Dupâquier. 1968. *Histoire de la population du monde.* Paris: Montchrestien.

Rosenblat, Angel. 1954. *La población indigena y el mestizaje en Amèrica.* Buenos Ayres: Editorial Nova.

Massimo Livi-Bacci

PETTY, WILLIAM

(1623–1687)

Sir William Petty was born in London in very modest circumstances, the son of a clothmaker. After some years in the navy of King Charles I, he studied medicine in the Netherlands; in Paris, where he became a friend of the philosopher Thomas Hobbes; and at Oxford. In 1650, at the age of twenty-seven, he became professor of anatomy at Oxford, resigning the next year when he was appointed physician-general to Cromwell's army in Ireland.

Much of the rest of Petty's life was spent in Ireland in various capacities. He organized a major topographical survey that was needed for the redistribution of the forfeited property of Catholic landowners; after the restoration of Charles II he was a member of parliament for Ireland and was engaged in managing an industrial colony on the estate he had acquired in County Kerry. In his London life he was one of the group of philosophers and scientists, including Robert Boyle and John Graunt (1620–1674), who founded the Royal Society. He was knighted in 1661.

Petty's major intellectual contributions to both economics and demography fall under the broad rubric of political arithmetic, a term he invented. This was the application of Francis Bacon's (1561–1626) methods of natural philosophy to understanding social conditions and economic life—on the assumption that the *body politik* could be studied quantitatively in the same manner as the *body natural*. In his account of Petty in *Brief Lives* (c. 1690), John Aubrey concisely, if somewhat dismissively, characterized the approach as "reducing polity to numbers." Petty's work laid the foundations for the development of systematic social and economic statistics by subsequent scholars such as Charles Davenant (1656–1714) and Gregory King (1648–1712). On the basis of his pamphlet *Verbum Sapienti* (1690, a posthumous publication, like most of Petty's writings) Richard Stone (1997) calls Petty "the originator of national accounting." This general perspective and its influence on the thinking of his contemporaries and successors is the main reason Petty has a place in the history of demography: Population dynamics were to him an integral part of social accounting.

Petty also made specific demographic contributions, in particular in estimating mortality and population size, chiefly of major cities. He played a role, most likely minor, in the preparation of Graunt's pathbreaking *Observations* on the (London) bills of mortality (1662). Petty has sometimes been credited with virtual authorship of this work, but a detailed investigation by his later editor Charles Henry Hull found little evidence to support that contention. Stone agrees that such an attribution is baseless. Petty admired Graunt's work and drew on it in his own studies, especially of the Dublin bills of mortality.

His estimates of city sizes—based on calculations such as the number of burials divided by the supposed death rate or the number of houses multiplied by the average household size (guessed)—he recognized as highly conjectural, needing to be replaced by independent enumerations. (His population of London was much too large, that of Paris too small.) At the end of his *Observations on the Dublin Bills* (1683), he wrote: "Without the knowledge of the true number of the people, as a principle, the whole scope and use of keeping bills of birth and burials is impaired; wherefore by laborious conjectures and calculations to deduce the number of people from the births and burials, may be ingenious, but very preposterous." Petty's land survey of Ireland, the results of which were published in his *Political Anatomy of Ireland* (1691), was effectively Ireland's first census (1659).

See also: *Demography, History of; Graunt, John; King, Gregory; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY WILLIAM PETTY.

Petty, William. 1686. *An Essay Concerning the Multiplication of Mankind: Together with Another Essay in Political Arithmetick, Concerning the Growth of the City of London: with the Measures, Periods, Causes, and Consequences thereof, 1862.* 2nd edition. London: Mark Pardoe. Excerpted in *Population and Development Review* 10(1984): 127–133.

———. 1690. *Political Arithmetick, or, A discourse concerning the extent and value of lands, people, buildings, husbandry, manufacture, commerce, . . . , as the same relates to every country in general. . .* London: Robert Clavel and Hen. Mortlock.

———. 1691. *The Political Anatomy of Ireland. . . To which is added Verbum sapienti, or, An account of the wealth and expences of England, and the method of raising taxes in the most equal manner. . .* London: D. Brown and W. Rogers. Facsimile edition: Shannon, Ireland: Irish University Press, 1970.

———. [1899] 1964. *The Economic Writings of Sir William Petty,* ed. Charles H. Hull. 2 vols. New York: A. M. Kelly.

SELECTED WORKS ABOUT WILLIAM PETTY.

Aubrey, John. 1898. *Brief Lives . . . Set Down between the Years 1669 & 1696.* Oxford: Clarendon Press.

Hull, Charles H. 1900. "Petty's Place in the History of Economic Theory." *Quarterly Journal of Economics* 14(4): 307–340.

Stone, Richard. 1997. *Some British Empiricists in the Social Sciences 1650–1900.* Cambridge, Eng.: Cambridge University Press.

Geoffrey McNicoll

POPULATION

In modern usage the word population, means "the total number of persons inhabiting a country, town, or other area," or "the body of inhabitants" (*Oxford English Dictionary [OED]*). The two meanings seem much the same and are often conflated, but conceptually they are distinct—the first, the number of persons, is the demographer's stock in trade; the second, the body of inhabitants, is the stuff of social science generally. The word derives from the Latin *populare,* "to populate, to people," and the late Latin noun *populatio.* Curiously, in classical times the verb more commonly meant to lay waste, plunder, or ravage, and *populatio* was a plundering or despoliation. Both meanings entered English. The usage of population as devastation, however, had become obsolete by the eighteenth century.

The word's first recorded use in a modern sense, according to demographer Adolphe Landry, is in an essay by the philosopher Francis Bacon from 1597. Another Bacon essay, cited by the *OED* in a 1625 edition, already gives the term a distinctive Malthusian flavor: "It is to be foreseene, that the Population of a Kingdome, (especially if it not be mowen downe by warrs) doe not exceed, the Stock of the Kingdome, which should maintain them." But at this time, and for most of another two centuries, population retained its gerund-like connotation of process—the process of populating or peopling. That usage appears in the 1776 Declaration of Independence of the United States, where one of the particulars among the "abuses and usurpations" charged against George III was: "He has endeavoured to prevent the Population of these States; for that Purpose obstructing the Laws for Naturalization of Foreigners; refusing to pass others to encourage their Migrations hither, and raising the Conditions of new Appropriations of Lands."

Adolphe Landry, in his *Traité de démographie* (1945) traces the parallel shifts in usage in French. He notes the early use of *dépopulation,* in the sense of devastation, and in the eighteenth century the gradual loss of the connotation of population-as-peopling. The new meaning was affirmed when the statesman Comte de Mirabeau could title his 1757 work *L'ami des hommes, ou traité de la population.* A fuller account is contained in Hervé Le Bras's *L'Invention des populations* (2000).

The main demographic interest in population is as a simple magnitude: population size. Well before Bacon there was of course a need to talk about numbers of inhabitants in a particular territory. In English, for example, the word "souls" in the sense of enumerated individuals was used from the fourteenth century or even earlier. But for most purposes the egalitarianism implied by weighting individuals equally would have been seen as distorting reality. Nobles and commoners, or citizens and noncitizens, could not be simply added together. Women and children might count for little; slaves for nothing. Plato's optimal size of a city-state, 5040, referred to the number of citizens—a category that excluded women, children, and slaves. The actual population corresponding to this figure would have been ten or twelve times the size. The *populus* of republican Rome, in the phrase *Senatus populusque Romanus* (SPQR) displayed by its legions and on present-day Rome's manhole covers, were the freeborn citizens—far fewer than the population.

In later times it was the disadvantaged in the society, potentially a charge on the exchequer, that might need to be enumerated. Here, the word "populace" could be employed—in its meaning, dating from the sixteenth century, of riffraff or rabble, to be distinguished from the gentry. In early modern England, a significant motivation for measures to record population numbers was to identify those receiving assistance under the Poor Law.

In England, the subsequent emergence of the word population, qua population size, can be traced in the documents assembled by the demographer David Glass on the history of census-taking. A 1753 bill (not enacted) called "for Taking and Registering an annual Account of the total Number of People, . . ." The term population did not appear, the text constantly referring to the total number of persons or inhabitants. Within two decades the word was in use. English agriculturalist Arthur Young's pamphlet of 1771 advocating a census was entitled *Proposals to the Legislature for Numbering the People. Containing Some Observations on the Population of Great Britain, and a Sketch of the Advantages that would probably accrue from an exact Knowledge of its present State.* Population was used repeatedly in the text, unitalicized and with minimal echoes of its origins as process. The 1800 law establishing the British census was called simply *An Act for taking Account of the Population of Great Britain, . . .*

The application to nonhuman collectivities dates at least from T. R. Malthus's *Second Essay* (1803), where Malthus wrote: "The population of the tribe is measured by the population of its herds." Straightforward extensions of usage cover sets of inanimate objects, especially where age or vintage is a member characteristic. Often demographic analysis finds immediate application to such collectivities—for instance, deriving life tables for stocks of forest trees or automobiles, or investigating birth and death processes for organizations. In the field of genetics, a population is a collection of organisms as opposed to a collection of genes, giving rise to the contrast between *genetic* processes and *population* (or sometimes, *demographic*) processes (see, for example, Young and Clarke 2000). *Metapopulation,* a term used in ecological studies, is a system of local populations connected by dispersing individuals (see Gilpin and Hanski 1991).

In both ordinary English usage and in demographic analysis, population refers to a well-defined set, with clear-cut membership criteria. Thus, to take a common example, the population of the United States as identified in the 2000 census—281,421,906—refers to the residents (legal and illegal) of the 50 states and assorted territories plus U.S. military and civil officials stationed abroad, as of April 1, 2000. Conceptually, the membership criteria are clear, even if the resulting number inevitably has a margin of error—by Census Bureau estimates, for example, the 1990 U.S. census missed about 8.4 million persons and double-counted 4.4 million. In some other cases, the concept of population to be applied is itself fuzzy. Consider, for example, the population of a city. The boundaries of an urban agglomeration defined by some specified array of functional characteristics may bear scant relationship to a city's administrative borders, the former being more than a little arbitrary and the latter reflecting historical contingency. Even if there are agreed physical boundaries, the number of legal residents may differ greatly from the number of *de facto* residents, and there is an evident fringe or penumbra of membership beyond both, comprising persons with lesser degrees of attachment. The actual number of people within a city's defined borders varies greatly by time of day, day of the week, and season.

See also: *Census; Demography, History of; Organizations, Demography of.*

BIBLIOGRAPHY

Gilpin, Michael E., and Ilkka A. Hanski, eds. 1991. *Metapopulation Dynamics: Empirical and Theoretical Investigations.* London: Academic Press.

Glass, David V., ed. 1973. *The Development of Population Statistics.* Farnborough, England: Gregg International Publishers.

Landry, Adolphe. 1945. *Traité de Démographie.* Paris: Payot.

Le Bras, Hervé. 2000. "Peuples et populations." In his *L'Invention des populations: Biologie, idéologie et politique.* Paris: Odile Jacob.

Young, Andrew G., and Geoffrey M. Clarke, eds. 2000. *Genetics, Demography and Viability of*

Fragmented Populations. New York: Cambridge University Press.

GEOFFREY MCNICOLL

POPULATION BIOLOGY

See *Animal Ecology; Biodemography; Biology, Population; Evolutionary Demography*

POPULATION DECLINE

Population decline was a frequent experience until the nineteenth and twentieth centuries, when population growth became the norm. By the beginning of the twenty-first century, that era of growth was ending. In Europe, population decline is expected to become general by the mid-twenty-first century, and by the end of the century, global population itself may be falling.

Dynamics of Population Decline

Fewer births, more deaths, and net emigration can each provoke population decline: the basic "balancing equation" can be expressed as:

Population Change =

Births − Deaths ± Net Migration

With modern mortality, where most children survive, each woman needs to produce on average just over two children to replace the population over a generation (25 to 30 years). Average family size is measured by the *Total Fertility Rate* (TFR), the number of children which the average woman would have over her fertile lifetime (conventionally, ages 15 to 49), given current fertility rates at each age. A TFR of 2.11 implies that women would have, on average, 2.11 children at current rates—1.03 girls and 1.08 boys (assuming the sex ratio at birth to be 1.05). If the female survival rate to the end of the childbearing period is 0.97, women would have, on average, exactly 1.0 surviving daughter to replace them: the *Net Reproduction Rate* (NRR) is 1.0. Other things being equal, below-replacement fertility—an NRR below 1.0 or, roughly, a TFR below 2.1—implies population decline in the long run.

In the industrial world since the 1970s, and increasingly in the developing world, the TFR has fallen below 2.1 and the NRR below 1.0. Yet most of these populations continue to grow, partly because of immigration (e.g., Germany and Italy). However, most Western countries still have a positive natural increase (excess of births over deaths). Births can exceed deaths for a time, even when the TFR is less than 2.1, if the number of women in their reproductive years is exceptionally high as a legacy of past population growth or bulges such as the "baby boom" cohorts of the 1960s. Only when this structural anomaly ceases will deaths finally exceed births. This delay is known as *population momentum.* It can sustain growth only for a few decades; the population momentum was ending in most Western populations by the beginning of the twenty-first century (Table 1).

Momentum operates in both directions. A declining population with a structure aged through years of below-replacement fertility would continue to decline in numbers for some years, even if fertility increased to replacement rate (this is the case, for example, in Germany).

Population Decline in the Past

For millennia, until the eighteenth century, average long-term rates of human population growth must have been close to zero. Periods of mild population decline would have been almost as normal as periods of population growth, and except for crisis years, no more perceptible. "Normal" processes served to regulate populations through alternating periods of mild growth and decline, as in early modern Western Europe. There fertility could respond to hard times through delayed marriage, as first described by the English political economist T. R. Malthus (1766–1834).

Deleterious changes (e.g., human mismanagement of resources) can reduce carrying capacity through deforestation or the exhaustion or salination of soils, as in ancient Sumer, the Mayan regions of Central America, and Easter Island. Exogenous climate change helped to eliminate the medieval Vinland and Greenland colonies and almost did the same to Iceland. Other crises were provoked by institutional collapse, new diseases, or warfare, which reduced population irrespective of carrying capacity. Epidemics and famines provoked frequent, sharp but often transient turndowns in population in Eu-

TABLE 1

Population Size, Rates of Change, Total Fertility Rate, and Net Reproduction Rate: Europe and the United States, 2000

Country	Population 2001 (millions)	Annual Rate of Population Growth/ Decline (%)	Annual Rate of Natural Increase (%)	Annual Rate of Net Migration (%)	Total Fertility Rate (TFR)	Net Reproduction Rate (NRR)
Ukraine	49.0	**-0.85**	**-0.76**	**-0.09**	...	...
Latvia	2.4	**-0.58**	**-0.50**	**-0.08**	1.24	0.59
Russian Federation	144.8	**-0.52**	**-0.66**	0.14	1.21	0.57
Bulgaria	8.1	**-0.51**	**-0.51**	0.00	1.26	0.60
Hungary	10.0	**-0.38**	**-0.38**	0.00	1.32	0.63
Estonia	1.4	**-0.37**	**-0.39**	0.02	1.39	0.67
Belarus	10.0	**-0.29**	**-0.41**	0.12	1.31	0.63
Lithuania	3.7	**-0.16**	**-0.13**	**-0.03**	1.27	0.61
Czech Republic	10.3	**-0.11**	**-0.18**	0.06	1.14	0.55
Romania	22.4	**-0.11**	**-0.09**	**-0.02**	1.31	0.62
Poland	38.6	**-0.02**	0.03	**-0.05**	1.34	0.64
Germany	82.2	0.04	**-0.09**	0.13	1.36	*0.66*
Slovakia	5.4	0.07	0.04	0.03	1.29	0.62
Spain	40.1	0.12	0.02	0.10	1.24	0.58
Finland	5.2	0.19	0.14	0.05	1.73	0.83
Greece	10.6	0.21	**-0.02**	0.23	1.29	*0.62*
Japan	126.9	0.21	0.18	0.03	1.36	0.65
Austria	8.1	0.23	0.02	0.21	1.34	0.65
Belgium	10.3	0.24	0.11	0.12	1.66	...
Sweden	8.9	0.24	**-0.03**	0.28	1.54	0.75
Italy	57.8	0.28	**-0.04**	0.31	1.23	*0.57*
Denmark	5.3	0.36	0.17	0.19	1.77	0.85
United Kingdom	59.9	0.40	0.12	0.28	1.65	0.79
France	59.0	0.50	0.41	0.09	1.89	*0.86*
Switzerland	7.2	0.55	0.22	0.33	1.50	0.72
Norway	4.5	0.56	0.34	0.22	1.85	0.89
Portugal	10.2	0.63	0.14	0.49	1.50	0.73
Netherlands	16.0	0.77	0.42	0.36	1.72	0.83
United States	275.3	0.89	0.60	0.29	2.13	1.03
Ireland	3.8	*1.07*	*0.58*	*0.49*	1.89	0.91
Iceland	0.3	1.53	0.87	0.67	2.08	1.01

Note: Countries are listed in ascending order by rate of population growth. Negative rates are in bold. 1999 data in italics. Population sizes are as of January 1, for Europe, mid-year for U.S.

SOURCE: Council of Europe (2001), national demographic yearbooks. Ireland, Spain: growth, natural increase and net migration data from Eurostat.

rope, China, India, Japan, and elsewhere. Disease usually kills most of the victims of famine. The destruction by blight of the Irish potato staple in 1846 left 1 million dead. Two million Irish emigrated, inaugurating a new regime of emigration in which Ireland was the only major European area to lose population in the nineteenth century, its size falling from 8 million to 4 million. However, massive famines of the twentieth century, causing population decline if only for brief periods, were mostly the result of human actions: China's Great Leap Forward of 1958–1961 led to some 30 million excess deaths; the Ukraine collectivization famine of 1932 caused 7 million deaths. The globalization of disease can radically reduce population size. Europe's population fell to two-thirds of its previous level after the Black Death of 1348. The Aztec population was at least halved in the sixteenth century, partly through new diseases.

In simple societies, depopulation can result from genocidal conflict. Attrition by nomads on the settled populations in Eurasia suppressed the latter's populations for a thousand years. Europe lost about a quarter of its population in the centuries following the end of the Western Roman Empire, and China may have lost a quarter of its population in its unsuccessful resistance to Mongol invasion in the thirteenth century. The 30 Years War (1618–1648) inflicted similar proportionate losses on much of Northwestern Europe. In the twentieth century, the near-total destruction of Europe's Jews was the worst of a number of genocidal episodes. Enslavement often followed conquest in earlier epochs, but in some cases enslavement was the aim. The effect of slavery on the populations of tropical Africa cannot be known exactly, but in some areas it may have reduced population to a marked degree.

Contemporary Population Decline

As a broad generalization, in the 1930s the developed world reached a two-child family norm. In 2000, the average TFR in the developed world was 1.6. The United States is the only developed country with fertility approximately at replacement level. By the turn of the twenty-first century, the developed world also faced population decline. Countries with *natural decline* (deaths exceeding births) as of 2001 included Italy (−0.08% per year), Germany (−0.09%), most countries in Eastern and Central Europe, and all of the European states of the former Soviet Union. Natural decline is fastest in the Russian Federation (−0.63%), Ukraine (−0.60%), and Bulgaria and Hungary (−0.48%). However, births in France, the Netherlands, and Norway still exceed deaths (their natural increase is over 0.3% per year; in the United States it is 0.3%). Positive natural increase also continues in the United Kingdom, Denmark, and Finland. East of the river Elbe, population decline is exacerbated by persistent high mortality. Population decline in Italy and Germany is only averted by immigration from Eastern European and non-European countries.

Future trends depend primarily on birth rates and migration. According to the United Nations' medium projections made in 2000, France's population is expected to grow to 62 million by 2050 from 59 million in 2000. Germany, however, is projected to decline from 82 to 71 million, Italy from 58 to 43 million, Japan from 127 to 109 million, and Russia from 146 to 104 million. However, it is difficult to accurately predict population change so many years in the future. The low fertility rates in Russia and Eastern Europe in 2000 were deflated by widespread postponement of childbearing, and may recover substantially. By contrast, in the developing world where fertility in many regions is still relatively high, birth rates may not cease to decline once they reach replacement level, as many projections have assumed. But the possibility or even likelihood of global population decline beginning within a century has become accepted by demographers. Figure 1 shows total population estimates and projections from 1950 to 2050.

Political Economy of Population Decline

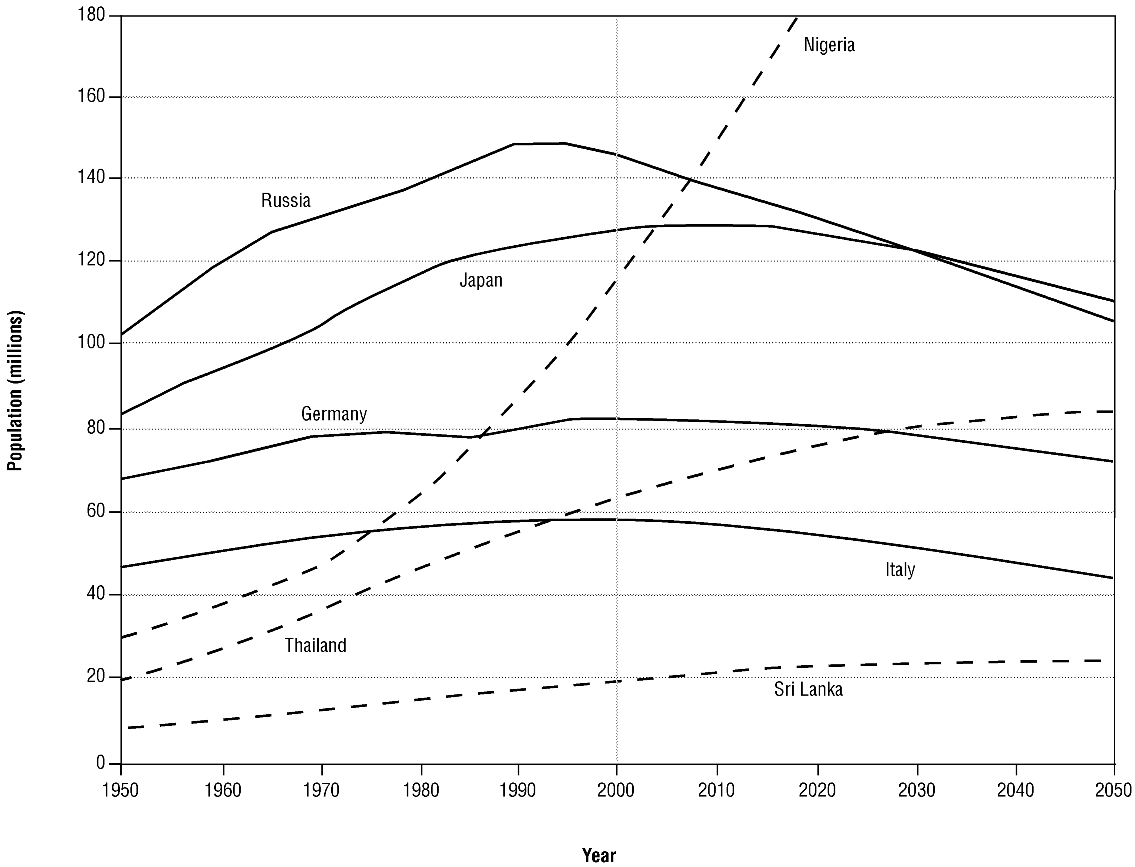
Fear of population decline, and policy designed to avert it, are almost as old as states themselves. In the distant past, population was, with land, the chief factor of production. Population increase was encouraged, often by means of conquest and enslavement; its diminution to be avoided at all costs. Mercantilist emphasis on population size, even at the cost of individual standards of living, was reinforced by concerns about the size of armies and the security of territory. Some classical economists assumed that Malthusian population checks and diminishing returns imply an early end to economic and population growth, leading to a stationary population. Others, however, including Adam Smith, saw substantial further growth through productivity driven by technology. He saw population growth as desirable: It would expand markets and encourage division of labor. Larger populations permitted economies of scale and increasing rather than diminishing returns, even though resource constraints imposed ultimate limits to growth.

Economic analysis of the consequences of declining population (e.g., the work of William B. Reddaway) began when birth rates first fell to replacement rate in the 1930s. In 2002, conventional economic opinion was almost unanimous in believing that population decline would remove the guarantee of future customers that underwrites future investment, diminish the size of markets, and reduce productive capacity as the workforce falls and as the stimulus for innovation declines. The economist Ester Boserup feared, at the extreme, that some economies would decline to a more extensive, less specialized level. For Julian Simon, population was the "ultimate resource": Fewer people means fewer geniuses.

In Western democracies, France has shown the most consistent policy response to the fear of population decline, nurtured by the stagnation of its population in the nineteenth century. France, which began the nineteenth century as Europe's demographic, military, and economic superpower, ended it just on a par with the United Kingdom and Germany. Near-defeat in the First World War reinforced fears about declining power and population. The official Institut national d'études démo-

FIGURE 1

Estimates and Projections of Total Population, Selected Countries, 1950–2050



SOURCE: United Nations (2001). Estimates and medium-variant projections. The 2050 figure for Nigeria is 279 million.

graphiques (INED) was set up to analyze population trends and develop effective pro-population policies. Its first director, the demographer Alfred Sauvy (1898–1990), was an indefatigable analyst of the economic and social evils of depopulation and population aging.

With low vital rates, population decline goes hand-in-hand with population aging. The latter, however, provokes different concerns: of excess consumption by an increasing proportion of elderly dependents, rather than the under-consumption arising from population decline feared by English economist John Maynard Keynes.

Other considerations can prevail in crowded Europe. The United Kingdom's Royal Commission on Population (1949) and its Population Panel (1973) felt that the end of population growth would moderate problems of food imports and balance of payments. It concluded that "our analysis . . . leads to the conclusion that Britain would do better in future with a stationary rather than an increasing population" (Population Panel, p. 6). The Netherlands has long considered itself overpopulated; up to the 1950s it sought, like the United Kingdom, to encourage emigration to ease domestic population pressure. That remains part of the rationale for contemporary policies seeking to discourage immigration. Even in the United States, the 1972 concluding report of the Commission on Population Growth and the American Future saw an end to U.S. population growth—although not a decline—as, on balance, advantageous. Population growth is commonly regarded as a major cause of environmental degradation, the reduction of biodiversity, and the destruction of countryside; on environmental grounds, the prospect of population decline is usually welcomed. An "optimum" population size has been proposed for countries such as the United Kingdom of a third or less of the existing total (20 million). Australian environmentalists, arguing from considerations of sustainable "environmental footprint" (the area of land needed to sustain the current consumption or lifestyle of an individual, community, or country), desire a population for Australia of 10 million, half its 2002 size.

While population decline brings problems, it may be argued that a smaller but stable population has advantages. Problems of overcrowding are ameliorated and the environment is potentially better protected. Unsatisfactory infrastructure, hastily constructed to cope with growth, can be demolished. Labor shortage may reduce unemployment and moderate inequality, and should promote capital substitution as wages rise. Depopulation after the Black Death in Europe helped to end feudalism and ushered in the "golden age of the peasant." With international trade and alliances, markets and security transcend frontiers; in Western Europe there is no relationship between the standard of living and population size or rate of population change. Some European countries have lost territory and (in most cases) inhabitants over the last century (United Kingdom, Germany, Austria), without harming their standard of living. The universal loss of colonies has been a beneficial relief to the former colonizers.

Policies Affecting Fertility and Population

Continental European countries took fright at the below-replacement fertility of the 1930s and instituted wage supplements, loans, and cash benefits to promote family life and the birth rate. In the post-World War II West (except in France), explicit pronatalist measures were discredited by their enthusiastic adoption by pre-war Fascist regimes and were rendered moot, at least temporarily, by the baby boom. Post-war communist regimes in Eastern Europe, faced with rapid falls of fertility, espoused similar policies, which helped to preserve a birth rate around the replacement rate until the collapse of communism. Pronatalist polices to avert impending population decline and moderate population aging in Japan, in Singapore, and elsewhere since the 1970s have so far lacked conspicuous success.

Twenty-first century Western European policies for child and family welfare are little different from pronatalist policy, except that the demographic rhetoric is lacking and with few exceptions (e.g., France) there are no special benefits for higher-order children. Measures include cash transfers and tax relief for parents, priority to families with children for subsidized housing, paid parental leave, and subsidized child care. The effects these policies have on birth rates are not easily demonstrated, but in Northwestern European countries, where they are best developed, both female workforce participation and birth rates are relatively high, at least in comparison to countries where such policies are absent, as in the more "familist" Southern Europe and East Asia. Central, Southern, and Eastern European and East Asian countries face the prospect of the sharpest population declines.

In the latter part of the twentieth century, European countries had tended to adopt restrictive immigration policies. But by the end of the century, European political and media opinion tended to see immigration as salvation from population decline and population aging. The notion that immigration can solve population aging can quickly be dismissed: preservation of current support ratios—that is, the ratio between persons of labor force age and persons of retirement age—would require very high levels of immigration, generating wholly infeasible rates of population growth. In the case of the Republic of Korea, according to a United Nations calculation, that country would require 6.2 billion immigrants (equaling the world's population as of 2002) by 2050. Future population decline could be averted by more modest, but substantial and fluctuating, levels of immigration: an average of 324,000 persons per year to Germany and 312,000 to Japan, a total inflow of some 16 or 17 million each by 2050. In the end, however, immigration cannot substitute for reduced birth rates. Any population trying to maintain its numbers by importing people to compensate for below-replacement fertility would eventually be replaced by the new immigrants.

See also: *Family Policy; Fertility, Below-Replacement; Keynes, John Maynard; Momentum of Population Growth; Population Policy; Projections and Forecasts, Populations.*

BIBLIOGRAPHY

Chesnais, Jean-Claude. 1996. *La crepuscule de l'occident.* Paris: Robert Laffont.

Courtoise, Stephane, et al. 2000. *The Black Book of Communism: Crimes, Terror, Repression,* trans. J. Murphy and M. Kramer. Cambridge, MA: Harvard University Press.

DaVanzo, Julie, and Gwendolyn Farnsworth, eds. *Russia's Demographic "Crisis."* Santa Monica, CA: Rand.

Demeny, Paul. 1997. "Replacement-level Fertility: The Implausible Endpoint of the Demographic Transition." In *The Continuing Demographic Transition,* ed. Gavin Jones et al. Oxford, Eng.: Clarendon Press.

Glass, David Victor. [1940] 1967. *Population Policies and Movements in Europe*. London: Oxford University Press.

Keynes, John Maynard. 1937. "Some Economic Consequences of a Declining Population." *The Eugenics Review* 29: 13–17.

Lutz, Wolfgang, Warren Sanderson, and Sergei Scherbov. 2001. "The End of World Population Growth." *Nature* 412: 543–545.

McEvedy, Colin, and Richard Jones. 1978. *Atlas of World Population History.* Harmondsworth, NY: Penguin.

Reddaway, William. 1939. *The Economics of a Declining Population.* London: Allen and Unwin.

Sauvy, Alfred. 1969. *General Theory of Population,* trans. Christophe Campos. New York: Basic Books.

Teitelbaum, Michael, and Jay Winter. 1985. *Fear of Population Decline.* London: Academic Press.

Thornton, Russell. 1997. "Aboriginal North American Population and Rates of Decline ca. A.D. 1500–1900." *Current Anthropology* 38(2): 310–315.

United Nations. 2000. *Expert Group Meeting on Policy Responses to Population Ageing and Population Decline.* New York: United Nations.

———. 2001. *World Population Prospects: The 2000 Revision.* Vol. 1. New York: United Nations.

David Coleman

POPULATION DYNAMICS

Population dynamics refer to the way in which the size and age structure of populations change over time and the characterization of that change in mathematical terms. This article is a basic introduction to the topic, largely avoiding the mathematics.

Population Growth/Decline

Population growth (or decline) is the net balance of births, deaths, in-migration and out-migration. If growth is assumed to occur on a discrete basis, usually annually, and if the rate of growth is constant, population size at a future time t, $P(t)$, can be related to population size at time 0, $P(0)$, by the geometric equation $P(t) = P(0)(1 + r)^t$ where r is the rate of growth. In practice, demographic events are spread throughout the year so that growth is usually smooth enough to be described by a continuous variable over time. If the rate of growth is constant, $P(t)$ can be related to $P(0)$ by the simple exponential equation $P(t) = P(0)e^{rt}$.

A convenient measure of population growth is doubling time, or the time that would be needed for population size to double at the current rate of growth. The doubling time is calculated by solving the above equation for t in the case where $P(t) = 2P(0)$. Hence the doubling time is the natural logarithm of 2 (about 0.693) divided by the rate of growth (equivalent to dividing 69.3 by the percentage rate of growth). For example, if the annual rate of growth is 2 percent, the doubling time is 69.3 ÷ 2 or just under 35 years. The higher the rate of growth, the shorter the doubling time.

Balance Equation

Changes in population size are a function of the three constituent components of population change: birth, death, and migration. Change is expressed in discrete terms by the *balance equation:*

$$P(t+1) - P(t) = B(t, t+1) - D(t, t+1)$$
$$+ I(t, t+1) - O(t, t+1)$$

where $B(t, t+1)$ is the number of births occurring during the interval t to $t+1$ (usually a year), and D, I, and O are corresponding numbers of deaths, in-migrants, and out-migrants. When age is taken into account, this equation expresses the changes occurring to cohorts (persons of the same age in years at time t) alive at time t. For example, the number of children in the cohort aged 2 at time t+1 will be equal to the number aged 1 at t, minus deaths occurring to the cohort during the interval from t to t+1, plus net migrants of the same age cohort arriving or departing during this interval (note that B is zero). These demographic accounting equations are used in assessing data quality, in estimating net migration, and, in populations closed to migration, as the basis for demographic estimation using indirect methods.

Age Structure

The age structure of a population is determined by the relative size of past successive cohorts at birth and subsequent changes in size because of death and migration. The numbers of births, deaths, and migrants in the present year (or other time interval) are determined by prevailing fertility, mortality, and migration rates and the existing age structure of the population, which in turn is a result of previous demographic rates and structures. Thus the present age structure is a function of current and past demographic rates—that is, of the population's demographic history. Past changes in demographic rates lead to changes in age structure over time.

Usually, the most significant factor in determining population structure is fertility and, in particular, changes in fertility over time. High-fertility populations are characterized by a population pyramid with a wide base relative to older ages, whereas low-fertility populations have a much narrower base. A rapid change in fertility, whether an increase or a decrease, can lead to dramatic changes in both population structure and growth. An example of such a change is the post–World War II increase and subsequent decrease in fertility in many Western countries, resulting in the period of large birth cohorts known as the "baby boom." A large birth cohort appears as a bulge that "ripples" through the population age structure toward older ages over time. As this cohort passes through the childbearing ages, it produces a secondary large birth cohort (large relative to adjacent cohorts and for given fertility rates), which will itself produce a further large cohort a generation later. The effect—sometimes described as an echo—is progressively dampened as a consequence of the wide age range of childbearing and gradually disappears. Thus, through the initial effect on population structure, an increase in fertility, even if temporary, affects population size and structure for many years into the future.

More permanent changes in fertility and changes in mortality and migration have similar effects. Age- and sex-specific effects caused by war, major epidemics, and large-scale migration can have a marked effect on population structure, with consequent effects on future births and hence on population growth and structure.

Population Momentum and Aging

The effect of age structure on population growth is referred to as *population momentum.* Even if fertility were to change immediately to the level that would just ensure the replacement of each generation (that is, a net reproduction rate of 1), the population would continue to grow (or decline) for as long as structural effects remain in force. Thus, for populations that experienced fertility declines from high levels to near replacement levels in the latter decades of the twentieth century, the age structures are such that substantial further growth will occur for many decades into the twenty-first century. (Momentum effects can also perpetuate population decline, despite a fertility increase, after a long period of below-replacement fertility. This has not yet been observed.)

A consequence of changing age structure is uneven growth across age groups. This is easily seen in the ripple effect of the baby boom. In many populations, past declines in fertility accompanied by increases in longevity have resulted in the aging of the population. An aging population experiences increases in the size of the older population (for example, persons aged 65 and over) relative to the total. In contrast, population rejuvenation occurs when the younger population (for example, persons aged 0 to 14) increases in relative size, normally because of falling infant and child mortality or increased fertility. Growth in the size of different age groups can be compared across ages and populations. For example, during the period from 1950 to 2000, the population of India aged 0 to 14 years increased by a factor of 2.5 compared with a factor of 3.8 for the population aged 65 and over, while the total population increased by a factor of 2.8. This compares with the more rapidly aging population of Singapore, which has corresponding factors of 2.1 at age 0 to 14, 12.0 at age 65 and over, and 3.9 for the total population. By 2050, the populations aged 65 and over in India and Singapore are expected to have increased (since 1950) by factors of 18 and 55 respectively, compared with factors of only 4 or 5 for the total populations, illustrating both the magnitude of growth at this age and the wide variation between populations. The disparity is caused by the different speeds at which fertility declined and mortality improved in the two populations: rapidly in Singapore and only moderately in India.

See also: *Aging of Population; Age Structure and Dependency; Baby Boom; Estimation Methods, Demographic; Fertility Measurement; Momentum of Population Growth; Mortality Measurement; Renewal Theory and the Stable Population Model.*

BIBLIOGRAPHY

Chesnais, Jean-Claude. 1990. "Demographic Transition Patterns and their Impact on the Age Structure." *Population and Development Review* 16: 327–336.

Preston, Samuel H., Patrick Heuveline, and Michel Guillot. 2001. *Demography: Measuring and Modeling Population Processes.* Oxford: Blackwell.

Shryock, Henry S., and Jacob S. Siegal. 1973. *The Methods and Materials of Demography.* Washington, D.C.: U.S. Government Printing Office.

Heather Booth

POPULATION GEOGRAPHY

See *Geography, Population; Geopolitics*

POPULATION GROWTH

See *Peopling of the Continents; World Population Growth*

POPULATION ORGANIZATIONS

NATIONAL AND INTERNATIONAL AGENCIES

This article provides an overview of international, national, governmental, and nongovernmental organizations, including foreign assistance agencies, that work in the field of population.

Intergovernmental Organizations

Many intergovernmental organizations that are active in the population field are part of the United Nations (UN) system discussed in a subsequent article. Some regional intergovernmental organizations are active in advocacy and policy promotion, but most are reluctant to infringe in areas that are seen as national prerogatives. Europe is the principal exception.

The Council of Europe is a human rights–based intergovernmental organization. Any European state can become a member if it accepts the principle of the rule of law and guarantees human rights and fundamental freedoms to any person under its jurisdiction. The council's European Population Committee monitors demographic trends in the member states and advises them on demographic policies. The Parliamentary Assembly, which consists of representatives of the national parliaments, considers European and international problems and proposes solutions. One of its specialist committees deals exclusively with migration, refugees, and demography. The resolutions adopted by the assembly provide guidance to the member states and have considerable influence on national policies.

The International Organization for Migration (IOM), the most important intergovernmental organization dealing with migration, also has European origins. It was established in 1951 as the Provisional Intergovernmental Committee for the Movement of Migrants from Europe (PICMME) to deal with emigration from Europe to non-European destinations after World War II. It became the IOM in 1989, when its constitution was modified to broaden its objectives and scope of operation. The IOM has evolved into a forum for governments, a research institute, a technical advisory center, and a program manager. It continues to deal with national migration programs, including labor migration and the transfer and repatriation of refugees and internally displaced persons. It focuses on migratory movements caused by emergencies, including irregular migration and trafficking in humans, and on post-conflict interventions. It also deals with issues of migrants's health, with an emphasis on the needs of women.

International Nongovernmental Organizations

The International Planned Parenthood Federation (IPPF) is the second largest international nongovernmental organization, after the International Federation of Red Cross and Red Crescent Societies (IFRC). The IPPF was created in 1952 by eight national family-planning associations and has members in over 180 countries. The IPPF and its members are committed to promoting the rights of women and men to decide freely the number and spacing of their children. They also promote sexual and reproductive health. They consider that a balance between the world's population size and its natural resources is a necessary condition for improving the quality of life worldwide. To achieve its aims, the IPPF carries out advocacy campaigns to influence policymakers and public opinion, sets standards for contraceptive safety, and offers a wide range of reproductive health services, with special attention to the needs of adolescents and young people.

Although it is not a population organization, since 1995 the IFRC has paid more attention to public health issues, including reproductive health. Some of its members provide reproductive health services, with an emphasis on the prevention of sexually transmitted diseases, including HIV/AIDS. Together with UN and nongovernmental organizations it offers basic health services to refugees and internally displaced persons.

National Governmental Organizations

A wide range of national governmental organizations deal with population issues. Developed countries do not have explicit comprehensive population policies: In those countries population concerns are dealt with by ministries or specialized agencies. Where needed, policy coordination is the responsibility of the ministry of labor, health and social welfare, or the interior. In the United States the Bureau of Population, Refugees, and Migration of the Department of State formulates and coordinates that country's policies on international population issues.

In developing countries, national governments are responsible for the formulation, implementation, and monitoring of population and development policies. Following the recommendations of various international population conferences (Bucharest 1974, Mexico City 1984, Cairo 1994), many developing countries created special organizations to deal with population issues. In some cases these are ministries; in other cases they are national population boards or commissions that function as independent units or are attached to a ministry or planning authority.

Reliable and timely population statistics are needed for the formulation, monitoring, and evaluation of population policies. Population statistics are collected and collated by national statistical offices, national census organizations, and civil registries. Several governmental agencies carry out specialized population surveys. All the developed countries have well-established national systems of population statistics. In the United States the main source of population data is the Bureau of the Census, which is constitutionally mandated to carry out the decennial census. The National Center for Health Statistics (NHCS), which is part of the Centers for Disease Control and Prevention of the Department of Health and Human Services, is the principal federal health and vital statistics agency.

Migrant-receiving countries such as the United States, Canada, Australia, and New Zealand have explicit policies that regulate the inflow of migrants. Those policies are developed and implemented by specialized government agencies. In the United States the Immigration and Naturalization Service and its successor agencies within the Department of Homeland Security are entrusted with the administration of the immigration laws. In Canada a special ministerial-level agency, Citizenship and Immigration Canada, is responsible for the development and implementation of immigration and citizenship policies: It controls movement across the border, promotes the integration of migrants, and conducts research on immigration issues. Most developing countries, even those with a large number of foreign residents and continued immigration, do not have explicit migration policies or specialized migration agencies.

National Nongovernmental Organizations

Since the 1970s there has been a rapid increase in the number and variety of nongovernmental organizations (NGOs) that deal with population. Organizations in developing countries tend to be modest in size and to deal with a single issue and often depend on foreign support. A number of NGOs in developed countries are active both in their own countries and overseas. All the service-providing NGOs also have a strong advocacy component. A selection of these organizations is listed below:

Population Action International, a U.S.-based organization concerned exclusively with enhancement of public awareness in support of worldwide population programs based on human rights.

The Planned Parenthood Federation of America, an organization that provides a wide range of reproductive health services that complement those provided by governments.

Marie Stopes International, a United Kingdom–based reproductive health organization that provides information, training, technical assistance, and services to people in 40 countries and promotes research.

Family Health International, a U.S.-based organization that is active in 40 developing countries and attempts to improve reproductive health services worldwide through innovative health service delivery interventions, training, and information provision as well as through biomedical and social science research.

Japanese Organization for International Cooperation in Family Planning, an organization created to share Japan's experience in family planning and maternal and child health that works in 26 developing countries by means of community-based interventions.

Population Reference Bureau, a U.S.-based organization that provides objective and timely information on U.S. and global population trends and their implications.

Helpage International, a United Kingdom–based global network of not-for-profit organizations that works in 39 countries to improve the quality of life of disadvantaged older people.

African Gerontological Society (AGES International), an organization with members in 16 African countries whose main objective is to sensitize African governments and the public at large to issues of aging.

Foreign Assistance Agencies

Before the 1970s technical assistance in regard to population was provided mainly by U.S.-based foundations such as the Rockefeller Foundation and the Ford Foundation. Since that time nearly all developed country governments have provided technical and financial support for population as part of their foreign assistance activities. Donor countries and organizations provide foreign assistance through a special unit in the ministry of foreign affairs or an independent technical assistance agency. The U.S. Agency for International Development, which was created in 1961, is the principal federal agency responsible for U.S. assistance to foreign countries. It is an independent agency that receives policy guidance from the Secretary of State. The EuropeAid Co-operation Office is responsible for the coordination of the technical assistance activities of the European Union, including population assistance, to developing countries and countries in transition.

See also: *Bibliographic and Online Resources; Conferences, International Population.*

BIBLIOGRAPHY

Ducasse-Rogier, Marianne. 2001. *The International Organization for Migration 1951–2001.* Geneva: International Organization for Migration.

European Commission. 2000. "Partnership Agreement between the Members of the African, Caribbean and Pacific Group of States of the One Part, and the European Community and Its Member States, of the Other Part, Signed in Cotonou on 23 June 2000–Protocols–Final Act–Declarations." *Official Journal of the European Communities,* L 317 15.12.2002: 3–353.

Hyde, Sarah, Costanza de Toma, and Giorgiana Rosa, eds. 2000. *Handbook on European Community Support for Population and Reproductive Health,* 2nd edition. Garden City, NY: Waterside Press.

International Federation of Red Cross and Red Crescent Societies. 2000. *World Disaster Report 2000: Focus on Public Health.* Geneva: International Federation of Red Cross and Red Crescent Societies.

Maas, Jörg, and Mirja Rothschädl. 1999. *Guide to European Population Assistance: An Orientation*

Guide for Institutions in Developing Countries on Funding for Population and Reproductive Health. Hannover, Germany: Balance Verlag.

United Nations, Department of Economic and Social Affairs, Population Division. 2000. *Charting the Progress of Populations.* New York: United Nations.

United Nations Population Fund. 2000. *Financial Resource Flows for Population Activities in 1998.* New York: United Nations Population Fund.

INTERNET RESOURCES.

African Gerontological Society (AGES International). 2003. <http://www.geocities.com/csps_ghana/>.

Bureau of the Census. 2003. <http://www.census.gov>.

Citizenship and Immigration Canada. 2003. <http://www.cic.gc.ca>.

Council of Europe. 2003. <http://www.coe.int>.

EuropeAid Co-operation Office. 2003. <http://europa.eu.int/comm/europeaid/index_en.htm>.

Family Health International. 2003. <http://www.fhi.org>.

Ford Foundation. 2003. <http://www.fordfound.org/>.

Helpage International. 2003. <http://www.helpage.org>.

International Federation of Red Cross and Red Crescent Societies (IFRC). 2003. <http://www.ifrc.org>.

International Organization for Migration (IOM). 2003. <http://www.iom.int>.

International Planned Parenthood Federation (IPPF). 2003. <http://www.ippf.org>.

Japanese Organization for International Cooperation in Family Planning. 2003. <http://www.joicfp.org/eng/>.

Marie Stopes International. 2003. <http://www.mariestopes.org.uk/>.

National Center for Health Statistics (NHCS). 2003. <http://www.cdc.gov/nchs/>.

Planned Parenthood Federation of America. 2003. <http://www.plannedparenthood.org>.

Population Action International. 2003 <http://www.populationaction.org>.

Population Reference Bureau. 2003. <http://www.prb.org>.

Rockefeller Foundation. 2003. <http://www.rockfound.org/>.

United States Agency for International Development. 2003. <http://www.usaid.gov/>.

United States Bureau of Population, Refugees, and Migration of the Department of State. 2003. <http://www.state.gov/g/prm>.

United States Department of Homeland Security, 2003. <http://www.whitehouse.gov/deptofhomeland/sect3.html#3-2>.

Alphonse L. MacDonald

PROFESSIONAL ASSOCIATIONS

In the population field, as in other areas of learning, professional associations have helped to define the field and to bring practitioners into a network of persons with similar interests. Researchers were originally so few in number that a single national organization could cover all disciplines, as did the Royal Society of London, chartered in Britain in 1662, and the Académie Royale des Sciences, established in France in 1666. In the eighteenth and nineteenth centuries similar organizations appeared in much of Europe and the United States. The nineteenth century saw the coming into existence of the first national disciplinary organizations, followed by the first international ones. This was the outcome of the growth of research and advanced teaching in a world becoming wealthier and more specialized. The strongest international demand in each field was usually for conferences, and their organization frequently preceded the establishment of associations.

History

In the early years of the Royal Society there was a marked interest in population promoted by such members as John Graunt, William Petty, and Edmund Halley. It was not sustained: not until years from 1965 to 1970, during the presidency of Howard Florey, was that interest briefly revived. In the late nineteenth and early twentieth centuries, demographers were still so few in numbers that their needs were met by membership in organizations most suited to their substantive interests in such areas as statistics, economics, geography, or health. Demography achieved explicit recognition at the International Conferences of Hygiene, the Fourth of which (Geneva 1882) included demography as a defined section; the Fifth (Hague 1884) and subsequent meetings included "Demography" in the conference title. Demographers also attended the International Statistical Congress from its inauguration in 1853 and belonged to the International Statistical Institute from its establishment in 1885. In 1922 the International Geographical Union was founded, the first international association in any of the social sciences and one with population interests.

Population soon acquired its own association, apparently the second international social science association to be established. Its origin lay in the World Population Conference (WPC) organized by the American feminist Margaret Sanger (1879–1966) and held in Geneva in 1927. This meeting included some academic demographers, but they were outnumbered by others from biology, medicine, statistics, and economics, many of whom were attracted by eugenics or Malthusianism, prominent topics on the program. WPC discussions led to the creation the following year of the International Union for the Scientific Investigation of Population Problems (IUSIPP). IUSIPP's membership was made up of national committees, none of which existed when it was formed. In America, Britain, France, Germany, Italy, and elsewhere in Europe these committees, numbering 14 in all and consisting largely of delegates to the WPC, were set up between 1928 and the first IUSIPP Conference in Rome in 1931. Opposition to racial eugenics and ideology-laden concepts such as *lebensraum* caused some national delegations to boycott the conference and others to withdraw from it, leading to an alternative meeting in London. Similar friction arose at the second conference in Berlin in 1935.

Except in the United States, the establishment of IUSIPP national committees did not lead to the formation of national population associations. In America it did so, with the Population Association of America (PAA) coming officially into being at its first conference in May 1931. The growth of the demographic profession in the United States can be gauged by the attendance at its annual conferences: 38 in 1931, 155 in 1936, 300 in 1946, 500 in 1957, over 1,000 in 1964, over 2,000 in 1971, and over 2,600 in 1975. Then numbers leveled off for almost 20 years, climbing again in the mid-1990s to pass 3,000 in 1996.

IUSIPP was reorganized in 1947 as the International Union for the Scientific Study of Population (IUSSP), with a membership of individual scholars rather than national committees. It displayed disciplinary maturity by omitting "problems" from its title. On the other hand, it retained "scientific," unlike other disciplinary associations—evidence of demographers's wariness of the effect on population research of the ideologies surrounding eugenics, population control, and the promotion of higher fertility. In 2002, the Union had about 1900 members in 130 countries.

As the field expanded after World War II, more national societies, with memberships mostly below 500, came into existence: in Japan in 1948; in West Germany in 1953; in several countries in Latin America in the 1960s; in France, Britain (the British Society for Population Studies), India, and Pakistan in the 1970s; and in Australia, New Zealand, China, and Thailand in the early 1980s. Pan-continental organizations also appeared: the European Association for Population Studies (EAPS) in 1983 and the Union for African Population Studies (UAPS) in 1984.

Roles of Population Associations

The role of population associations is generally similar to that of other learned bodies. Among international associations the IUSSP is distinctive in having a substantial number of its members coming from developing countries and a large proportion of its conference proceedings and research workshops being focused on these countries. This emphasis can be explained by the international interest in the consequences of rapid developing-world population growth during the second half of the twentieth century and the consequent funding the IUSSP could obtain from international organizations and foundations. In most of the world demographers are still few and scattered, and membership in the IUSSP has compensated for the lack of a demography department or faculty. Only in America is the position different, and this explains why the PAA has a greater membership than the IUSSP and attracts greater numbers to its conferences. The majority of PAA members are involved in research focused on America.

Associations have been necessary to promote disciplines and define their boundaries. The definition of *demography* and even the broader *population studies* is a continuing problem, and there has been a tendency to define it by the use of its core methodology and techniques so that many demographers belong both to a population association and to another learned body covering the substantive area from which they draw their methodology (e.g., sociology, economics, anthropology, history, public health, statistics, biostatistics). The definition may also proceed to producing an agreed terminology and publishing dictionaries as the IUSSP does. The IUSSP is an elective organization, supposedly for those who have distinguished themselves in the field although in practice no longer very restrictive. Most national associations admit all interested persons and have membership ranging from academia to the bureaucracy and beyond. Associations facilitate communications by publishing (or placing on the Web) information about members, including in the IUSSP's case (and befittingly as demographers) their exact dates of birth. All this is facilitated by a permanent head office, located in Liège, Belgium, from 1969 to 1999, and transferred to Paris in the latter year.

Most associations produce peer-reviewed journals and newsletters and organize conferences. IUSIPP published *Population* from 1932 to 1939. IUSSP, almost uniquely, does not have a journal, but for many years helped support and distribute *Population Studies* (Britain), *Population* (France), *Population Index* (USA), and *Genus* (Italy). PAA published a bibliographical journal, *Population Literature,* from 1934 (taken over by Princeton University's Office of Population Research in 1936 and becoming *Population Index*), and from 1964 published the journal *Demography.* English-language journals are published by the Indian Association for the Study of Population *(Demography India),* the Australian Population Association *(The Journal of Population Research),* the Population Association of New Zealand *(The New Zealand Population Review),* EAPS (*European Journal of Population,* in part also in French) and UAPS *(The African Population Review).*

Most national population associations hold annual or biennial conferences. The IUSSP organizes four-yearly general conferences and occasional regional meetings. In 1953 (Rome) and 1965 (Belgrade) it organized international population conferences in conjunction with the United Nations Population Division and it has been a co-sponsoring body for subsequent UN conferences (Bucharest 1974, Mexico City 1984, Cairo 1994). Some associations help give direction to research—notably the IUSSP, through its scientific committees and their workshops. Some award prizes, as IUSSP has done annually since 1991 and PAA for a longer period. Many act as lobbying organizations for the recognition and support of the discipline of demography, and many also raise funds for programs. IUSSP has been particularly active in the latter area.

See also: *Conferences, International Population; Demography, History of; Journals, Population; Population Thought, History of.*

BIBLIOGRAPHY

Grebenik, Eugene. 1991. "Demographic Research in Britain, 1936–1986." *Population Research in Britain,* Supplement to *Population Studies* 45: 3–30.

Hodgson, Dennis. 1991. "The Ideological Origins of the Population Association of America" *Population and Development Review* 17(1): 1–34.

Lunde, Anders S., Frank W. Notestein, and Frank Lorimer. 1981. "The PAA at 50." *Population Index* 47(3): 479–494.

Notestein, Frank W. 1982. "The Development of Demography in the United States." *Population and Development Review* 8(4): 651–687.

Sanger, Margaret, ed. 1927. *Proceedings of the World Population Conference.* London: Edward Arnold.

JOHN C. CALDWELL

RESEARCH INSTITUTIONS

Population research is in many ways an inherently collective enterprise. For many reasons—the need to create and manage large data sets, the value of collaborative projects covering broad geographic areas, and the need to borrow theories and methods from other disciplines—the institutional setting has always been important to population studies.

Early Institutions

Before World War II, there were few specialized institutions for research and training in demography, although small research groups often coalesced in population units of government statistical bureaus or around professorial posts in universities. As a formal university-based unit, the Office of Population Research (OPR) at Princeton University, founded in 1935, was an influential pioneer, training many of those who built other institutions in the United States, Europe, and eventually Asia and the Americas. Funding for OPR came from the Milbank Memorial Fund and the Scripps Foundation for Research in Population Problems, and later from the Rockefeller Foundation. For the League of Nations, OPR undertook four book-length studies of the population of Europe and the Soviet Union, which were published from 1944 to 1946. On the initiative of the U.S. Department of State, then concerned with postwar planning, these studies were extended to include Asia, resulting in influential reports on Japan and India. But even for these, funding came from private sources.

In Europe, early research institutions were created with public funding. The Institut national d'études démographiques (INED) was founded in Paris in 1945, building to some extent on a predecessor set up by the Vichy government. Ever since, INED has maintained a prominent role as a major center of demographic research. Demographic research and training, especially the study of mortality in former colonial regions, was a specialty of several health institutes in France, Belgium, and the Netherlands, and at the Universities of London and Liverpool in the United Kingdom. The immediate postwar period also saw the establishment of a department of demography at the Australian National University.

The Population Council, set up by John D. Rockefeller 3rd in 1952, became an important center for research, a source of fellowships for many people who later became leaders in the field in newly independent countries, and a progenitor of research institutes around the world. One of Rockefeller's motives was frustration at the reluctance of large foundations to work directly on population issues because of controversy surrounding the ethics of contraception and the stigma of demography's past connection with eugenics. The council, based in New York, received a large grant from the Ford Foundation, followed by grants from other foundations, and from the late 1960s on it received funding from the U.S. Agency for International Development and aid agencies of other governments. Its programs span laboratory research and clinical trials, social sciences, and field research on programs in developing countries.

Research Centers Funded in the 1960s and 1970s

Many of the largest and most productive research centers are based at universities in the United States. Most trace their origin to Ford Foundation grants in the 1960s and 1970s. Oscar Harkavy, Ford's program officer in population, saw a need for training population researchers and program administrators in poor countries. It is inappropriate to see the foundation's motivation solely as a concern to staff family planning programs. Harkavy and officers of other foundations also wanted population issues to be incorporated into development planning, and they hoped to train demographers who could lead research institutions in their home countries. The centers funded faculty research projects and travel, development of new courses, fellowships for foreign students, and other institutional needs. Foundation grants also sustained collaborations between U.S. universities and institutions in other countries, notably India, Indonesia, the Philippines, Thailand, and Taiwan.

Ford Foundation grants went to the Universities of Michigan, Pennsylvania, and Chicago in the early 1960s. Beginning in the mid-1960s, grants were made to schools of public health at Johns Hopkins and Harvard Universities, the University of North Carolina, and the University of Michigan, and to the department of demography at the University of California, Berkeley. Ford grants also went to the London School of Economics and the Australian National University to help internationalize existing programs.

The university centers varied in their emphases and the intensity and scope of their international connections. Compared to those located in social science faculties, those based at public health schools tended to place greater emphasis on training for family planning program management and evaluation.

The focus on family planning programs and their needs intensified when the Agency for International Development began to fund population research in 1967. The director of the agency's office of population, Reimert Ravenholt, was able to secure funds for innovative and complex research ventures, notably the World Fertility Survey. But Ravenholt's interest in research (and research results) chiefly as a support for family planning program activities fueled the suspicions of those who feared loss of objectivity and independence from reliance on funding from a "mission agency."

Demography was not alone in suffering deep divisions in the late 1960s. Criticism of collaboration with government programs and policy, lack of sympathy with the growing feminist movement, unequal cooperative arrangements with researchers in "underdeveloped countries," scant involvement of members of racial minorities in research at home, perceived obsession with maintenance of academic standards—these criticisms were aimed at research institutes and professional associations in many disciplines. The population research institutes survived in better shape than some other multidisciplinary institutions (created in many cases by grants to the same universities from the same foundations), such as area studies centers and development studies centers. The greater durability of population research institutes may be due both to the existence of a scientific core in demography and to the growth of new funding agencies with a more purely research orientation.

NIH Grants and Foundation Funding

Beginning in the 1970s, the largest sources of funding for population research have been divisions of the U.S. National Institutes of Health (NIH): the National Institute of Child Health and Human Development (NICHD) and the National Institute on Aging (NIA). Through its Demographic and Behavioral Sciences Branch, NICHD began funding social science research on fertility and family demography as an adjunct to clinical research on contraception. Research on longevity and the effects of an aging population were natural extensions of the health portfolio of the NIA. NIA's budget grew especially rapidly during the 1990s, in part because of the increasing salience of population aging as a demand on government budgets. Demography, as Samuel H. Preston pointed out in a 1997 article, has been the only social science to have a "secure foothold" at the NIH, a great advantage because "cost-conscious legislators continue to place medical research, and NIH in particular, near the top of their priority lists" (p. 236).

NIH grants are made on a highly competitive basis, with committees of non-government scientists playing a crucial role in selection. In 2000 NICHD funded 13 population research centers with program grants, four centers for international training, and 12 training grants to institutions. A number of institutions receive both research and training grants as centers, and also numerous individual project grants for their researchers. NIA funds ten centers for economic and demographic research on aging, often at the same universities that house the NICHD centers.

In the United States, as in other anglophone countries, most population institutes are connected to universities, with research and training closely linked. There are also productive centers based at nonprofit research organizations, such as RAND, the Urban Institute, and Battelle Memorial Institute; much of the work at these centers is concerned with analysis of social, health, and income support policies in the United States.

Foundations have remained a vital source of funding. The Andrew W. Mellon Foundation and the William and Flora Hewlett Foundation provide flexible funding to centers, particularly valuable to centers seeking to maintain international connections. The Mellon Foundation has emphasized support for anthropological demography, the study of urbanization, and refugee studies. The Hewlett Foundation emphasizes reproductive health. The Wellcome Trust, based in the United Kingdom, began in the 1990s to fund several centers in Asia and Africa. Newer foundations, such as the David and Lucile Packard Foundation and the Bill and Melinda Gates Foundation, have also become active in funding.

Organizational Structure

Successful population research centers in the United States are complex organizations requiring entrepreneurial skill as well as intellectual leadership. One research group may include senior demographers with their own individual research grants from NIH, research assistants with stipends paid through foundation postdoctoral fellowships, and visiting scholars whose expenses are paid with NIH center funds, all of whom are supported by administrative staff whose salaries typically are paid from general university funds. Their colleagues may include faculty members performing contractual research for a state health department and graduate students with unrestricted university fellowships. This diversity creates work for accountants but also provides continuity, autonomy, and protection from shifting priorities of funding sources.

A small number of research institutes account for much of the scholarly output in the field. During the 1990s, 44 percent of all first authors of articles in the leading U.S. journal *Demography,* published by the Population Association of America, were affiliated with just ten institutions (all located in the United States). During that decade, all non-U.S. institutions together accounted for fewer first authors of articles in *Demography* than the University of North Carolina alone. This reflects the prominence of U.S. institutions, although perhaps also a degree of insularity among both those who submit articles and the journal editors or the methodological emphases of American demography.

Non-U.S. Institutions

Regional demographic institutes covering major world regions have had partial success in countering the great hindrances to research in poor countries: low salaries, the lack of a critical mass of population scientists in individual countries, and a tradition of hostility between government and universities, especially social science faculties. The United Nations (UN) Secretariat proposed such regional centers for demographic research and training in 1955. The Centro Latinoamericano para demografia (now the Centro Lationamericano y Caribeño de demografia) was founded in Chile in 1957 and the Cairo Demographic Centre in 1963. India under its first prime minister, Jawaharlal Nehru, was determined to create and maintain its own world-class research institutes, mainly in the laboratory sciences and engineering but also in the social sciences. The Government of India and the Tata Trust endowed what became the International Institute of Population Sciences (IIPS) in Bombay. IIPS took on a regional training role beginning in the 1950s, with support from the UN. Sub-Saharan Africa has had several centers that have been important providers of training for statistical services but has had few regional research centers. The two most significant are the UN's Regional Institute for Population Studies at the University of Ghana and the Institut de formation et de recherche démographiques at the University of Yaounde II, Cameroon. Two recently established centers, set up with foundation funding, are the African Population and Health Research Center in Nairobi, Kenya, and the Africa Centre for Health and Population Research in Durban, South Africa.

In Asia and Africa, research groups have grown up around the sites of longstanding health and demographic surveillance systems. The oldest, in Matlab in what is now Bangladesh, was originally a site for cholera vaccine trials conducted by the International Centre for Diarrhoeal Disease Research, Bangladesh (now the Centre for Health and Population Research), which has had many demographers on its staff or as visiting scholars. Other surveillance sites, such as the British Medical Research Council site in Gambia, research sites in West Africa funded by the French government through the Institut de recherche pour le Développement, and the Agincourt site in South Africa, also began as field stations for vaccine trials or community health research. The Navrongo field station in Ghana studies alternative forms of family planning and health services for rural Africa. These centers for demographic surveillance form a network, sharing expertise and software.

The International Institute for Applied Systems Analysis (IIASA) is a unique international institution, created originally to bring together scientists from Western and communist countries to work cooperatively on global problems, and located in Austria on the then frontlines of the cold war. Its population program has included studies in multistate mathematical demography, population projections, and other topics. Perhaps the most significant institutional development in the 1990s was the founding of the Max Planck Institute for Demographic Research, part of the Max-Planck-Gesellschaft through which the German government funds research in the natural and social sciences. It planned a staff of 150 by 2002, which would make it the world's largest single center for demographic research. The institute, which is located in Rostock, has particular strengths in aging, biological demography, mathematical demography, and European and Asian population studies.

Trends and New Developments

Universities are conservative institutions. Population research institutes have proven durable and attractive to several generations of scholars and students. There is no lack of interesting problems (with practical consequences) for which the population sciences provide useful tools for analysis and solution. The largest funders of research give a major role in allocation of resources to committees of scientists who themselves were trained in and work in the existing research centers. Thus the safest prediction is that the population research centers will continue to exist in much the same form as at the beginning of the twenty-first century.

But some potentially important changes are discernible. The development of the Internet has made communication and sharing of files easier. The Wellcome Trust is supporting an Asian Meta-Centre for Population and Sustainable Development Analysis, linking six university-based centers and IIASA, a potential prototype for "virtual" centers linking smaller institutions in neighboring countries. Particularly interesting is the growth of Internet networks such as H-Demog for historical demographers, which is funded by the National Endowment for the Humanities. More formal networks have been created on an experimental basis, for example, the Family and Children Well-Being Research Network funded by the NICHD. One will no longer have to live near and work for a large university in a rich country to benefit from frequent interaction with colleagues with related interests.

Advances in decentralized computing have also reduced the need to be connected to a major research center. Most demographers have in their own homes far more computing power than was available at the facilities lavishly described in funding proposals for center grants in the 1970s. Commercial statistical packages offer online support services and training. Data sets and documentation are increasingly available on the Internet.

The Internet and decentralized computing could lead to new versions of the scientific networks of the early modern era, when the Royal Society and other "invisible colleges" flourished, and scholars of all nations exchanged letters in Latin and gave seminars even in countries at war with their own. Twenty-first-century globalization in science, as in other fields, is in part a return to a golden past.

There are countervailing forces, however. One is the increasing concern in Europe and North America for data privacy. The very factors that have made analysis easier have also heightened concern about confidentiality. A durable function of research institutes may be to guarantee security of data on individuals. Institutes may also expand their roles as data producers, as demographers and other social scientists increasingly rely on complex longitudinal data sets. Keeping in touch with a cohort of respondents in a mobile society through successive rounds of data collection requires continuity and a scale of effort hard to assemble on a short-term basis. Data analysis may be decentralized, but survey management may remain lodged in experienced institutions. Finally, research centers may still be needed as the nurturers of intellectual companionship.

The balance of centrifugal and centripetal forces may favor researchers who can function on multiple levels: as members of a traditional university department, as members of a localized population research center, and as members of networks and "virtual centers" for collaboration with scientists around the world. Demographers will likely adapt to this new world more easily than scientists trained in more self-contained disciplines.

See also: *Bibliographic and Online Sources; Demography, History of; Journals, Population; Population Thought, Contemporary.*

BIBLIOGRAPHY

Caldwell, John C., and Patricia Caldwell. 1986. *Limiting Population Growth and the Ford Foundation Contribution.* London: F. Pinter.

Donaldson, Peter. 1990. *Nature Against Us: The United States and the World Population Crisis, 1965–1980.* Chapel Hill: University of North Carolina Press.

Greenhalgh, Susan. 1996. "The Social Construction of Population Science: An Intellectual, Institutional, and Political History of Twentieth-Century Demography." *Comparative Studies in Society and History* 38: 26–66.

Preston, Samuel H. 1997. "Where Is U.S. Demography Headed?" In *Les contours de la démographie: Au seuil du XXIe siècle,* ed. Jean-Claude Chasteland and Louis Roussel. Paris: Institut national d'études démographiques.

INTERNET RESOURCE.

Comité International de Cooperation dans les Recherches Nationales en Démographie. 2002. *Directory of Population Research Centers.* <http://www.cicred.ined.fr/acerd>.

John G. Haaga

UNITED NATIONS SYSTEM

Prior to the establishment of the United Nations in 1945, the League of Nations, in existence from 1919 to 1946, had taken a number of initiatives aimed at improving population statistics and information among its member countries. Many of these initiatives have played an important role in the work of the United Nations in the population field. In particular, the League focused on the compilation and publishing of national statistics, including demographics. The *International Statistical Yearbook,* starting with the year 1926, included data on population, births, deaths, growth, age structure, occupational groups, and unemployment. In addition to the *Yearbook,* the League published the *Monthly Bulletin of Statistics,* which contained current national population statistics.

Within the United Nations system, various bodies share responsibility for population issues—at UN headquarters, in the regional commissions, in programs and funds set up under the General Assembly, and in the specialized agencies. Brief descriptions of the population activities of these bodies are given below, based on mission statements and related official information.

The Population Information Network, POPIN, established in 1979 and maintained by the United Nations Population Division, makes population information from all UN sources easily available to the international community. Details of UN publications from each agency can be found at their respective Web sites or through POPIN.

UN Headquarters

The two primary offices concerned with population matters at UN Headquarters are the Population Division and the Statistics Division, both of which are within the Department of Economic and Social Affairs (DESA). In addition, a number of other divisions within DESA have work programs that touch upon aspects of population. In particular, the Division for Social Policy and Development deals with the issue of aging and the Division for the Advancement of Women deals with gender issues.

The Population Division began its work in 1946 as the secretariat to the Population Commission, which was established in the same year as a subsidiary body of the Economic and Social Council. The Division is responsible for monitoring and appraisal of the full range of areas in the field of population, including outcomes of UN global conferences on population and development—notably the Program of Action of the 1994 International Conference on Population and Development. The Division provides substantive support to the Commission on Population and Development (formerly the Population Commission), as well as to related work of the General Assembly and the Economic and Social Council.

The Population Division also facilitates access by governments to information on population trends and their interrelationships with social and economic development as an input to government policy and program formulation. One important activity in this area is the preparation of population estimates and projections for all countries and areas of the world, as well as for urban and rural areas and major cities. These data serve as the standard and consistent set of population figures for use throughout the United Nations system.

The Statistics Division began its work in 1946 as the secretariat to the Statistics Commission established in the same year as a subsidiary body of the Economic and Social Council. The Statistics Division promotes the development of national statistics and the improvement of their comparability. It provides central statistical services to the UN Secretariat and promotes the coordination of the statistical work of the specialized agencies, including the improvement of statistical methods in general.

Within the Statistics Division, population issues fall primarily within the responsibility of the Demographic and Social Statistics Branch. The Branch collects, compiles, and disseminates official national population statistics from censuses, surveys, and vital registration systems and prepares methodological reports and guidelines for the coordination of data collection. Its best-known publication is the *Demographic Yearbook,* issued since 1948.

Regional Commissions

The United Nations has five regional commissions, which as part of their activities deal with population matters. They are: the Economic Commission for Africa (ECA); the Economic and Social Commission for Asia and the Pacific (ESCAP); the Economic Commission for Europe (ECE); the Economic Commission for Latin America and the Caribbean (ECLAC); and the Economic and Social Commission for Western Asia (ESCWA). In the past, most commissions had population divisions, but these have merged with other offices. The commissions promote dialogue among the governments of their respective regions on various aspects of population change and related issues, such as food security, sustainable development, and poverty reduction. They also coordinate regional activities dealing with data collection and research relating to population matters.

Funds and Programs

UNICEF. The United Nations Children's Fund (UNICEF) was established in 1946 as a temporary body to provide emergency assistance to children in war-ravaged countries. In 1953 the General Assembly placed the Fund on a permanent footing and charged it with assisting in the development of permanent child health and welfare services, particularly in developing countries.

UNICEF's mandate is to protect children's rights and promote their welfare. It is guided by the Convention on the Rights of the Child, which seeks to establish children's rights as enduring ethical principles and to support international standards of behavior toward children. UNICEF also monitors the implementation of the World Declaration on the Survival, Protection and Development of Children.

UNFPA. In 1967 the United Nations established a Trust Fund for Population Activities. In 1969 the Trust Fund was renamed the United Nations Fund for Population Activities (UNFPA). In 1987 its name (but not its acronym) was again changed, to the United Nations Population Fund.

UNFPA is the largest international source of population assistance. About a quarter of all population assistance from donor nations to developing countries is channeled through it. It has three main program areas: reproductive health, including family planning and sexual health; population and development strategies; and advocacy in support of its goals. UNFPA is guided by the principles, recommendations, and goals of the Program of Action of the 1994 International Conference on Population and Development—the Cairo conference.

UNHCR. The office of the United Nations High Commissioner for Refugees (UNHCR) was established by the United Nations General Assembly in 1950, one of several initiatives by the international community to provide protection and assistance to refugees. Initially, UNHCR was given a limited three-year mandate to help resettle some 1.2 million European refugees left homeless in the aftermath of World War II. However, as other refugee crises emerged around the globe, UNHCR's mandate was extended and has continued to be extended every five years.

UNHCR promotes international refugee agreements and monitors government compliance with international refugee law. Its principal functions are to provide international protection to refugees, seek durable solutions to their plight, and furnish material assistance. Protection involves preventing *refoulement*—that is, the forcible return of a refugee to a country where he or she may have reason to fear persecution. In addition, UNHCR provides material assistance to refugees in the form of shelter, food, medical aid, education, and other social services.

UN-Habitat. The United Nations Human Settlements Programme, UN-Habitat, formerly known as the UN Centre for Human Settlements (UNCHS-Habitat), was established in 1978. UN-Habitat aims to promote the socially and environmentally sustainable development of human settlements and the attainment of adequate shelter for all. On population issues, UN-Habitat's work is particularly relevant in the areas of urbanization and internal migration. A key element in its work is the implementation of the Habitat Agenda—the global plan of action adopted at the 1996 Habitat II Conference in Istanbul.

UNAIDS. The Joint United Nations Programme on HIV/AIDS, UNAIDS, is the leading coordinator of worldwide action against HIV/AIDS. Its mission is to lead, strengthen, and support an expanded response to the epidemic that will prevent the spread of HIV; to provide care and support for those infected with the disease; to reduce the vulnerability of individuals and communities to HIV/AIDS; and to alleviate the socioeconomic and human impact of the epidemic. UNAIDS is sponsored by the World Health Organization (WHO), the UN Development Programme, UNFPA, UNICEF, UNESCO, the World Bank, and the UN Drug Control Programme. UNAIDS compiles data and statistics on HIV/AIDS globally and undertakes studies addressing the determinants and consequences of the epidemic.

Specialized Agencies

WHO. The World Health Organization was established as a specialized agency of the United Nations in 1948. WHO maintains an international surveillance system to investigate, provide early warning, and respond to epidemics of newly emerging and re-emerging diseases. The agency compiles a variety of health- and mortality-related statistics and conducts research on a broad range of health issues. It coordinates international efforts to eliminate or eradicate some infectious diseases. In 1980, for example, WHO certified the global eradication of smallpox—the first disease to be eradicated by the human race. WHO also works to prevent and control major chronic non-communicable diseases that strike people later in their lives.

WHO has a program in the area of reproductive health, including family planning and safe motherhood, sexually transmitted diseases, and HIV/AIDS.

ILO. The International Labour Organization (ILO) was established in 1919, its constitution forming a part of the Treaty of Versailles, which brought the League of Nations into being. In 1946, ILO became the first specialized agency of the United Nations. Although mainly concerned with employment conditions and industrial relations, ILO also compiles employment statistics, which are fundamental to many population and development analyses.

World Bank. Founded in 1944, the World Bank is the world's largest source of development assistance. The Bank provided U.S.$17.3 billion in loans to its client countries in fiscal year 2001. The Bank emphasizes the need for investing in people, particularly through basic health and education; focusing on social development, inclusion, governance, and institution-building as key elements of poverty reduction; and strengthening the ability of the governments to deliver high-quality services efficiently and transparently. In undertaking its development assistance, the Bank collects an extensive range of demographic and related statistics and conducts numerous studies relating to population and development issues.

UNESCO. Established in 1945, the United Nations Educational and Scientific and Cultural Organization (UNESCO) promotes collaboration among nations in the fields of education, science, culture, and communication. In particular, it compiles educational enrollment and attainment statistics for countries and regions—a crucial element in many analyses of population and development.

FAO. The Food and Agriculture Organization of the United Nations (FAO) was founded in 1945 with a mandate to raise levels of nutrition and standards of living, to improve agricultural productivity, and to improve the conditions of rural populations. A specific priority is encouraging sustainable agriculture and rural development—a long-term strategy for increasing food production and food security while conserving and managing natural resources.

FAO compiles extensive international statistics relating to the rural environment, food production, and population.

See also: *Bibliographic and Online Resources; Conferences, International Population.*

BIBLIOGRAPHY

INTERNET RESOURCES.

International Labour Organization (ILO). 2002. <http://www.ilo.org/>.

Joint United Nations Programme on HIV/AIDS (UNAIDS). 2002. <http://www.unaids.org/>.

United Nations Children's Fund (UNICEF). 2002. <http://www.unicef.org/>.

United Nations Department of Economic and Social Affairs (DESA). 2002. <http://www.un.org/esa/>.

United Nations Division for Social Policy and Development. 2002. <http://www.un.org/esa/socdev/>.

United Nations Division for the Advancement of Women. 2002. <http://www.un.org/womenwatch/daw/>.

United Nations Food and Agriculture Organization of the United Nations (FAO). 2002. <http://www.fao.org/>.

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). 2002. <http://www.unescap.org/>.

United Nations Economic and Social Commission for Western Asia (ESCWA). 2002. <http://www.escwa.org.lb/>.

United Nations Economic and Social Council. 2002. <http://www.un.org/depts/unsd/>.

United Nations Economic Commission for Africa (ECA). 2002. <http://www.uneca.org/>.

United Nations Economic Commission for Europe (ECE). 2002. <http://www.unece.org/>.

United Nations Economic Commission for Latin America and the Caribbean (ECLAC). 2002. <http://www.eclac.cl/>.

United Nations High Commissioner for Refugees (UNHCR). 2002. <http://www.unhcr.ch/>.

United Nations Human Settlements Programme (UN-Habitat). 2002. <http://www.unhabitat.org/>.

United Nations Educational and Scientific and Cultural Organization (UNESCO). 2002. <http://www.unesco.org/>.

United Nations Population Division. 2002. <http://www.unpopulation.org/>.

United Nations Population Fund (UNFPA). 2002. <http://www.unfpa.org/>.

United Nations Population Information Network (POPIN). 2002. <http://www.popin.org/>.

World Bank. 2002. <http://www.worldbank.org/>.

World Health Organization (WHO). 2002. <http://www.who.int/>.

Joseph Chamie

POPULATION POLICY

Population policy may be defined as deliberately constructed or modified institutional arrangements and/or specific programs through which governments influence, directly or indirectly, demographic change.

The generality of the definition lends itself to varying interpretations. For any given country, the aim of population policy may be narrowly construed as bringing about *quantitative* changes in the membership of the territorially circumscribed population under the government's jurisdiction. Additions to membership are effected only through births and immigration, losses are caused by emigration and by deaths. Concern with this last component is usually seen as a matter for health policy, leaving fertility and migration as the key objects of governmental interest in population policy.

More broadly, policy intent may also aim at modification of *qualitative* aspects of these phenomena—fertility and international migration—including the composition of the population by various demographic characteristics and the population's spatial distribution.

Furthermore, governments' concern with population matters can also extend beyond the borders of their own jurisdictions. International aspects of population policy have become increasingly salient in the contemporary world.

Population Control in Traditional Societies

Rulers of any political unit have a stake in the size and composition of the population over which they have authority, hence an incentive to try to influence demographic change in a desired direction. Thus "population policy" may be said to have a long history, starting at least with the empires of the ancient world. Greater numbers tended to connote greater wealth and power, at least for those at the apex of the social pyramid. Measures encouraging marriage and sometimes immigration testify to the prevailing populationist sentiment among rulers throughout history.

But the leverage of the weak premodern state over fertility in traditional societies was necessarily limited. The dominant influence setting the patterns of reproduction was located, instead, in a deeper layer of social interaction. Births, the key element affecting population change, are produced by individual couples—seemingly an intensely private affair yet one in which the immediate kin group and the surrounding local society in which that group is embedded have a material stake. All societies, if at varying degrees, grant a measure of self-sovereignty to their members. An individual has certain rights over his or her direction in life. But this is always subject to some constraints, not only biological but also social. Well before rights and obligations are formally codified in legal terms, they are established through spontaneous social interaction—a self-organizing process. Restrictions on freedom to act take the form of social expectations and pressures that individuals can ignore only at considerable personal costs to themselves. Typically, there is strong expectation that men and women should marry and have children. Parental and kin obligations in the matter of bringing up children are well understood by all adults and informally enforced by the community. In most societies there is the expectation that children are to be born to married couples only; that a man can have one wife at a time; that a husband is obligated to support his wife and a father his children; and that he can expect reciprocal services from them. And informal rules shaped by community interest tend effectively to regulate the entry of foreigners.

The fabric of such demographically relevant behavioral stances, supported by internalized personal norms and buttressed by religious injunctions, is a product of social evolution; how effective such institutions are becomes an important determinant of societal success. As a classic statement of the British demographer Alexander Carr-Saunders (1922, p. 223) put it, persons and groups of persons:

> are naturally selected on account of the customs they practise, just as they are selected on account of their mental and physical characters. Those groups practicing the most advantageous customs will have an advantage in the constant struggle between adjacent groups over those that practise less advantageous customs. Few customs can be more advantageous than those which limit the number of a group to the desirable number . . . .[In the traditional society] there would grow up an idea that it was the right thing to bring up a certain limited number of children, and the limitation of the family would be enforced by convention.

Given the harsh biological and economic constraints premodern societies invariably experienced, that "desirable number" presupposed fairly high fertility; high enough to provide a sufficient margin of safety over mortality. Successful societies—societies that survived to the dawn of the modern era—thus obeyed the biblical injunction to be fruitful and multiply, even though such multiplication as a matter of historical record was necessarily very slow. But traditional demographic regimes resulting from spontaneous social interaction achieved modest growth rates at varying levels of fertility and mortality. Early modern Western Europe succeeded in maintaining a relatively low average level of mortality by means of keeping birth rates low, primarily by means of a fairly high average age of marriage and substantial proportions that remained permanently single. A contrasting pattern, such as in India, combined early and universal marriage and a consequent high level of fertility with slow population growth by virtue of death rates that were also high, approximating the level of the birth rate. With respect to the rate of population growth these different combinations of birth and death rates in traditional societies were very similar. The potential for rapid population growth that might be triggered by a fall of mortality was, however much higher when the premodern equilibrium was the result of a combination of high mortality and high fertility.

Rationale for Population Policy

Modernity—the rise of democratic state formations reflecting the public interest and the emergence of rapid economic development—brought about the realistic promise of realizing age-old human aspirations for a better life. The state increasingly came to be seen as an institution created by the voluntary association of free individuals to further their interests. The central function of the state was to produce public goods—goods that individuals cannot secure for themselves. The U.S. Constitution, promulgated in 1789, articulated key items in the collective interest concisely and with universal validity. The aim of the Union formed by the People was, in the words of the Constitution's Preamble, to "establish Justice, insure domestic Tranquility, provide for the common defence, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity." In pursuing such goals, regulation of immigration into a state's territory is clearly defined as a public good, thus delineating a particular role for population policy. And aggregate fertility may also be construed a public good, if its level as determined by spontaneous social interaction is too high or too low in terms of the collective interest.

The potential role of the state in regulating immigration is straightforward: individuals wishing to restrict or promote it cannot set up their own border patrols or issue entry visas. Individual preferences in the matter, however, are likely to differ. It is the task of the government to weigh and reconcile conflicting individual desires and come up with a policy deemed the best under the accepted rules of the political process.

To claim a role for the state in the matter of fertility is more problematic. Additions to the population are the result of a multitude of individual decisions concerning childbearing. Within the constraints of their social milieu, these decisions reflect an implicit calculus by parents about the private costs and benefits of children to them. But neither costs nor benefits of fertility are likely to be fully internal to the family: they can also impose burdens and advantages on others in the society. Such externalities, positive and negative, do represent a legitimate concern for all those affected. An individual's influence on the fertility of other families, however, is very limited: there are no private markets offering preferred patterns of aggregate demographic processes to individual buyers. Remedying such market failure may then be attempted through intervention by the state so as to affect individual behavior in order to best serve the common good—the good of all individuals.

The earliest clear formulation of the population problem as a problem of coordination among individual preferences, hence establishment of the rationale for potential state intervention in the matter of fertility, was given by William Foster Lloyd, an Oxford mathematician and economist, in an essay published in 1833. In the spirit of the Malthusian concerns of his time, Lloyd (1833/1968, pp. 22–23) envisaged the possibility of overpopulation even under conditions when all families have only the children they actually want and suggested the direction in which remedy ought to be sought:

> The simple fact of a country being overly populous . . . is not, of itself, sufficient evidence that the fault lies in the people themselves, or a proof of the absence of a prudential disposition. The fault may rest, not with them as individuals, but with the constitution of society, of which they form part.

Population policy should therefore strive toward institutions and incentive systems—a constitution of society—that provide signals to individuals guiding them to behave in harmony with the collective interest.

Population Policy in the Liberal State

Technological progress and consequent improvements in the standard of living in modernizing societies result in a far more effective control of mortality than was possible in the traditional society. But the fall of the death rate accelerates the rate of population growth which, in turn, could strain the capacity of the economic system to accommodate the increased population numbers. Falling living standards then would once again increase death rates, reestablishing an approximate balance between births and deaths at a low standard of living. This was the pessimistic central vision of T. R. Malthus's 1798 *Essay.* But this outcome, although held to be highly probable, was, according to Malthus, avoidable. Given sound public policies, there was an alternative to subsistence-level equilibrium, both agreeable and achievable.

A salient element in the 1798 *Essay,* and in subsequent writings influenced by it, was disapproval of the schemes for poor relief prevailing in Britain and elsewhere in Europe—on the grounds that they were likely to encourage irresponsible reproduction. Efforts of the paternalistic state to reduce poverty were held to be misguided; by stimulating fertility, hence population growth, such efforts would generate only more misery. Malthusians argued that the state's correct stance in demographic matters, as in the economy at large, was *laissez faire.* This would foster the prudential habits among the general population similar to those that already existed among the propertied classes. It would do so by assuring that the costs of childbearing were not shared by society at large but were primarily borne by the individual couples having children.

Heeding such a prescription did not imply that the state was to play a passive role in demographic matters. Malthus's own writings, most clearly his 1820 tract *Principles of Political Economy* (1989, pp. 250–251), spell out a broad agenda which expresses the philosophy that came to be dominant in the liberal states of the West in the nineteenth century. Material improvements, such as higher wages for labor, could indeed be defeated if they would be "chiefly spent in the maintenance of large and frequent families." But Malthus also envisaged a different, happier possible outcome: "a decided improvement in the modes of subsistence, and the conveniences and comforts enjoyed, without a proportionate acceleration of the rate of [population] increase."

The possibility of such diametrically different responses to the stimulus of higher wages suggests a large element of indeterminacy in fertility behavior. To Malthus, the causes of these divergent responses were to be found in the circumstances, social and political, in which people lived—in particular, whether those circumstances hindered or rewarded planning for the future. From his analysis he derived a prescription for a population policy that would yield the hoped-for demographic outcome:

> Of all the causes which tend to generate prudential habits among the lower classes of society, the most essential is unquestionably civil liberty. No people can be much accustomed to form plans for the future, who do not feel assured that their industrious exertions, while fair and honourable, will be allowed to have free scope; and that the property which they either possess, or may acquire, will be secured to them by a known code of just laws impartially administered. But it has been found by experience, that civil liberty cannot be secured without political liberty. Consequently, political liberty becomes almost equally essential. (ibid.)

During the long nineteenth-century—that may be thought of as stretching to the outbreak of the First World War—the politics in Europe and in its overseas offshoots favored, even if imperfectly, the development of institutional and legal frameworks in harmony with such principles. This, in interaction with economic and cultural changes shaped by the industrial revolution, created a milieu that fostered the prudential habits of parents, rendering the micro-level calculus of the costs and benefits of children increasingly salient. Rising demand for labor, including greater use of child labor, and rising income levels tended to sustain high fertility or even to stimulate it. But rising material expectations, broadening opportunities for social mobility, and the patterns and circumstance of urban living pulled in the opposite direction. This was powerfully reinforced by some programmatic activities that were consistent with the limited role the liberal state claimed in managing the economy. These included public health programs and projects aimed at improving basic infrastructure for transport and communication. And most importantly, the state, or local government, assumed a key role in fostering, organizing, and financing public education. At basic levels school attendance was made mandatory and enforced and, in parallel, labor laws curtailed the employment of children.

Reflecting long-standing cultural values and religious injunctions, and contrary to laissez-faire principles, the liberal state generally banned the spreading of contraceptive information and the sale of contraceptive devices and made abortion illegal. Such restrictions typically remained in effect well into the twentieth century. But by all evidence, any upward pressure on fertility from these restrictions was swamped by the downward pressure on parental demand for children resulting from the state policies and programs just mentioned. By the last quarter of the nineteenth century birth rates were falling rapidly in the countries of the West. In many cases, rates of population growth fell also, despite continuing improvements in mortality. In Europe this trend was facilitated by emigration, which both sending and receiving countries—notably the United States, Canada, and Australia—either positively encouraged or at least permitted.

The stance of the liberal state on population policy thus brought about the prospect of a new demographic equilibrium in the West that could be consistent with continuing material progress: achievement of a stationary population at low levels of fertility and mortality and allowing freedom of movement internationally.

Population Policy between the World Wars

The massive losses of life resulting from World War I and from the influenza pandemic at its immediate aftermath, and the sharp drop in the number of births during the war years, were temporary disruptions in the steadily declining trends of fertility and mortality characterizing the prewar decades in the West. Those trends soon made it evident that there is no built-in guarantee that the sum total of individual fertility decisions will eventually settle at a point at which, in the aggregate, the rate of population growth will be exactly zero or fluctuate tightly around a zero rate. Although, owing to relatively youthful age distributions, the rate of natural increase remained positive, by the late 1920s demographers realized that fertility rates in several Western countries had fallen to such a low level that, in the longer term, natural increase would become negative. This trend became more accentuated and more general under the impact of the Great Depression. Some observers foresaw a "twilight of parenthood."

Just as excessive reproduction called for corrective public policies, there were calls for corrective action achieving the opposite result: enhancing fertility so as to assure at least the simple maintenance of the population. In some countries the ban on contraceptives was tightened and the penalties on abortion were increased. These measures had little effect. So did, predictably, governmental exhortation appealing to families to have more children.

The most promising avenue for population policy seemed to be to use the instruments available to the state for redistributing income so as to reward demographic behavior considered socially desirable (and to discourage contrary behavior). By the 1930s such pronatalist policies came to be fairly widely if rather tight-fistedly applied in a number of countries. Among Europe's emerging democratic welfare states Sweden and France were pioneers in providing financial rewards and services in kind to families with children, especially to larger families. (Sweden, however, also allowed liberal access to contraception.) Similar policies were applied with equal or greater vigor in fascist Italy and Germany.

Invariably, the proponents of such policies claimed some results in terms of birth rates somewhat higher than would have been expected in their absence. But the latter quantity is a hypothetical one, which introduces a necessary caution to such claims. More pertinently, when average fertility is low, the birth rate in any given year is an unreliable measure of long-run fertility. Couples have considerable latitude to time the birth of their children earlier or later, without affecting the number of children they ultimately wish to have. Logically, pronatalist policies seek to affect that lifetime total rather than aiming at temporary increases in the birth rate.

International Population Policy after World War II

In the countries that the United Nations categorizes as less developed, population policy issues attracted little attention until the middle of the twentieth century. Fertility remained high, more or less at its premodern level. Population growth was slowly increasing, however, as a result of improvements in mortality. Following the end of World War II, mortality decline accelerated greatly and as a result so did population growth. In 1950 the world population was 2.5 billion. Some 1.7 billion of that total was in countries classified as less developed, with an average annual birth rate of 44 per 1000 population—twice as high as in the more developed group. Unless a decline of the birth rate got under way fairly rapidly, an unprecedentedly large expansion of human numbers was inevitable.

Although the trigger of such population growth was a welcome development—falling death rates—growth rates that would double or even treble a population within a generation seemed a major obstacle to development. And the large and widening differential between the more developed and the less developed countries in terms of population size and average income levels was seen as holding out the prospect of major dislocations and long term instabilities within the international system. As a result, in the 1950s an intense debate started on what policies could reduce fertility in the less developed world. This policy debate was primarily Western, much of it American, just as the diagnosis of the problem itself had been. The proposals that emerged were to be applied in countries representing a large and growing share of the global population. Population policy became international.

The West of course already had relatively low fertility, and with it much historical experience on why birth rates fell. Social science analysis was virtually unanimous in interpreting this experience. The explanation centered on the role of changing structural conditions of the economy, conditions to which micro-level units of the population tended to respond, in demographic as well as in other matters. Demand for smaller families was seen as the primary force determining birth rates; the means by which couples regulated their fertility was not unimportant, but seen as a distinctly secondary factor. If the demand was strong enough, fertility would be low, even if birth control technology was primitive. A transition to low fertility presupposed changing preferences, and such preferences were responses to market signals. If policy was to have an explicit role, it would be through reinforcing those signals.

In the experience of past fertility transitions four components of the incentive structure seemed especially pertinent: (1) the direct costs parents must incur in bringing up children; (2) the opportunity costs of children to parents; that is, the earnings a couple must forgo because of children; (3) the contribution of children to family income through labor services; and (4) the contributions of children to parents' economic security in old age, in comparison to alternative sources of security.

Fertility declines when shifts in these components make family limitation advantageous to couples, overcoming cultural resistance supporting traditional behavior. Patterns of development generate that effect when at least some, but especially when all of the following conditions are fulfilled: (1) social expectations and formal institutional arrangements place on parents the major financial responsibility for raising their own children, including much of the cost of education and health care; (2) women have access to income-earning opportunities in the labor market, including jobs not easily compatible with childbearing and childrearing; (3) social institutions make formal education (primary and early secondary) compulsory and effectively enforce school attendance; (4) child labor is made illegal; (5) effective legal guarantees of property rights, legal enforcement of private contracts, and the development of public and private insurance and pension schemes provide attractive and comparatively secure alternatives to children as a source of old-age security.

Social and institutional conditions that make such changes potent generators of fertility decline include the following: (1) emphasis on personal economic contribution (rather than, for example, class status or political loyalty) as the primary factor determining a person's earnings, thus providing an incentive for increased investment in human capital; (2) systems of promotion that provide opportunities for upward social mobility according to merit and tolerate downward social mobility; (3) openness to outside influences that create rising expectations with respect to material standards of living; and (4) emphasis not only on the rights but also on the social and economic responsibilities of the individual.

Some of the factors that prompted the fall of fertility in the West also became potent in the less developed countries as concomitants of successful economic and social progress. International conferences, for example the 1974 Bucharest conference on population, spelled out many of the essential socioeconomic changes necessary for fertility to shift from high to low levels. But assembling the instruments so identified into a coherent development strategy of institutional-structural reforms, reforms justified also by demographic objectives, remained an elusive task. In promoting development governments came to see their roles not in supporting institutions harnessing the market, but replacing the market in key developmental tasks through specific goal-oriented categorical programs. In the matter of population policy, the rapid postwar progress in the technology of birth control provided an appealing apparent short-cut for achieving fertility decline through programmatic means. Markets, it was held, could not be relied on to bring that technology to those wishing to practice birth control. Governments could, instead, organize free delivery of birth control information, and provide effective means for preventing births to all those, primarily (it was assumed) women, who wished to plan their families. Surveys indicated that there existed a substantial latent demand for such services. Satisfied customers, in turn, would serve as role models, bringing new clients to the program.

By the mid-1960s, in programmatic terms the international population policy debate on the relative importance of demand versus supply was essentially decided in favor of the latter. For the next quarter century, population policy in the developing world became essentially synonymous with family planning programs.

Financial and administrative limitations within developing countries necessitated the heavy involvement of foreign assistance in launching and sustaining family planning programs. Although donor countries' own domestic experience in this area was practically nonexistent, such aid, justified by the seriousness of the "population problem" (a problem whose cause was defined in terms of aggregate indexes of population growth) was readily forthcoming, partly in the form of bilateral assistance and partly through international aid institutions.

The cost of birth control technology was, in itself, relatively modest. But sustaining an effective delivery service did represent significant claims on scarce human and material resources. Declared demand for birth control does not necessarily translate into effective willingness to practice it: conflicting desires may interfere. Weakness of measures of latent demand, or "unmet need," is reflected in the requirements that programs are supposed to satisfy if they are to be successful. These typically included such items as "doorstep accessibility of quality services," "broad choice of contraceptive methods," "forceful IEC [information, education, and communication] programs," "sound financing strategies," "sound management with proper logistics," "evaluation systems," "a continuous process of strategic thinking, planning and management," and "staff leadership for program parameters" (Mahler 1992, p. 5).

The effectiveness of family planning programs in reducing fertility remains a matter of controversy. According to international guidelines, programs recruit their clients on a strictly voluntary basis. By accepting the service voluntarily, the individual acceptor demonstrates that she values that service. But some of the more successful programs, notably in

Asia, tended to increase acceptance by often heavy-handed methods of persuasion, and, in the especially important case of China, by coercion backed by legal sanctions. Where fertility fell in less developed countries with active family planning programs, it is typically found that program-provided free services account for a large percentage of those practicing contraception. This non-surprising result is then often taken as an indicator of success in reducing aggregate fertility. But what would have happened in the absence of the program is conjectural, hence routinely ignored. Some less developed countries that lacked government programs also experienced major falls of fertility: Brazil is a conspicuous example. Similarly, if programs have seemingly only minor success in reducing fertility, this can be taken as evidence that the program is inadequately financed, organized, and managed: greater efforts would have led to better results.

Family planning programs as they were commonly conceived had a strong resemblance to health programs. But given the special priority accorded to family planning services in foreign assistance, typically they were organized as a separate "vertical" program, or kept administratively distinct within the broad health program. The justification for such treatment was that while acceptors of family planning services are recruited because the program satisfies their individual need, the program also serves a national developmental need by helping to reduce aggregate population growth, hence deserves priority. Once a family planning program is organized, its managerial and professional cadres form a natural advocacy group strongly interested in the program's sustenance. Invoking the public interest in lowered fertility, as distinct from simply serving the needs of the clients of the program, has long served as a key supporting argument in that endeavor.

Over time, this developmental prop has eroded. This was in part a result of criticisms of the intrinsic scientific merit of the argument but most of all a reflection of the extensive decline of fertility that has occurred, a decline often attributed to the success of the family programs themselves. At the eve of the 1994 International Conference on Population and Development, a review, considered highly respectful of the importance of fertility decline for successful development, reached the guarded conclusion that the evidence on the subject "mostly support the view that rapid population growth in poor countries under conditions of high fertility is inimical to many development goals"—with stress on the qualifying words "mostly," "high fertility," "many development goals," and "rapid," and with the last-mentioned term defined as "in excess of 2 percent annually" (Cassen 1994, p. 13). By that time, among world regions, only Africa and West Asia had a population growth rate meeting that criterion.

Accordingly, the development rationale of family planning programs was gradually dropped and was replaced by the argument that the programs satisfy important health needs and help people exercise a fundamental human right. The Cairo conference formalized this shift: even though the name of the conference for the first time included a reference to development, scant attention was paid to that concept. Family planning programs were redefined, instead, as reproductive health programs, responding to a broader range of women's health needs, such as prevention of unsafe abortions and sexually transmitted diseases, including HIV/AIDS. But beyond this, new emphasis was put on some requirements that would contribute to women's empowerment: reduction of infant and maternal mortality and improvement in girls' education and women's opportunities for employment and political participation. Although the connection was not highlighted, these are conditions that are likely to help reduce the birth rate through stimulating the demand for smaller family size. The Cairo conference, in effect, reverted to some key elements of a demand strategy for reducing birth rates.

The future of family planning service programs are thus left in a somewhat tenuous status. Without invoking a collective interest in a wider practice of birth control, it is not clear what level of priority should be accorded to such programs as just one part of publicly financed health programs, or indeed relative to many other social welfare programs that also serve demonstrable human needs. Not surprisingly, there are increasing efforts in national programs to rely on the market in enhancing access to contraceptives and to provide program services on a fee-for-service basis.

Population Policy in Response to Below Replacement Fertility

During the second half of the twentieth century debates about population policy, and consequent programmatic action, were centered on the issue of rapid population growth in the less developed world.

Toward the end of this period, however, a quite different demographic phenomenon has begun to attract increasing attention: aggregate fertility levels that are inadequate for the long-run maintenance of the population. Analytically, the potential population policy issue raised by low fertility is identical to the problem inherent in rapid population growth: it is caused by the disjunction between the sum total of individual reproductive decisions and the collective interest in a long-run demographic equilibrium. But this time individual aspirations generate a deficit rather than an excess in population growth. The syndrome, as was noted above, is not entirely novel: it was detectable in fertility trends in the West, especially in Europe, in the 1920s and 1930s, and in some instances, notably in France, even earlier. But in the decades immediately following World War II the baby boom seemed to make the issue of low fertility moot. Indeed, by any historical standard, population growth was rapid during the second half of the twentieth century even in the developed world. Europe's population, for example, grew during that period from 550 million to about 730 million.

The baby boom was, however, a temporary interruption of the secular downward trend in fertility. By the 1970s the net reproduction rate was at or below unity in most countries in Europe and also in the United States. In the U.S. fertility stabilized at or very close to that rate, but in Europe fertility continued to decline. By the beginning of the twenty-first century, the average total fertility rate was 1.4. Such a level, if maintained indefinitely, would result in a population loss of one-third from generation to generation, that is, roughly, over each period of some 30 years. Some countries, notably in Southern, Central, and Eastern Europe, period fertility rates were at low levels without historical precedent for large populations. If continued, in the absence of large compensatory immigration this would not only lead to rapid population decline but also result in very high proportions of the population at old ages. It might be expected that in the affected countries such prospects would generate not only concern, but also vigorous remedial policy action.

By and large, however, this response has not been evident. Most governments as well as the general public tend to view below-replacement fertility with an equanimity quite unlike the alarmed reaction that the same phenomenon elicited when it first emerged between the two World Wars. And explicit pronatalist policies, common in the 1930s, are conspicuous by their absence. There are a variety of reasons explaining this indifference.

First, the preeminent population issue confronting policymakers in the post-World War II period was rapid global population growth. Programs aimed at moderating fertility in the developing world received assistance or at least encouragement from the rich, low-fertility countries. Although the rationale was modified over time, such assistance and encouragement has continued, as indeed substantial further population increase in the less developed countries is still anticipated in the early decades of the twenty-first century. Even though population issues tend to be *sui generis,* reflecting differences in demographic behavior country-by-country, there was, and remains, a perceived dissonance between fertility-lowering assistance to other countries and engaging in action at home serving the opposite aims. Faulty logic notwithstanding, the international terrain has not been favorable for domestic pronatalism.

Second, the natural rate of increase—the difference between the number of births and the number of deaths—is still positive in many of the countries with fertility well below replacement. This is the result of age distributions that reflect past fertility and mortality, and notably the effects of the postwar baby boom, that still favor population growth. While this momentum effect is temporary, the longer-term implications for population decline and population aging are only dimly perceived by the general public and provide an excuse for inaction on the part of policymakers.

Third, when those longer-term demographic effects are understood, a calmer attitude still prevails. There is an inclination, reinforced by increasing concern with the quality of the natural environment, to regard a degree of demographic "decompression" as a not necessarily unwelcome prospect, especially in countries with an already dense population. And it is assumed that the economic and social disadvantages that might be imposed by a declining population can be effectively dealt with through institutional adjustments and social policy measures other than measures aiming for a higher birth rate. A demographic policy often regarded as potentially helpful in this regard is encouragement of immigration. That willing immigrants are available to compensate for low birth rates is taken for granted—a realistic assumption in high-income countries.

Fourth, there is a vague expectation that the population decline, impending or already begun, will in due course trigger corrective homeostatic mechanisms, leading to a spontaneous rebound in the level of fertility. Another baby boom may not be in the offing, but fertility may rise sufficiently to once again reach or at least approximate replacement level. Governments, it is assumed, would be ill-advised to interfere with this natural process by trying to increase birth rates and then seek to fine-tune them at the desirable steady-state level. According to this view, a laisser-faire fertility policy is justified since, apart from broad upper and lower limits, governments are not competent to determine what constitutes an optimal fertility rate, or growth rate, or population size in any given year, decade, or even longer time interval.

Finally, even if the will were there, there is a paucity of effective pronatalist policy instruments. Exhortation from governments are not promising, and in any case unlikely to be tried in a democratic polity. Restrictions imposed on access to modern contraceptive technology are not politically acceptable; they would be also certain to prove a failure. This leaves the traditional levers of social policy: dispensing material incentives and disincentives so as to increase the willingness of couples to have children. Such incentives can be engineered by the government through fiscal measures, such as differential taxation, and/or through provision of services in kind. This approach was tried in the interwar years, but, as noted above, with at best limited success. After World War II many similar measures continued to be applied; in fact, with the steadily expanding welfare state, they were often upgraded and their scope, too, was extended. However, they were no longer considered "pronatalist" but were absorbed within the more encompassing frames of family and general welfare policy. The new label partly reflected a political-ideological preference, but in part also the fact that some distinctive features of pronatalism—such as differential rewards that favored large families, and non-means-tested or even regressive allocation of family and child benefits—were generally no longer acceptable.

Although the redistributive policies of the contemporary welfare state are biased in favor of the elderly and the poor, government-organized transfers to parents of children, or to children directly (such as through publicly financed day-care services and free or subsidized education often beyond the secondary school level, which lessen the cost of children to parents), are substantial in all low fertility countries. Indeed, it is typically assumed that existing family and welfare policies sustain fertility above a level that would ensue in their absence. Accordingly, making these policies more generous—socializing an even larger share of child costs—is often seen as a means toward increasing fertility, whether as an outright policy objective or, more in the prevailing spirit of the time, as an unintended but welcome by-product. Such extension, however, is difficult, given the fiscal constraints of already overcommitted welfare states. And more to the point, the net effect of family-friendly redistribution of incomes and provision of services is uncertain. It is notable that in the United States, where such schemes are distinctly less well funded than, for example, in Western Europe, fertility is, nevertheless, relatively high.

In recent decades, in modern industrial economies, participation of women in the formal labor force expanded rapidly. This tendency, reflecting market forces but also encouraged by government policy (partly as an antidote for deteriorating dependency ratios as the population becomes older), is likely to continue. Among the factors explaining the low level of fertility despite general material affluence, many observers point to the double burden on women of both raising children and working outside the home. To the extent that higher birth rates are seen to be socially desirable, the derived policy prescription is to adopt measures that make motherhood and women's labor force participation more compatible. The higher fertility in countries (notably in Scandinavia) where such measures are strongly applied, compared to countries (especially those in Southern Europe) where they are largely absent, suggests that enhanced compatibility (through day-care services, flexible work-hours, liberal sick-leave allowances, and the like) is an effective pronatalist policy even if motivated by other considerations. But it is far from clear whether the fertility differential so generated is high enough to bring the total fertility rate back to replacement level. Steady labor force participation of women during the childbearing years can certainly be made compatible with having one child or even two. It is likely to be far less compatible with sustaining, or even increasing, the proportion of women who have more than two children. Many career-oriented women voluntarily remain childless; many others prefer a single child. It follows that, to achieve average replacement-level fertility, the proportions of such women need to be counterbalanced by high enough proportions of women who have chosen third-, fourth-, or even higher-order births. There is little indication at present that policies directed at enhanced compatibility achieve that result.

When fertility is high, as it still is in most developing countries, it is a safe prediction that with economic development it will eventually decline, at least to replacement level. In the longer term, apart from outmigration, the only alternative is higher mortality. The record of the high-income countries indicates, however, that replacement level fertility is not a necessary resting point. Once fertility is lower than that, predictions become highly hazardous. European, and also East Asian experience suggests that fertility has a tendency to settle below an average of two children per woman, hence a tendency toward sustained population decline. The question, to which no good answers exist at the dawn of the twenty-first century, is "how far below?" "Scandinavian"-style family policies may stabilize fertility only modestly below replacement—such as around a total fertility rate of 1.8. That would imply a fairly moderate relative shortfall of births compared to deaths, and population stability in rich countries with such vital rates could be fully or nearly compensated with a modest level of controlled immigration. Population aging would be then kept within relatively narrow limits, which postindustrial economies could readily adjust to. The demographic weight of such countries within the global total in the foreseeable future would continue to shrink, raising possible problems of a shifting geopolitical balance. Still, such demographic configurations would be likely to push the day of demographic reckoning beyond the policy horizons that governments feel an obligation to be actively concerned with. Pronatalist interventions would find at best a marginal place on governments' policy agendas.

On the other hand, fertility levels in the lowest-fertility countries—countries with a total fertility rate of 1.3 or below around the turn of the century—might stabilize at that level, or even shrink further, reflecting the decentralized and uncoordinated decisions of individuals and individual couples. Such an outcome might also foreshadow future reproductive behavior in countries in which fertility is still fairly close to replacement level. This would create a qualitatively different demographic situation for which there are few precedents in modern history. It would represent a clear threat to the continuing viability of the countries affected. Compensatory immigration flows would have to be so large as to be inconsistent with any reasonable degree of cultural and ethnic continuity. Alternatively, population aging in the absence of immigration would create virtually unsolvable challenges, and there would be a likely drastic loss of relative geopolitical status. Spontaneous homeostatic mechanisms may not come into play to save the day, or may do so too sluggishly to matter. A radical rethinking of fertility policy would then become a necessity for social—and national—survival.

See also: *Eugenics; Family Policy; Immigration Policies; One-Child Policy; Reproductive Rights.*

BIBLIOGRAPHY

Bauer, P. T. 1981. *Equality, the Third World, and Economic Delusion.* Cambridge, MA: Harvard University Press.

Berelson, Bernard. 1969. "Beyond Family Planning." *Studies in Family Planning* No. 38.

Blake, Judith. 1972. "Coercive Pronatalism and American Population Policy." In U. S., Commission on Population Growth and the American Future, *Aspects of Population Growth Policy,* Vol VI of Commission research reports, pp. 85–109, ed. Robert Parke, Jr. and Charles F. Westoff. Washington, D.C.: Government Printing Office.

Bongaarts, John. 1994. "Population Policy Options in the Developing World." *Science* 263: 771–776.

Carr-Saunders, A. M. 1922. *The Population Problem: A Study in Human Evolution.* Oxford: Clarendon Press.

Cassen, Robert, and contributors. 1994. *Population and Development: Old Debates, New Conclusions.* Washington, D.C.: Overseas Development Council.

Casterline, John B., and Steven W. Sinding. 2000. "Unmet Need for Family Planning in Developing Countries and Implications for Population Policy." *Population and Development Review* 26: 691–723.

Chesnais, Jean-Claude. 1996. "Fertility, Family, and Social Policy in Contemporary Western Europe." *Population and Development Review* 22: 729–739.

Cross, Máire, and Sheila Perry, eds. 1997. *Population and Social Policy in France.* London and Washington: Pinter.

Davis, Kingsley. 1967. "Population Policy: Will Current Programs Succeed?" *Science* 158: 730–739.

Davis, Kingsley, Mikhail S. Bernstam, and Rita-Ricardo-Campbell, eds. 1987. *Below-Replacement Fertility in Industrial Societies: Causes, Consequences, Policies.* Cambridge: Cambridge University Press.

Demeny, Paul 1986. "Population and the Invisible Hand." *Demography* 23: 473–487.

———. 1988. "Social Science and Population Policy." *Population and Development Review* 14: 451–479.

———. 1992. "Policies Seeking a Reduction of High Fertility: A Case for the Demand Side." *Population and Development Review* 18: 321–332.

Donaldson, Peter J. 1990. *Nature Against Us: The United States and the World Population Crisis, 1965–1980.* Chapel Hill, NC: The University of North Carolina Press.

Finkle, Jason L., and Barbara B. Crane. 1975. "The Politics of Bucharest: Population, Development and the New International Economic Order." *Population and Development Review* 1: 87–114.

Finkle, Jason L., and C. Alison McIntosh, eds. 1994. *The New Politics of Population: Conflict and Consensus in Family Planning.* Supplement to Vol. 20 of *Population and Development Review.*

Glass, D. V. 1940. *Population: Policies and Movements in Europe.* Oxford: Clarendon Press.

Gwatkin, Davidson R. 1979. "Political Will and Family Planning: The Implications of India's Emergency Experience." *Population and Development Review* 5: 29–59.

Hardin, Garrett. 1968. "The Tragedy of the Commons." *Science* 162: 1,243–1,248.

Hartmann, Betsy. 1995. *Reproductive Rights and Wrongs: The Global Politics of Population Control,* Rev. edition. Boston: South End Press.

Hodgson, Dennis. 1983. "Demography as Social Science and Policy Science." *Population and Development Review* 9: 1–34.

Johansson, S. Ryan. 1991. "'Implicit' Policy and Fertility during Development." *Population and Development Review* 17: 377–414.

Lloyd, W. F. 1968 (1833). "Two Lectures on the Checks to Population." In *Lectures on Population, Value, Poor Laws and Rent.* New York: Augustus M. Kelley.

Mahler, Halfdan. 1992. "Our Next Forty Years." *People* 19: 3–6.

Malthus, T. R. 1820. *Principles of Political Economy.* London: John Murray.

McIntosh, C. Alison, and Jason L. Finkle. 1995. "The Cairo Conference on Population and Development: A New Paradigm?" *Population and Development Review* 21: 223–260.

McNicoll, Geoffrey. 1975. "Community-level Population Policy: An Exploration." *Population and Development Review* 1: 1–21.

———. 2001. "Government and Fertility in Transitional and Post-transitional Societies." *Population and Development Review* Supplement to vol. 27, pp. 129–159.

Myrdal, Alva. 1941. *Nation and Family: The Swedish Experiment in Democratic Family and Population Policy.* London: Routledge.

National Research Council. 1986. *Population Growth and Economic Development: Policy Questions.* Working Group on Population Growth and Economic Development. Committee on Population. Washington, D.C.: National Academy Press.

Olson, Mancur Jr. 1965. *The Logic of Collective Action.* Cambridge, MA: Harvard University Press.

Pfenning, Astrid, and Thomas Bahle, eds. 2000. *Families and Family Policies in Europe: Comparative Perspectives.* Frankfurt am Main: Peter Lang.

Pritchett, Lant H. 1994. "Desired Fertility and the Impact of Population Policies." *Population and Development Review* 20: 1–55.

Teitelbaum, Michael S., and Myron Weiner, eds. 1995. *Threatened Peoples, Threatened Borders: World Migration and U. S. Policy.* New York: W. W. Norton.

Teitelbaum, Michael S., and Jay M. Winter. 1985. *The Fear of Population Decline.* San Diego: Academic Press.

United Nations, Department of Economic and Social Affaires, Population Division. 1999. *Below Replacement Fertility. Population Bulletin of the United Nations.* Special Issue, Nos. 40/41.

———. 2001. *Replacement Migration: Is It a Solution to Declining and Ageing Populations?* New York: United Nations.

———. 2002. *National Population Policies 2001.* New York: United Nations.

United States National Academy of Sciences. 1971. *Rapid Population Growth: Consequences and Policy Implications.* Washington, D.C.: National Academy Press.

Warwick, Donald P. 1982. *Bitter Pills: Population Policies and Their Implementation in Eight Developing Countries.* New York: Cambridge University Press.

Winckler, Edwin A. 2002. "Chinese Reproductive Policy at the Turn of the Millennium: Dynamic Stability." *Population and Development Review* 28: 379–418.

PAUL DEMENY

POPULATION QUALITY

See *Quality of Population*

POPULATION REGISTERS

A population register, broadly interpreted, is a list of persons who belong to a predefined group, containing information identifying the members in a unique way. In that broad sense, a list of members of a club, union, or society could be called a population register if it contains some characteristics like name, address, and date of birth which (in combination) provide unique identifications.

In a more formal sense, the term population register denotes a list (register) of persons who are citizens or residents of (or in some other sense "belong to") a country or a sub-national region. That list typically includes each person's name, current address, and date of birth as an external identifier, and a personal identification number as an internal identifier. This identifier should be unique.

Brief History and Status

Population registers in the more formal sense of the term have been known for several centuries. The parish registers found in many European countries are an example. Local civil registers were established with the development of social security and similar programs at the end of the nineteenth century, when municipal and other authorities needed lists of persons under their responsibility. The demand for national registers intensified in northwest Europe after World War II, with the development of the welfare state. For some countries, that meant a fully centralized register; in others local registers were maintained but under central leadership and coordination (to ensure that every person was included in only one local register).

Since the 1960s, registers have normally been kept in an electronic format, at local and/or national level. This format makes for greater usefulness but is not a prerequisite for a well-functioning population register.

As of the 1990s, most European countries had some sort of population register, local or central or both, and assigned some kind of personal identification numbers. Ireland and Romania are exceptions. Aarno Laihonen's 1998 article provides an overview of the situation. Many less developed countries either already have some kind of population register or are planning to develop one. In Eastern Europe during the Communist period, population registers were used for control as well as administrative purposes, and the successor regimes for the most part have not maintained them. The U.S. lacks any sort of national population register.

The use of registers and identification numbers for statistical and analytical purposes, and the laws regulating this use, vary greatly by country. The Nordic states, the Netherlands, and Belgium have fully centralized registers available for analytical purposes. Israel and Slovenia have similar systems; Austria has one under development.

Content and Linking

The number and nature of variables included in a population register are determined by the political and administrative intention for use. The normal identifiers are name, date of birth, and sex; marital status is recorded; information on children and family may be included, and in some countries, ethnic group. Address or locality information makes it possible to combine regional registers or integrate them at the national level. Some registers on principle include as little information as possible, to avoid items that change frequently. Sex, age, marital status, and a numerical identifier are probably the minimum for a basic register. Other registers that may be linked to it would include the variables needed for specific purposes, like address, births, or co-residence. A register with such variables will have to be updated often.

The key determinant of the ease of use of a register is whether or not it assigns a personal identification number (PIN-code) to each name. Such a number is typically made up of digits indicating date of birth and a sequence number, a code for sex, and one or more control digits. The encoded information should not, of course, include items than may change.

Use of PIN-codes makes it easy to link information from different registers, so the content of any particular register is less important. The variables in the whole cluster of registers can be used simultaneously. For example, in the 2001 Norwegian census about 30 registers were combined.

Where two or more registers of the same population can be linked, the system of registers permits refined analysis of population processes in combination with a broad range of covariates (Aukrust and Nordbotten (1973), Statistics Denmark (1995)). Indeed, linked systems are like social and demographic surveys, but without the surveys' response problems and sampling errors. Ideally, a register keeps a record of all previous variable values, along with the date of change. This is important for historical studies and for longitudinal micro-level analyses with time-varying covariates.

Administrative Registers

Population registers belong to a broader family of administrative registers. These may be numerous, often including employment and unemployment registers, income registers, social security registers, registers of criminality, education registers, etc. Because they are established and run for administrative purposes, their content may not always be well-suited for scientific purposes. For instance, analysts of internal migration may prefer a different definition of place of residence than the one used by tax authorities. However, both the responsible authorities and the researchers share a common interest in appropriate definitions and timely updating.

Quality Aspects

The main advantage of an administrative register is quality. A register run for purely statistical or scientific purposes, can seldom keep high enough quality. Those registered will not have serious interests in informing the register about every change of status. An administrative register is often linked to, and uses administrative routines, which also can be used for controlling the register content. It will often be in the interest of both the registered persons and the users to keep the register correct. Neither register users nor the registered persons can accept that important decisions are based on registers with wrong information. Frequent use increases the possibility to detect mistakes.

A population register adds persons at birth or at entry and deletes them at death or departure. Coverage problems mainly concern migration. There may be a strong personal interest in not having a correct register status. In Scandinavia, however, there are probably more persons (but still below one percent of the total population) who have left the country without notification than are persons living there illegally. Remaining clandestinely in highly regulated countries like the Nordic states without being registered is very difficult.

Internal migration causes particular problems for local registers, due to delayed or completely missing migration notifications. Moreover, for researchers, the rules for registration of place of residence may be ill-suited to demographic analysis. The more actively the register cooperates with other institutions (mail and telephone systems, electricity, schools, health care, etc.), the better its quality.

Statistics based on population registers share some of the same problems as those based on sample surveys. Persons who want to hide themselves or their characteristics will probably not be better covered by sample surveys than by registers. The two sources can, however, be combined. Registers can be used as a sampling frame for a survey, or certain pieces of information can be taken from the register instead of bothering the respondent. In addition, having a register linked to a survey allows survey non-response to be properly analyzed; whereas in a register-based system non-response is virtually non-existent. If variables needed for some purpose are not included in the register, or included with unacceptable definitions, sample surveys or other direct methods of data collection may be necessary.

Data Protection and Privacy

Linking of registers provides information of potentially great value to government, but also great potential for misuse. The same is true for social scientist users of these data. In both cases, confidentiality and protection of privacy have to be properly taken care of. Virtually every country with register systems that allow linking has a Data Surveillance Authority or equivalent agency with the aim of strict enforcement of privacy requirements. These usually specify that information should never be available for identifiable persons; individual data are to be available only for making statistical tables or estimates. In Europe, this work is regulated by the European Union (EU 1995).

See also: *Census; Data Collection, Ethical Issues in; Demographic Surveillance Systems; Family Reconstitution; State and Local Government Demography; Vital Statistics.*

BIBLIOGRAPHY

Aukrust, Odd, and Svein Nordbotten. 1973. "Files of Individual Data and their Potentials for Social Research." *Review of Income and Wealth* 19(2): 189–201.

European Union (1995): Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on free movement of such data. Brussels, Belgium.

Laihonen, Aarno, Ib Thomsen, Elisabetta Vassenden, and Britt Laberg. 1998. *Final Report from the Development Project in the EEA: Reducing Costs of Censuses through use of Administrative Registers.* Documents 98/1. Oslo: Statistics Norway.

Statistics Denmark. 1995. *Statistics on Persons in Denmark.* ECSC-EC-EAEC. Brussels-Luxembourg.

LARS ØSTBY

POPULATION THOUGHT, CONTEMPORARY

Population thought is the body of work that reflects on the causes and consequences of demographic change. Drawing on studies whose aim is to analyze population trends accurately, it primarily includes works that specify the problematic nature of population trends and works that attempt to induce desired population trends. Individuals with a concern about population, a group far broader than academic demographers, have produced the bulk of twentieth-century population thought so defined.

During the twentieth century most countries have experienced dramatic changes in both the number and the composition of their populations. Many observers have judged that these demographic changes have made the accomplishment of a variety of goals more difficult, whether enhancing national power, maintaining ethnic or cultural hegemony, improving the economy, preserving the environment, or attaining gender equity. These observers have produced a stream of policy-oriented works that highlight an assortment of population problems and argue for a variety of population policies. A chronological treatment of contemporary population thought therefore largely reflects the changing concerns of twentieth-century policymakers.

Academic analyses of twentieth-century population trends both reflected current population concerns and influenced the development of population thought. Demography as an activity has historically contained elements both of a social science and a policy science, and demographers have been motivated both by a desire to understand population trends and a desire to influence them. For instance, the worrisomely low fertility evident throughout much of Europe and the United States during the 1930s clearly influenced the Italian demographer Corrado Gini (1884–1965), who developed a cyclical theory of the rise and fall of population, and the French demographer Alfred Sauvy (1898–1990), who adopted a life-long anti-Malthusianism and a concern for population aging and decline, and the American economist Joseph J. Spengler, who contended that children had become "commodities" like "automobiles" that only would be produced in greater numbers by applying "the economic principles of price." After the baby boom made its appearance during the 1950s the American economists

Gary Becker and Harvey Leibenstein (1922–1994) actually viewed children as a special kind of commodity and elaborated a "new home economics," a key component of which was a sophisticated micro-economic model of fertility. The economist Richard Easterlin, studying the long swings in the growth of population and the economy uncovered by the economist Simon Kuznets (1901–1985), produced a macro-economic explanation of developed societies' fertility trends that focused on the influence played by shifts in cohort sizes over time.

At mid-century, though, rapid population growth in the less developed world attracted the most attention from academic demographers. Frank Notestein (1902–1983) was so alarmed by this population crisis that he left his position as director of Princeton University's Office of Population Research and became president of the Population Council. The Princeton economist Ansley J. Coale (1917–2002) helped convince world leaders of the need for fertility control programs by specifying the economic consequences of rapid population growth. The American demographer Donald Bogue even called for the establishment of a new discipline of family planning research that would have the explicit goal of lowering fertility. Not all academic demographers adopted a neo-Malthusian stance. Alfred Sauvy was a voice of skepticism, and the Danish economist Ester Boserup (1910–1999) argued that increases in population densities historically had been the chief stimulus to the adoption of more productive agricultural methods. The American sociologist Kingsley Davis (1908–1997), believing that a society's fertility level was the result of complex institutional arrangements within its social system, doubted that high fertility could be easily lowered by simply providing individuals with contraceptives. Later in the century Ron Lesthaeghe would take a similar position when examining the potential of increasing the below-replacement fertility of European countries. The American demographer Ronald Freedman and the Australian demographer John C. Caldwell, while believing that fertility levels were largely determined by socio-cultural factors, contended that government policy initiatives to influence fertility ought, themselves, to be considered significant components of the socio-cultural determinants of fertility. Clearly, academic demographers actively participated in twentieth century population debates and both reflected and helped to mold the broader stream of population thought.

The Goal of Population Thought

Twentieth-century students of population had an overarching disciplinary goal: to summarize accurately the mortality and fertility transitions that accompanied the agricultural, industrial, and political revolutions of the modern era and predict their future course. Their analyses more often than not aroused the concern of policymakers. The provisional nature of demographic knowledge played a role in this process, as did the tendency to project trends to the point where problems would be produced. For instance, as the twentieth century began, students of population were attempting to make sense of a number of demographic trends. What was most notable to Walter Willcox (1861–1964) in 1906 was the "enormous" increase in the world's population from 1 billion in 1750 to 1.5 billion in 1900. Willcox attributed almost the entire increase to the "expansion of Europe" as increased agricultural and industrial productivity brought death rates down both in Europe and in "Europe overseas." He did note, however, that fertility had begun to decline throughout most of that of region and predicted that it would continue to do so.

Causes of Fertility Decline

What captured the attention of Western policymakers were not descriptions of 150 years of substantial population growth but instead predictions of continued fertility decline. By the turn of the twentieth century a consensus had emerged among students of population that fertility decline was due to individuals voluntarily controlling their fertility in response to pressures created by changing economic and social conditions. As Arsène Dumont (1849–1902) posited in his 1890 "social capillarity theory," individuals attempting to improve their social position in increasingly stratified societies had come to view children as encumbrances. They therefore lowered their fertility rate to improve their chances of upward mobility.

Statistics on fertility differentials by class, education, and occupation were just beginning to be compiled in the early 1900s, and the trends they revealed worried the elites. In the United States the sons and daughters of New England's oldest families were delaying and forgoing marriage to such an extent that as the century began, their fertility was barely at replacement levels. President Theodore Roosevelt railed against such "race suicide" and declared that "the greatest problem of civilization is to be found in the fact that the well-to-do families tend to die out; there results, in consequence, a tendency to the elimination instead of the survival of the fittest"(Roosevelt, p. 550).

The Social Darwinist Perspective

The social Darwinist belief that competition and natural selection produce beneficial change within human societies had become nearly universal among the educated in the late nineteenth and early twentieth centuries. When they used social class and race as surrogate measures of biological quality, as they were inclined to do, differential fertility assumed supreme importance. In the United States the declining fertility of old-line Americans and the influx of prolific and presumedly "inferior" peoples from southern and eastern Europe came to be viewed as a national catastrophe, a "degradation" of the race.

One policy response to this crisis was the passage in the 1920s of national origin quota acts that severely restricted the entry of supposedly "inferior" immigrant groups. During the first third of the twentieth century many Western nations also passed laws requiring the sterilization of various "defective" groups. In Germany eugenic attempts at race purification eventually led to the implementation of Nazi selective breeding programs and campaigns to eradicate undesired minorities.

The Neo-Malthusian Movement

Early in the twentieth century a neo-Malthusian movement had a very different perspective on fertility decline. Neo-Malthusians believed that growing populations are a major cause of poverty and that lowering fertility by making contraception more accessible facilitates prosperity. The movement originated in Great Britain early in the nineteenth century and had spread throughout Europe by 1900, when the first International Neo-Malthusian Conference was held in Paris.

The Eugenicist and Birth Control Perspectives

By 1900, however, much of the initial concern about population growth had dissipated as fertility decline spread throughout Europe. Neo-Malthusians might praise fertility decline and contraception, but eugenists successfully fought to restrict access to contraceptives, contending that their use harmed the commonwealth since only the "more fit" classes were sufficiently disciplined to use them. Into the fray stepped Emma Goldman (1869–1940), Margaret Sanger (1883–1966), and Marie Stopes (1880–1958), seeking to establish feminist-oriented "birth control" movements in the United States and Great Britain. During a period when high-ranking politicians were publicly reminding educated women of their patriotic duty to marry and have children, these advocates of birth control began mobilizing citizens to legalize a woman's access to contraception.

With most academic population experts at the time siding with the eugenists, advocates of birth control had to work hard to develop convincing counterarguments proving that legalized contraception would be socially beneficial. Margaret Sanger was the most successful, fashioning a case for a woman's right to access to birth control by deftly weaving together eugenic and neo-Malthusian themes: Restrictive laws could not keep contraception out the hands of the educated classes and only served to slow the adoption of birth control among the less motivated "inferior" classes, an adoption that would benefit both the individual and the society.

The Pronatalist Position

Fertility decline did spread throughout the classes in many Western populations during the 1910s and 1920s, even in places where access to contraceptives was legally restricted. It reached such a high level that fears of actual depopulation developed, and with them a backlash against the birth controllers' message. France, for example, had an active birth control movement in the early twentieth century, the production and sale of contraceptives were legal, and the national fertility level was low. After the devastating military losses of World War I, however, worry grew among French leaders over what population decline might mean for the nation's competitiveness.

In 1920 the French government, advised and aided by French population experts, enacted a strongly pronatalist population policy that sought to encourage fertility through a combination of positive programs that enhanced couples' ability to care for children and repressive programs that limited couples' access to contraceptives and abortion. The law of February 13, 1920, made manufacturing, selling, or advocating the use of contraceptives illegal, punishable by fines or imprisonment. The French birth control movement found itself under a systematic attack and without much public support.

In the United States Louis Dublin (1882–1969) and Alfred Lotka (1880–1949) developed "intrinsic" vital rates that controlled for the influence of the age structure on crude birth rates and dramatically announced that the average American woman in 1920 was having only half a child more than was needed to maintain a stationary population. P. K. Whelpton (1893–1964) devised the cohort-component method of population projection in 1928 and forecast a significant slowdown in U.S. population growth. Dublin followed with a call for more "birth release" and less "birth control." U.S. leaders began worrying less about declining population quality and more about declining numbers.

The Effects of Fertility Decline

By 1930 a number of Western countries had ended their modern period of population expansion as their fertility rates reached the low levels already achieved by their mortality rates. At that time students of population in the United States (Warren Thompson [1887–1973]), France (Adolphe Landry [1874–1956]), and Great Britain (A. M. Carr-Saunders [1886–1966]) brought forth very similar summations of modern population dynamics.

Generalizing from the Western experience, they all contended that a shift from high to low vital rates was associated with the transformation of agrarian societies into industrial societies. Because mortality declined earlier and more quickly than did fertility, a period of population growth accompanied the shift. The United States and Western Europe had already experienced this "demographic revolution," eastern and southern Europe and Japan were in the middle of their expansion stage, and much of the rest of the world had just begun the revolution.

This summary of modern population dynamics, which reemerged after World War II as demographic transition theory, represented a great achievement for academic demographers. However, its appearance in the 1930s proved troublesome. Germany and Japan both were engaged in imperialist moves into their neighbors' lands that they claimed were necessitated by their growing populations. Western policymakers rejected the legitimacy of such moves. They also largely ignored these early transition treatments of modern population movements that seemingly imparted scientific legitimacy to such *lebensraum* rationales for Axis expansionism.

In general, the 1930s was a period when nationalistic chauvinism made any examination of international population trends controversial. The International Union for the Scientific Investigation of Population Problems (IUSIPP), launched in 1928, planned to hold its first meeting in Rome in 1931. Hints that the meeting would be used to promulgate Mussolini's racial theories caused the IUSIPP's leadership to convene a hastily planned counter-conference in London. The IUSIPP's next official meeting was held in Berlin in 1935, and several national committees that correctly feared that it would be used to spread Nazi racial theories boycotted that meeting.

Postwar Developments

Among countries engaged in World War II older mercantilist notions that equated larger populations with enhanced state power tended to reemerge immediately after entry into the conflict and to remain in place until the war ended. The period after World War II was one of dramatic change in both population trends and population concerns. The unexpected baby boom that occurred in many Western low-growth populations ended fears of depopulation. The enormity of the Holocaust dissipated any remaining enthusiasm for eugenics. The removal of German and Japanese military threats broke the association between transition accounts of modern population dynamics and population-pressure rationales for territorial expansion. In fact, the transition framework in the postwar world was a valuable tool for Western policymakers, serving as a way to interpret the unprecedented demographic changes arising in the world's "underdeveloped" regions during the 1950s and 1960s.

The use of newly developed antibiotics and the application of effective methods for eliminating malaria produced unprecedented mortality decline throughout much of the "Third World," an entity engendered by postwar decolonization. The resultant rapid population growth was problematic for both political and demographic reasons. From the perspective of postwar versions of demographic transition theory put forward by population experts working at Princeton's Office of Population Research, the economic strains associated with rapid population growth might prevent the transformation of traditional agrarian societies into modern industrial societies. Rapid population growth in the Third World might forestall the very socioeconomic changes—industrialization and urbanization—that would induce fertility decline and complete the demographic transition. Without fertility decline, the Third World's period of population expansion would come to an end with mortality rising as starvation and disease increased.

The Populating Dilemma of the Third World

Politically, the Third World was a Cold War battleground where the United States and the Soviet Union fought for supremacy. Starvation, economic stagnation, and growing poverty were judged to be propitious for the spread of communism. There appeared to be only one way to humanely resolve the Third World's emerging population dilemma and, incidentally, the geopolitical threat to the free world: inducing fertility decline in societies that were still agrarian.

American population experts expounded this vision of the postwar global population situation, and by the early 1950s, John D. Rockefeller 3rd and the leadership of the Ford and Rockefeller foundations had accepted its validity. They began establishing a neo-Malthusian movement with a global focus. Their goal was to lower fertility and lessen population growth throughout the Third World by setting up family planning programs. They recognized that only governments could implement effective family planning programs, and their immediate task became to convince policymakers in both the First World and the Third World that high fertility was a major social problem that required state intervention.

At first the population crisis appeared to be a peculiarly "Asiatic problem" to those foundations. Would food and natural resource supplies be adequate to feed, clothe, and shelter increasingly large and dense populations? By the end of the 1950s, however, the crisis had grown in their minds to include all countries with high population growth rates. Any population with a 3 percent annual rate of growth of its population would need an equally high rate of growth in the economy simply to assure that its current standard of living would not slip even lower and a much higher rate to experience significant economic development. Simulation models to quantify the economic benefits of lowering fertility were developed. They found the benefits to be substantial, and movement advocates used those findings to persuade many Third World leaders to adopt antinatalist policies.

Opposition to Neo-Malthusianism

There were voices in opposition to this global neo-Malthusian movement. At the first United Nations-sponsored population conference, which was held in Rome in 1954, the Soviet delegation presented a Marxist critique: Poverty and lack of development were caused by imperialism and colonialism, not population growth. In France a long-standing pronatalist tradition among demographers and government leaders produced skepticism about the validity of neo-Malthusian precepts. Many Third World leaders, especially in low-population-density regions of Latin America and Africa, believed that population growth would aid their countries' development, not detract from it. Finally, the Roman Catholic Church strongly objected to neo-Malthusians' advocacy of "artificial" birth control. With the development of new nonbarrier contraceptives in the late 1950s, especially the birth control pill and the intrauterine device, neo-Malthusians hoped that Catholic opposition might end, but Pope Paul VI's 1968 encyclical on the regulation of birth, *Humanae Vitae,* contained no change in the church's position even though it recognized the existence of a "population problem."

The Neo-Malthusian Movement in the 1960s and 1970s

In the 1960s the global neo-Malthusian movement developed deeper roots among First World policymakers and the public, especially in the United States. In 1965 the U.S. government, at the direction of President Lyndon Johnson, began offering family-planning aid to developing countries and quickly became the major source of such funds. In 1968 Paul Ehrlich published a neo-Malthusian tract, *The Population Bomb,* that sold over 3 million copies. In the same year Zero Population Growth was founded, an organization committed to bringing about global population stabilization; within three years its membership had exceeded 30,000. The Commission on Population Growth and the American Future, established by U.S. President Richard Nixon, issued a 1972 report advocating population stabilization for the United States itself.

A somewhat different course of events, however, was occurring in the Third World. Beginning in the mid-1960s, a variety of First World institutions began pressuring Third World governments to adopt population control policies. Family-planning programs were one activity for which Third World governments could easily find First World monetary support. Such advocacy produced a growing list of leaders who nominally endorsed the need for population control, but those leaders were suspicious of the donors' motives. This ambivalence was evident at the 1974 United Nations World Population Conference held in Bucharest. Delegates from Third World countries refused to ratify a proposed plan of action that called for a united global effort to lower fertility. They countered that "development is the best contraceptive" and called for a "new international economic order" that would entail a redistribution of global power and wealth. If First World governments wished to slow Third World population growth, they should do so by appropriating the significant funds needed to foster comprehensive development, not the modest funds needed to establish family planning clinics.

The conference finally adopted a developmentalist plan of action, although the implementation of the plan after the conference was not without ironies. Although developmentalist rhetoric became obligatory among movement population experts, the Third World countries that led the developmentalist fight at Bucharest, India and China, proceeded to implement coercive "beyond family planning" fertility control programs at home, indicating a deep acceptance of neo-Malthusian precepts that belied their rhetoric at the conference. Accounts of Indian teenagers being forcibly given vasectomies and Chinese women, seven months pregnant, being badgered into accepting abortions would help fracture what had been solid U.S. government support for the neo-Malthusian agenda. After the U.S. Supreme Court's 1973 *Roe v. Wade* decision legalizing abortion, right-to-life advocates began mobilizing around a conservative reproductive agenda and skillfully used those accounts to further their efforts.

During the decade that followed the 1974 conference the neo-Malthusian movement experienced some advances: Family-planning programs expanded their range, communist opposition to neo-Malthusianism lessened considerably, and significant fertility decline occurred in much of the Third World. However, there also were setbacks: Public alarm over the "population bomb" diminished, and the movement's major private sources of funds, the Rockefeller and Ford foundations, significantly reduced their allocations for population-related work. Although the U.S. Congress steadily increased funding for international family planning programs, the media attention paid to coercive fertility control efforts, especially those employing abortion, made American politicians hesitant about offering unqualified support for population control.

The 1980s

Abortion politics eventually fueled a dramatic reversal in U.S. population policy with Ronald Reagan's election as an anti-abortion president. In 1984, a reelection year for Reagan, another United Nations conference on population was to be held in Mexico City. Anti-abortion social conservatives would interpret any talk of population problems by Reagan-appointed delegates as justification for abortion and state-mandated contraception.

Motivated by domestic politics, Reagan appointed U.S. conference delegates who declared that there was no international population problem, only an international abortion problem. They voted with the Vatican to amend that conference's plan of action to prohibit the promotion of abortion "as a method of family planning" and used the occasion to announce a new U.S. "Mexico City policy" aimed at curtailing the global spread of abortion. Julian Simon (1932–1998), an American economist, had written several "revisionist" works that questioned Malthusian assertions about the deleterious effect of rapid population growth on countries' economic development efforts, going so far as to argue that population growth stimulates economic growth. U.S. delegates adopted his revisionist thought to justify their dismissal of a population problem.

Concern over global population growth continued to lessen as the 1980s progressed. Population growth was decreasing, the Cold War ended, and many of the northern countries' political fears surrounding population growth dissipated. Moderate revisionist thought became more respectable as a 1986 study by the U.S. National Academy of Sciences concluded that any deleterious of effect of population growth on development was modest.

The 1990s

The global neo-Malthusian movement reacted to declining interest in its agenda by pragmatically looking for new issues and allies. The environmental movement seemed to be an obvious source for both.

One branch of the movement had begun emphasizing the need for developing countries to direct their development efforts away from maximizing economic growth and toward achieving "sustainable development," a key element of which was curbing population growth. However, these efforts to rejuvenate the neo-Malthusian movement by giving it an environmental focus provoked opposition. At the 1992 United Nations Conference on Environment and Development held in Rio de Janeiro a number of factions, chief among which were delegates from the southern countries and feminists, objected vigorously to considering population a significant cause of environmental degradation. Overconsumption by the rich, not the prolific reproduction of the poor, was the cause of environmental problems. The final Rio Declaration on the environment and development contained only an oblique mention of population.

The 1990s began with an international population agenda that had lost its clear neo-Malthusian focus. At the 1994 United Nations Conference on Population and Development in Cairo a new feminist-oriented population agenda made its debut. Despite a long feminist tradition of viewing all population policies as inherently coercive toward women, a group of reproductive health feminists united with what remained of the neo-Malthusian establishment to form a "common ground" alliance. The program of action adopted at Cairo embodied its major terms: Redressing gender inequities is needed for lasting fertility control, and women have reproductive rights to determine their reproductive destinies. With surprisingly few reservations delegates endorsed this essentially feminist agenda. Countries pledged themselves to eliminate social, cultural, political, and economic discrimination against women as the central component of an effort to balance population and available resources.

The Twenty-first Century

At the start of the twenty-first century most policymakers and population experts assumed that nearly every population would complete its mortality and fertility transitions, most likely by mid-century. Already a commonality of population trends is present: population aging in nearly every region, below-replacement fertility in much of the North, and declining population growth in much of the South. These trends are producing a new set of population concerns. In countries with extremely low fertility questions exist about the ability of the working-age population to provide adequately for the growing elderly population, and many people wonder if economic prosperity is possible with a declining population. Unlike the case a century earlier, no state is likely to restrict access to contraception as part of its pronatalist policy; such an affront to women's reproductive rights would no longer be tolerated.

More states are offering monetary inducements to spur childbearing, but the efficacy of such policies is unclear. "Replacement immigration"—filling the void left by declining native births by accepting migrants from countries with surplus populations— is being discussed seriously, but opposition to this strategy is strong. In Europe the compositional concerns of a hundred years ago are reemerging in public debates over whether an Algerian, a Turk, or a Pakistani can be "French," "German" or "British." Which concern—declining numbers or changing composition—will prove more influential in shaping tomorrow's population policy is unclear. Population thought, however, will continue to evolve as the proponents of each position make their cases.

See also: *Becker, Gary S.; Caldwell, John C.; Conferences, International Population; Davis, Kingsley; Demographic Transition; Demography, History of; Ecological Perspectives on Population; Eugenics; Landry, Adolphe; Lebensraum; Notestein, Frank W.; Sanger, Margaret; Sauvy, Alfred; Simon, Julian L.; Thompson, Warren S.*

BIBLIOGRAPHY

Becker, Gary. 1960. "An Economic Analysis of Fertility." In *Demographic and Economic Change in Developed Countries.* National Bureau of Economic Research. Princeton, NJ: Princeton University Press.

Boserup, Ester. 1965. *The Conditions of Agricultural Growth; The Economics of Agrarian Change under Population Pressure.* Chicago: Aldine Publishing.

Caldwell, John C. 1976. "Toward a Restatement of Demographic Transition Theory." *Population and Development Review* 2(3/4): 321–366.

Carr-Saunders, A. M. 1936. *World population.* Oxford: Clarendon Press.

Coale, Ansley J., and Edgar M. Hoover. 1958. *Population Growth and Economic Development in Low-income Countries: A Case Study of India's*

Prospects. Princeton, NJ: Princeton University Press.

Dublin, Louis, and Alfred Lotka. 1925. "On the True Rate of Natural Increase." *Journal of the American Statistical Association* 20(150): 305–339.

Dumont, Arsène. 1890. *Depopulation et civilisation: étude démographique.* Paris: Lecrosnier et Babe.

Ehrlich, Paul. 1968. *The Population Bomb.* NY: Ballantine Books.

Gini, Corrado. 1930. "The Cyclical Rise and Fall of Population." In *Population,* ed. Corrado Gini et al. Chicago: University of Chicago Press.

Goldman, Emma. 1916. "The Social Aspects of Birth Control." *Mother Earth* 11(12): 468–475.

Landry, Adolphe. 1934. *La révolution démographique; études et essais sur les problèmes de la population.* Paris: Sirey.

Lesthaeghe, Ron. 1980. "On the Social Control of Human Reproduction." *Population and Development Review* 6(4): 527–548.

National Research Council. 1986. *Population Growth and Economic Development: Policy Questions.* Washington, D.C.: National Academy Press.

Roosevelt, Theodore. 1907. "A Letter from President Roosevelt on Race Suicide." *American Monthly Review of Reviews* 35(5): 550–551.

Sanger, Margaret. 1919. "Birth Control and Racial Betterment." *Birth Control Review* 3(2): 11–12.

Sauvy, Alfred. 1969. *General Theory of Population,* trans. Christophe Campos. New York: Basic Books.

Simon, Julian. 1981, 1996. *The Ultimate Resource.* Princeton, NJ: Princeton University Press.

Spengler, Joseph J. 1932. "The Birth Rate — Potential Dynamite." *Scribner's Magazine* 92 (July): 6–12.

Stopes, Marie. *Contraception (Birth Control) Its Theory, History and Practice: A Manual for the Medical and Legal Professions.* London: J. Bale, Sons & Danielsson.

Thompson, Warren S. 1929. "Population." *American Journal of Sociology* 34(6): 959–975.

U.S. Commission on Population Growth and the American Future. 1972. *Final Report.* Washington, D.C.: U.S. Commission on Population Growth and the American Future.

Whelpton, P. K. 1928. "Population of the United States, 1925 to 1975." *American Journal of Sociology* 34(2): 253–270.

Willcox, Walter. 1906. "The Expansion of Europe and Its Influence upon Population." In *Studies in Philosophy and Psychology.* NY: Houghton Mifflin.

Dennis Hodgson

POPULATION THOUGHT, HISTORY OF

This article discusses European thinking on human population from the early modern period to the end of the nineteenth century. Later developments are treated in the article entitled "Population Thought, Contemporary."

European traditions of population thought began to take their definitive modern form in the sixteenth and seventeenth centuries. Some components that came together to bring about this transformation had much longer histories. Rudimentary census lists, for example, appear in Egypt as early as the eleventh century B.C.E.; developed subsequently in many places, their use remained no more than an adjunct of taxation and conscription for nearly three millennia. Reasoned accounts of population size and growth appear in treatises on government as early as the fourth century B.C.E. Plato and Aristotle, observing that republics and monarchies differ in their aims and capacities, argued that each type of government has an optimum population size. They proposed, in other words, that means used to regulate human numbers should be consistent with moral and political systems. By the Middle Ages, systematic theology carried this a step further. Theologists of the time argued that population size and growth can only be influenced by humans in accordance with God-given laws of nature (*lex naturalis*). As divine law cannot be apprehended directly, the role of the Church is to interpret scriptural evidence (*lex divina*) so that princes may rule legitimately (*lex civilis*). In this doctrine, the divine right of kings determines population movements either directly by policies of war, colonization, and trade, or indirectly by provoking divine judgment (epidemics, infertility, famines).

The Church's claim to sole authority collapsed in the sixteenth century, but the quest for a cohesive system uniting natural principles and human government remained. With the Reformation, the competition of religions undermined the supposed natural and divine legitimacy of kings. The foundations of human society and government could begin to be located more directly in the population of a state as a whole, or in ideas of natural law binding a ruler to the people. Humanist writers from Niccolo Machiavelli (1469–1527) to Thomas Hobbes (1588–1679) took a crucial step: in different ways, they faced up to the realpolitik that states often do not act in conformity with morality and nature. In their search for principles of effective and legitimate government, population obtained a twofold, generative, role and became integral to the modern theory of the state. First, population came to be seen as the natural source of a state's power in the sense that human fecundity produces the people that are the source of productive energies for all purposes; and second, a population was understood as the collective entity of individuals and groups whose interaction generates a political and moral community. In this view, power no longer resides in the natural and divine sanctions a prince imposes on his subjects, but in the members of that population acting individually and collectively. The quest for principles of legitimate government and conformity with nature thus converged on the problem of how to control, or at least manage, the generative capacities inherent in a population. Put another way, the relative greatness of states—including the size and growth of their population—depends on effective membership: whether people act (or can be constrained to act) cohesively.

An important point in sixteenth- and seventeenth-century writings was that the generative capacities of population are not necessarily positive, especially as they may lead to conflict. On one hand, larger, more populous states may decimate smaller ones. On the other, a large population does not necessarily make for a secure state. People commonly differ in their actions and interests. A governing elite composed of competing nobles, and sometimes merchant families, will form shifting alliances, each able to draw on a wider multitude of common people. Such competing memberships were difficult to control in a large population and, as Machiavelli observed, usually tended toward dissent and sedition. Internal struggles acted, in turn, as a drain on the exchequer. Hence states, even when well-endowed with people and other natural resources, could be defeated in war and surpassed in trade by less-endowed but more cohesive neighbors.

As princes turned to merchants for loans, an active body of mercantilist writings grew up. These writings urged that deficient state revenues could be made good only where policies promoted trade. Mercantilist writers argued that the greatness of states depends on a large population, and governments could achieve this by encouraging people into occupations and places where greater profits could be made. Trade would then flourish and growth would be sustained as more land came into cultivation, producing more raw materials for manufacture, raising merchants' profits, employment, and tax revenues. Once again, the size and growth of a population depend on how well its members are ordered: The second generative role of population takes priority over the first.

An important implication of this priority was that bad government was itself a major check on population. Where princes were badly advised, weak, or corrupt, people would feel insecure, and conflicts would inevitably ensue. Members would form themselves into opposing factions, or ally themselves with other states. Even authors sympathetic to republics like Jean Bodin (1530–1596), Hobbes, Machiavelli, and Charles de Secondat baron de Montesquieu (1689–1755) regarded a just sovereign or prince as best able to direct people's conflicting capacities. The idea that the generative powers of population and its growth are never entirely within princely control here became an important argument against tyranny. Rulers must attend justly to the needs of the population, otherwise the population will not grow and may even decline. Where, in contrast, a sovereign's rule was acceptable, then positive effects of cohesive membership would come to the fore. Merchant, political, and religious arguments agreed, advising princes to promote population growth by inducements to marriage, procreation, immigration, increased production and trade, and justice ensuring continued loyalty. But Giovanni Botero (1540–1617) speculated that in such circumstances there could conceivably be too many people relative to subsistence.

The Emergence of Population Arithmetic

One of the far-reaching changes induced by early modern reflection on population membership was the altered role of measurement. The need to recognize the members of a population and, if possible, control their aggregate dynamics made more systematic knowledge of human numbers desirable, and stimulated lines of questioning leading far beyond the ancient problems of raising armies and state revenue. Humanist and scientific developments were closely allied in the sixteenth and seventeenth centuries, opening the order of nature to question by direct, numerical observation. These developments were synthesized in Francis Bacon's (1561–1626) influential program for the systematic reform of knowledge. Methods of scientific observation were not, however, considered directly applicable to problems of government until the first essay in "population arithmetic," John Graunt's (1620–1674) *Natural and Political Observations* (1662). Graunt's work, written explicitly to carry out Bacon's program, showed how merchant accounting arithmetic could be combined with direct observation and the humanist methodology of language and rhetoric to develop a natural history of populations. Scientific approaches to population begin with Graunt, and his candor and critical approach to the quality of quantitative evidence are still considered outstanding. Many fundamentals of population research were treated cohesively and quantitatively by Graunt for the first time, including ratios of births, deaths, and sexes, the structuring of a population by age, urban and rural differences, proportionate changes over time in causes of death, and possible implications of all of these factors for the greatness of states.

For Graunt, scientific measurement belonged to natural history, but its applications embraced policy. The order of nature is intrinsically mathematical, and recurring balances in human numbers belong to this order. This approach enabled his political framework to remain outwardly conventional: population arithmetic, by revealing proportions and disproportions in the members of the body politic, would help princes to rule in conformity with natural and divine balances. Graunt also made clear, however, that population policy is not solely for princes to decide: His method showed pointedly how all readers may make calculations of their own. Rulers and citizens alike were thus enjoined to examine evidence of the quantitative impact of epidemics, the implications of unhealthy urban conditions for reproduction, and other problems of personal and collective concern. This evidence could be used to identify problems needing good government, and to ascertain whether a prince's policies really did anything to help people. For the first time, the search for unifying principles of legitimate government and laws of nature was posed in terms of sustained numerical observation and analysis.

Population arithmetic was not, however, integrated easily into government or daily life. The attitudes of the *ancien régime,* or of European government generally before the end of the eighteenth century, stressed deference to hereditary rights and the divine basis of monarchy, both strongly backed by religious teaching. This attitude prevailed in the eighteenth century, and in many places well into the nineteenth. Princes, while often conscious of the need to improve institutional capacities of government, remained wary of the implications of population arithmetic. Vital data were sensitive, as they indicated the capacities of states and the efficacy of governments. Where states made sustained attempts to collect these data, as in Prussia, Sweden, and France, access to the results was restricted.

Graunt's persuasive rationale nonetheless enabled individuals' quantitative inquiries (frequently critical of contemporary regimes) to be tolerated within this broadly authoritarian world view. His work was taken up enthusiastically across the whole range of contemporary opinion: by royalists and republicans; priests, dissenters, and atheists; merchants and ministers of state; physicians and philosophers; surveyors and tradesmen. Contemporary mathematical and scientific elites were involved in Holland (Jan DeWitt [1625–1672], Johannes Hudde [1628–1704], Christian Huygens [1631–1699], Nicolaas Struyck [1687–1769]), England (Abraham De Moivre [1667–1754], Edmund Halley [1656–1742], Richard Price [1723–1791]), France (Georges Louis Leclerc, comte de Buffon [1707–1788], Jean-Antoine-Nicolas Caritat, Marquis de Condorcet [1743–1794], Jean le Rond D'Alembert [1717–1783], Joseph Louis Lagrange [1736–1813], Pierre Simon de LaPlace [1749–1827], Antoine Laurent Lavoisier [1743–1794]), America (Benjamin Franklin [1706–1790] Thomas Jefferson [1743–1826]), Germany (Gottfried-Wilhelm Leibniz [1646–1716]), Sweden (Pehr Wargentin [1717–1783]), and Switzerland (Leonhard Euler [1707–1783], Jacob Bernoulli [1654–1705]). Population thought continued to develop significantly in advance of institutional realities until the nineteenth century.

Elements of Population Theory in the *Ancien Régime*

During the period historians have called the long eighteenth century (1660–1830), individual inquiries made for lively, if inconclusive, debates. Demographers and statisticians have sometimes dismissed the period as one of confusion and even stagnation, yet the end of this era witnessed the two restatements of Graunt's project that still shape most people's understanding of population: T. R. Malthus's *Essay* and the promulgation of statistics as a universal basis of government and national development. Both depended on the foundation laid in the sixteenth and seventeenth centuries. Given that good government and the population trends depend on a state's ability to balance the divergent capacities of populations, discussion turned to the implications of population arithmetic: Which specific proportionalities should a state maintain, and what means are best suited to this objective? Graunt's arithmetic implied not only that particular balances but also ratios of relative improvement or decline could be specified. Differing ratios, in turn, implied different population sizes and structures, and recourse to different mechanisms of control. Much further work was necessary for these implications to be formulated explicitly. Three developments of population arithmetic on which Malthus and statistics depended emerged in the century and a half following Graunt. Population arithmetic became central to separate developments in the calculus of probability, in attempts to conceptualize relations between labor and wealth, and in registration as an administrative procedure in many institutions.

Pioneers of mathematical probability—including Huygens, Leibnitz, and Bernoulli—found in Graunt's mortality arithmetic instances of what was later called the "law of large numbers." They conceived probability as a general method of social reasoning that could reduce the uncertainty of moral, political, and economic affairs to a single workable logic. Sex ratios, smallpox vaccinations, and life expectation provided the only empirical series with which to explore this logic. Their ambitions, although not realized, gave rise to the first and enduring formal model of population, the life table, which quickly passed into the wider literature on population arithmetic. In the most widely read application, Johann Peter Süssmilch's (1707–1767) *Die Göttliche Ordnung* (1765), age structures of death provided new and formidable evidence of God's laws indispensable to improved government.

Süssmilch's great volume, together with Jean-Baptiste Moheau's (1745–1794) treatise of 1778, mark the arrival of essays in population arithmetic on a scale that would now be called general social theory. Written in the service of powerful princes like Frederick II and Louis XVI, their works brought quantitative evidence to bear on the main traditions of political theory. More particularly, these thinkers set out to refute the contention of major eighteenth-century works critical of princely rule, like those of Montesquieu, Victor Mirabeau [1715–1789], and Jean-Jacques Rousseau [1712–1778], that prevailing monarchies fostered depopulation. Interestingly, arithmeticians like Moheau could disagree with Montesquieu over forms of government and their effects, but were in substantial accord that population growth or decline depended on the moral and political condition of citizens. In principle, only state policies that were consistent with natural rights to personal liberty, security, and livelihood would promote population growth.

Major economic contributors, notably François Quesnay (1694–1774), Du Pont de Nemours (1739–1817), and Anne Robert Jacques Turgot (1727–1781), could likewise disagree over the virtues of princely rule while developing Montesquieu's lead that *ancien régime* policies of taxation, trade, labor, and war had crippling effects on the security of ordinary citizens, and hence on their willingness to marry and have children. Moheau, like Montesquieu, considered that the dire effects of bad government on population proceeded largely via *moeurs,* that is, customs of marriage, procreation, inheritance, and other aspects of family life through which economic factors acted on social status. Where insecurity became entrenched in customs, the decline of reproduction could take centuries to reverse. Debates over depopulation were also prominent in Britain, addressed variously to ancient populations (David Hume [1711–1776], Robert Wallace [1773–1855]) and modern (Richard Price, William Wales [1734–1796], and Arthur Young [1741–1820], among many others). The republican Richard Price, the most formidable English probabilist and practitioner of population arithmetic in the later eighteenth century, came down firmly on the side that argued that modern populations were decreasing.

The numerical approach employed in these controversies was sometimes called "political arithmetic," following the phrase coined in the 1670s by Graunt's friend, William Petty (1623–1687). As the phrase suggests, the natural historical component of Graunt's method was dropped, and with it the need for practitioners to present calculations and evidence in a way that would enable readers to evaluate them independently. What remained were the multipliers and other proportional devices merchants used to abridge accounts in the absence of full information. Without doubt, the arithmeticians faced a serious difficulty. The general importance of population arithmetic could only be broached in terms of general population totals necessary to calculate vital and economic measures. Careful proposals for national censuses were duly put forward, notably by Sébastien le Prestre de Vauban (1633–1707), but not enacted. Without them, only the partial enumerations provided by parish records, bills of mortality, lists of annuitants, and local censuses, were extant. Petty therefore made multipliers central to his approach, and their use greatly expanded in the eighteenth century. In effect, political arithmetic made a virtue of necessity by aiming at reasonable orders of magnitude rather than systematic accounting. Typical methods took the number of households (usually estimated, or derived from a local list) and multiplied it by a postulated average household size; or the proportion of births to population in a local census would be applied to estimates of annual births at wider levels of aggregation. As late as 1814, LaPlace could argue that multipliers were superior for government purposes to the inaccurate figures any census would provide.

As a reliable aid to the economics and health of population, however, political arithmetic was always open to question. Petty's predominant interest lay in economic policy, and he used population multipliers to attempt pioneering estimates of national income, the distribution of labor, and surplus productive capacity. Like mercantile writers before him, he treated a growing population as conducive to the national wealth that is the possession of the prince and the elite. His methods were viewed critically in his own time by Gregory King (1648–1712) who, in gaining privileged access to tax records and applying Graunt's scrutiny to them, initiated the empirical study of national income and its distribution. King's arithmetical analyses were not prepared for publication, and were known only in brief excerpts given by Charles Davenant (1656–1714). The interrelation of population and economy as a unified system begins properly with Richard Cantillon (1697–1734), who turned his back on political arithmetic in two major respects: first, although quantitative (i.e., proportional) reasoning was instrumental to his logic, analysis of numerical records was secondary, and merely illustrative; second, the natural resource of a state is identified primarily not with population but with land, and secondarily with manufactures and trade. In his account, which shaped later work by Adam Smith (1723–1790), T. R. Malthus (1766–1834), Quesnay, and Turgot, Cantillon argued that population growth tends naturally to rise to the limits of subsistence; what checks it directly are those *moeurs* pertaining to age at marriage and procreation that regulate social status, and which make men and women attentive to their economic situation. Cantillon also broke new ground by developing his account of economics and *moeurs* within a clearly articulated social structure, divided simply into a small class of proprietors and a multitude of laborers. Proprietors, in their differing tastes for goods and services, determine the demand for labor, the way resources in land are utilized, and the balance of manufactures and raw materials in trade. His analysis made the relationship of subsistence and population central while retaining merchants' characteristic view that such factors become important to a nation's wealth chiefly as a support to trade.

Early economic writings, from mercantilism through political arithmetic to Cantillon, had generally assumed that populations would continue to grow while workers' wages remained at subsistence level. In other words, the ideal of a well-ordered polity in which a cohesive and growing population generates rising profits, taxes, and trade presupposed the brute fact that producers' wages would be kept at a minimum. A sophisticated discourse on population and agricultural economy that questioned this premise grew up in France after Cantillon. This discourse considered the condition of the poor to be a major source of depopulation and recognized its potential as a source of disorder. Physiocratic authors following Quesnay developed an analysis of economic classes that finally gave preeminence to relations between agricultural resources and population. Merchants might assume the natural capacity of population to increase whenever demand for labor rises, but the consequences for producers could not be taken for granted. The Physiocrats therefore reasserted the principle that legitimate government is based on populations endowed with natural rights, notably producers with rights to economic liberty and material security. For Turgot, every man has a fundamental right to work and to basic support, if not to indiscriminate charity. As the benefits of a growing population would nonetheless accrue chiefly to upper classes, Jacques Necker (1732–1804) argued that government has a critical role to play in ensuring justice.

The conceptual shift that made land the intrinsic source of wealth and state power thus did not devalue population. Rather, it focused attention more closely on population and resources within the state considered as a more or less fixed domain. If, as many writers seriously believed, countries well-endowed with resources like France and England were losing population, then the role of subsistence in limiting human numbers could not be put down to brute material want. Explanations continued to point to bad government as the key problem, but examined its implications in terms of variations in the demand for labor and of wages, in relations between mortality and living conditions, and in the strong role of custom in determining acceptable minimal living standards. Population arithmetic, carefully applied at the local level by Jean Muret, John Heysham (1753–1834), Vauban, and Antoine Deparcieux (1703–1768), among others, demonstrated convincingly that a range of factors (including infant mortality, epidemics, and emigration) exercised a major check on particular parishes. Such factors underlined the vulnerability of the poor.

A considerable body of British essays in the later eighteenth century by Smith, James Steuart (1712–1780), Young, Joseph Townsend (1739–1816), and others shared French concern over the moral and economic condition of the poor. Adam Smith, for example, took the view that population was in general kept down by high mortality as an inevitable consequence of economic adjustments. Increased demand for labor might improve living standards for a time, but it also tended to increase reproduction; in the absence of continuing improvements in land management or technology, the supply of labor could then exceed demand, and the infants of poor people without jobs would die. Turgot, in contrast, is indicative of more hopeful Enlightenment ideals that gained ground in continental writings. One of the first to formulate the law of diminishing returns, he strikingly did not consider its application important to population, at least in France. Population growth tends to rise or fall with changes in subsistence levels, but the crucial issue is to ensure that producers always make a small profit for themselves. Without this margin, people would choose not to marry, or would emigrate or remain indigent. Population then declines. In contrast, economic adjustment in a justly-governed population should follow a virtuous natural cycle in which producers' modest margin or profit sustains population growth, encouraging more land into cultivation, increasing subsistence, and driving down the price of provisions, thus enabling benefits to spread ever more widely.

Population and the Emergence of the Modern Nation-State

Thus, by the late eighteenth century a growing body of theory had emerged in which alternative proportional logics were used to explain how population levels rise and fall systematically in relation to political, economic, and moral values. Ironically, the debates over depopulation that did so much to stimulate interest belonged to an era that was later shown to have experienced population growth. Contemporaries would certainly have appreciated the irony. Reflecting the ideology of Enlightenment, many analysts viewed history as a progressive application of human reason. As rational government implied comprehensive and reliable information, the absence of national enumerations became a recurring issue from the 1740s.

Necker, as minister of finance to Louis XVI, was one of several senior officials who found their plans to improve national enumerations frustrated by the conservatism of the *ancien régime.* The arithmeticians, economists, and philosophes prominent in debates included local officials who were well aware of the limitations of the estimates they provided. In Prussia, rational government's basis in population knowledge became integral to cameralism (a prevalent political theory emphasizing bureaucratic management of the state's property) in writings put forward by government ministers like Johann Heinrich Gottlob von Justi (1720–1771) and Ewald Friedrich von Hertzberg (1725–1795). "Statistics" was proposed by Gottfried Achenwall (1719–1772) in 1768 as a general term and program of government, acquiring its specifically numerical associations in works by L. Schloezer (1735–1809), John Sinclair (1754–1835), Jacques Mourgue (1734–1818), Jacques Peuchet (1758–1830), and others at the turn of the eighteenth century. In England the need for censuses was argued as early as Petty, and reached parliamentary debate by the 1750s; censuses remained unacceptable, however, as they implied enfranchisement of dissenting religious and political opinion. Thus, even as population became the focus of sustained discussion of glaring differentials in living conditions and rights, the old order persisted in its attitude toward vital data as secrets of state.

Population knowledge remained integral to the theory of the state, however, erupting with the revolutions of the late eighteenth century. In the United States, the census was written into the constitution as a mechanism of apportioning political representation. In France, proposals impossible for Necker to effect in 1784 were redeveloped by Lavoisier and quickly passed by the National Assembly in 1791. Arguments for enumeration spread widely in the first decades of the nineteenth century, reiterating seventeenth- and eighteenth-century ideals. Following the French Revolution, natural rights of equality and liberty were linked directly to the need to establish public records detailing vital and civil status (for example, in relation to property). Yet the old order was not silenced so easily. Attempts to establish a general statistical office in France were taken over by Napoleon for imperial purposes, and then abandoned in 1812. American enumerations became the basis of political compromises in which Southern states counted slaves for congressional representation without having to enfranchise them. Statistics as a new governmental norm was adopted by established monarchies as well as new republics, often as a concession to reform, with controlled access to records. By the time Louis-Philippe re-established the French statistical bureau in 1833, national offices had spread to Prussia (1805), Bavaria (1808), Tuscany (1818), Holland (1828), Austria (1829), Belgium (1831), Saxony (1831) and the smaller German states, to be followed shortly by Norway (1833) and England (1837).

The continuity of population measures carried over from the *ancien régime* was strong, the "new" vital statistics drawing its ratios and life table techniques directly from population arithmetic. The rebirth of population arithmetic as statistics, however, radically altered its scope and potential influence. Censuses, registrations, and related statistical inquiries reconstituted the state as an empirical domain bounded and structured by its population. The early nineteenth century witnessed an explosion of enumerations detailing national production, commerce, health, and other factors to which population data were integral. The humanist and scientific ideal that population arithmetic is a critical foundation of government at last achieved centralized institutional form, and population statistics accordingly became a major platform for proposed social reforms. Three implications of this reconfiguration of population thinking deserve note.

First, the conduct and scale of enumerations gave them a much-vaunted objective value. Population arithmetic was no longer applied to partial records underwritten by the presumed rationality of enlightened opinion. Statisticians, applying mathematical procedures to uniformly collected, comprehensive enumerations, claimed that their methods and results possessed an empirical value both unique and completely general. On one hand, ratios or frequencies were measures of material facts in which local variations and other biases were averaged out among the great mass of data. On the other, the explosion of compilations on seemingly all topics meant that states, provinces, and localities could now be examined in their specificity as discrete empirical domains, in each of which population characteristics could be revealed in relation to other variables in exhaustive detail. This methodology was supposed to guarantee that data at whatever level stood above subjective estimates and political interests. Regularities repeatedly observed in national populations were taken to be instances of general and deterministic social laws comparable to those of the natural sciences.

Second, population statistics became integral to the growing professional ideology of government. New statistical bureaus were able to draw on a considerable body of experience from institutions like hospitals, insurance companies, prisons, the military, and some manufacturing. Even as the *ancien régime* had continued to view population arithmetic with caution, these institutions were developing comprehensive registration systems for local administrative purposes. In hospitals, registration functioned beyond clinical purposes as an encompassing regimen of patient and staff discipline, and as evidence securing financial support. Vital records kept by insurance companies provided a corporate data base on which actuarial observation and experience grew. The influence of nationally prominent physicians and actuaries like Benjamin Gompertz (1779–

1865), Louis Villermé (1782–1863), John Finlaison (1783–1860), William Farr (1807–1883), Joshua Milne (1776–1851), Rudolph Ludwig Karl Virchow (1821–1902), and Alexandre-Jean-Baptiste Parent-Duchâtelet (1790–1836) generalized the experience of reasoning quantitatively in terms of limited institutional domains to the national level.

Third, the finite empiricist approach implied a major reconfiguration of the way natural and political dimensions of population are related. From Machiavelli to Turgot, thinkers assigned primacy to the second of the two generative capacities of population that sixteenth- and seventeenth-century authors made fundamental to population thought: population as the source of political and moral community. In this way of thinking, nature would be amenable as long as human government observed inherent principles, whether conceived as matters of divine or natural right, moral tradition, or inherent balances between trade, people, and subsistence. A just government would enable population to grow in proportion to a state's needs. The emphasis on a cohesive, growing membership as essential to internal and external security as well as trade, is a reminder that in the *ancien régime* the limits of states and populations were not assumed to be fixed. Population arithmetic, however, notably failed to define the population balances proper to cohesive government with any precision.

However, once states, populations, and resources began to be conceived in finite, empirical terms, the room available to states for maneuver began to appear seriously circumscribed. The unhealthy environments, excess reproduction, limitations of technology and ecology that statistics documented constituted endemic constraints that the best efforts of a government might not be able to remedy. Not only resource imbalances but also manifest disproportions among class, ethnic, and regional identities (often attributed at the time to inherent natural characteristics), likewise came to be understood as a quantitatively demonstrable reality. In short, the way was opened to reexamine the potential power of the first generative role of population enunciated by sixteenth- and seventeenth-century thinkers: the capacity of population as a natural force to act on other resources independently of governmental control.

The Emergence of Demography

The six editions Malthus prepared of his *Essay on the Principle of Population* (1798–1826) belong to the early period of statistics' rise. In his work, finite population reasoning attained its most influential general statement. Malthus's analysis depended on prevailing premises of late-eighteenth-century population reasoning: that population tends to rise automatically with subsistence; that its growth, although a positive force for a time, can exceed the demand for labor, with dire consequences for the poor; that the way people respond to imbalances of population and subsistence depends on prevailing moral values; that civil liberty is essential to moral and national improvement; and that governments have a role to play in assisting the poor. The "principle of population" reformulated these ideas in a closed, deterministic framework. Malthus postulated that the constant passion of the sexes, if unchecked, tends to increase population geometrically; the maximum growth of agricultural production is, in contrast, limited to an arithmetical rate by the law of diminishing returns. The natural capacities of population and subsistence thus tend inevitably to conflict. Human societies are likely to experience high rates of mortality and suffering unless some means is available to check population. The window of hope Malthus offered was "moral restraint": the practice of delayed marriage and strict abstinence outside marriage. Malthus saw moral restraint not only as a response to threatened impoverishment, but as opening opportunities for the laboring poor to retain a higher standard of living instead of continued childbearing. In later editions of the *Essay,* Malthus wrote a comprehensive survey of historical and modern societies that showed the extent to which each relied on moral restraint, or was subject to the "positive checks" of disease, famine, and war. As he saw the evidence, moral restraint was commonly practiced only in northwest Europe, and even there insufficiently. Malthus famously opposed any use of contraception.

Malthus's principle quickly met with controversy, reflecting his apparent reversal of three established tenets of Western thought on population. First, the inherent quantitative regularity of nature was no longer assumed to be benign, or at least reasonably responsive to just government. Malthus argued in his first edition that God imposes suffering as a "partial evil" to induce men to foresighted action. Restraint of passion is difficult and means of subsistence are scarce because God meant to focus men's minds on moral behavior; only the higher classes of society, however, can be expected to show prudence at any given point in time. A second and parallel reversal, particularly with regard to preceding French population thought, was that any right to subsistence is not natural, but earned. Third, it followed that the role of the state in assisting the poor must be limited strictly to measures that encourage prudence. Malthus here emphasized education together with restricting assistance to the very poor on terms that proscribe procreation. The severity of Malthus's system is a compound of the strictures of his morality, limitations placed on state intervention, and the determinism of his laws.

All three aspects had been substantially rejected by the third quarter of the nineteenth century. The changes in European government informed by population statistics increased rather than reduced the scope for state intervention, while social changes encouraged the spread of contraception and revealed the limitations of deterministic laws. Malthus's *Essay* remains important in the study of pre-industrial family systems in Europe, although his postulated upper limit for agricultural output is insufficient. More influential in the history of population thought, however, are two refinements Malthus introduced. Since Graunt, the unity of natural principles and human government devolved on knowledge and just management of the inherent proportional regularity of population. Malthus, agreeing that the generative capacities of population require control if civil society is to be maintained, showed first that this central theme of modern population thought could be narrowed to a single issue: the quantitative regularity of individuals' decisions to marry and have children. Second, as E. A. Wrigley has observed, Malthus constructed a homeostatic model in which the primacy of these decisions becomes the crucial arbiter of the dynamics of population and subsistence. Reproductive checks are not just individuals' moral response to hard times, but part of a series of adjustments to potential or actual economic recession. Moral restraint checks population increase, enabling the demand for labor to rise. Rising demand in turn stimulates wages to rise, and the need for moral restraint lessens. An oscillation may then begin as marriage age falls, population growth resumes, and diminishing returns again drive down the demand for labor. Or, people may continue to exercise moral restraint, locking in their improved incomes. Malthus's system revealed that previous proportional logics in which population increase simply perpetuates economic growth apply only to one phase in a cycle.

"Demography" as a general term was introduced by Achille Guillard (1799–1876), who defined the field as population statistics in its broadest sense, giving pride of place to the vast body of data emerging from the new state statistical bureaus. Noting that the scale of compilations was particularly suited to probabilistic analysis, he nonetheless inclined to the prevailing period view that a science of population is anchored not in abstract mathematics, but in comprehensive enumeration and the law-like relationships that it describes. Indeed, historians have remarked that the enduring importance of nineteenth-century population thinking lies in the program established for recording mass vital and social characteristics. This way of reasoning was in practice more reliant on models like the life table than Guillard allowed. Nor did its practitioners' belief that classification and enumeration are a purely empirical exercise reflect their strategic use of the program to change the way society and its problems are defined. Population statistics, in developing occupational, cause of death, and other standard classifications, and tabulating them with age/sex structures, vital rates, and other measures, successfully named and codified a tremendous range of hitherto unspecified populations and population characteristics. New quantitative entities were brought into existence not as mere physical distributions, but as normative social phenomena. Statistical reformers like Villermé, Farr, and Adolphe Quetelet (1796–1874) followed Malthus in considering constants found in such data as evidence of inevitable moral and natural causes. Passionately committed to using population thinking to improve human government, these men used the new capacity to codify and distinguish subpopulations to identify problem groups, particularly amongst the poor. Their work greatly enlarged the view that the quantitative regularity of population legitimizes specific policies and interventions. Population differentials became staple formulae underlying *laissez faire,* socialist, and cooperative proposals.

The Problem of Determinism

In its earliest appearance, then, demography aspired to incorporate deterministic analysis into its empirical and governmental roles. The attempt to formulate general laws on the basis of crude quantitative regularities provoked debates that lasted throughout the nineteenth century. These may be grouped into four related developments.

First, vital statisticians used public data sources to construct new measures of health and the strength of the state, or "indices of salubrity." These statisticians, for example, argued that life tables demonstrated determinant laws of mortality at national and local levels. The main approach refined classifications and measures of mortality and localized them to specific urban, occupational, class, and other groups. Mortality differences were then attributed to variations of income, moral traits, or social and environmental conditions which new data sources provided on these groups. Like Malthus, vital statisticians saw individual moral choice as a crucial arbiter of demographic change, but considered hygiene a precondition. Many reformers, like Virchow, Parent-Duchâtelet, and Farr, argued that people have a right to good health; public provision of sanitation, instruction, and urban planning are necessary if individuals are to take control of their lives. Statistics on the impact of epidemic and endemic diseases, and of age, sex, and occupational patterns of mortality, provided an overpowering rationale for sewerage, piped water, factory reform, and other public works. For some vital statisticians, like Villermé, the association between poverty and high mortality supported a Malthusian view that a residual population of suffering and improvident poor would always remain. The moral and physical character of this residuum, like the positive checks that controlled its numbers, was regarded as natural, and began to be attributed to heredity. New classification schemes enabled a line of social demography from Quetelet to Emile Durkheim (1858–1917) to isolate populations of suicides, prostitutes, and criminals, and to argue that deviant groups are inevitable and statistically normal elements of all societies. As concern mounted in the later nineteenth century regarding fertility declines and continuing high levels of infant mortality, new reproductive indices were developed by James Mathews-Duncan (1826–1890), Jacques Bertillon (1851–1919), and József Kőrösi (1844–1906). Such measures were widely interpreted as indicating a decline in morality (especially of mothers) and the loss of national strength.

Second, Malthus's "principle" proved to be too broad, and the function of moral restraint too narrow, to be useful as general laws. Although methods were developed—by Ernst Engel (1821–1896) and Frédéric LePlay (1806–1882), for example—that explored the equilibrium of poverty and population in data on laborers' family budgets, population statistics remained largely unintegrated with economic theories of population. Instead, all manner of alternative laws to Malthus's proliferated. A diverse body of population thought from his contemporaries Thomas Rowe Edmonds and Archibald Alison (1792–1867) to demographers at the end of the century, like Emile Levassure (1828–1911) and Paul Leroy-Beaulieu (1843–1916), considered technological improvements, increased division of labor, and resulting economic growth capable of postponing subsistence crises indefinitely. Revisionist hypotheses from Nassau William Senior (1790–1854) to Arsène Dumont (1849–1902), and including those of neo-Malthusian writers, reasoned that workers would control their fertility to preserve living standards more readily than Malthus believed possible. By the end of the century, the decline in fertility was widely accepted as proof. A differing continuity with eighteenth-century population thought characterized other writers, notably Jean-Baptiste Say (1767–1832) and John Stuart Mill (1806–1873), who argued that unequal distribution of income remained a major check on population. Alternatively, for Karl Marx (1818–1883) such inequalities increased population size. Marx reasoned that each stage of society has its own population laws. In capitalist modes of production, population is regularly stimulated to exceed the demand for labor; the resulting surplus ensures that employment is insecure, wages low, and capital accumulation is confined to the upper classes. These and other deterministic hypotheses of nineteenth-century economic demography could not be reconciled, and by the turn of the century began to be bypassed by the new marginal analysis that did not require specific hypotheses about population growth.

Beneath the period passion for laws lay the deeper fascination with the stability of population series which, since Huygens's reading of Graunt, made population arithmetic the proving ground of probability theory. Public sources of mass population data opened up an apparently limitless horizon in which instances of the "law of large numbers" could be explored. A third attempt to develop deterministic laws of population was Quetelet's "social physics." Quetelet showed how error theory used by astronomers to reconcile observational variations could be used to express the regularity long observed in mortality and other vital series. For Quetelet, all material and moral aspects of society took the form of normal distributions around a hypothesized "average man," the statistical composite of all that is good in a given population. Changes over time in average tendencies reveal natural laws of social development, which Quetelet regarded as material, supra-individual forces. His ambition was to expand population thinking into an all-embracing, probabilistic social science, in effect reversing Malthus's attempt to show that the fundamental unity of nature and society comes down to individual agency. Variation, instead of being determined by singular moral choices, became deviance from aggregate natural forces. The role of a science of society based on population was to identify central tendencies and policies that allow causes thus established to take their course. Social physics implied *laissez faire.* Quetelet's program acquired immense prestige, but had very few applications and produced no general theory of development. Its importance in population thought owes, rather, to two very different critical responses it generated. These two responses may be considered a fourth development of the problem of determinism, which focused in different ways on the statistics of variation.

Wilhelm Lexis (1837–1914), Georg Friedrich Knapp (1842–1926), and other population theorists of the German historical school, in demonstrating that Quetelet's supra-individual statistical forces are imaginary, showed that the critical problems of explanation lie in patterns of variation, not central tendencies. Objecting strongly also to Malthus, these writers argued that quantitative regularities may be considered only *indicative* of natural laws, as they deal with distributions of events, not causes. Variations are at base historical and cultural; the nature of society, as a union of free persons, depends as much on people's differences as similarities.

This reassertion of the theme that population is fundamentally a common community did not prevail in demography. Health and economy predominated in the programmatic compilation of mass population data, and the importance of studying variation as a cultural and mathematical question appeared technically difficult and secondary. It is noteworthy, however, that the need to standardize data for comparative purposes led to eight international statistical congresses in the second half of the nineteenth century, in which officials from state statistical bureaus, vital statisticians, and economists agreed on protocols not only on matters like cause of death classification, but criteria detailing linguistic, religious, ethnic, and other populations. With the rise of nationalism and imperial conflicts, such criteria became controversial as grounds constituting rights of distinctive cultural groups. Henceforth population data on cultural variation appeared to question the legitimacy of modern states, just as population arithmetic had troubled the *ancien régime.* Congress criteria were ignored outside of Austria-Hungary, Russia, and in areas under British colonial administration.

The study of variation developed, instead, as population thinking became a common ground of theories of biological and social evolution. The second critical response to Quetelet, associated particularly with the work of Francis Galton (1822–1911), embraced the search for supra-individual forces, attributing them to heredity. The decisive role Malthus had assigned to reproduction was reinterpreted as the cornerstone of eugenics, the doctrine that social development depends on scientific control of human breeding. Malthus's idea that the pressure of population generates a struggle for existence influenced evolutionary theory even before Charles Darwin (1809–1882) developed his ideas of natural selection on the basis of the "principle of population." Herbert Spencer's (1820–1893) paper of 1852, for example, and a wide range of scientific and social opinion later called "Social Darwinism," saw population density as stimulating competition in which the socially and biologically fittest would dominate. For Spencer, the development of human intelligence was a part of this process, and would lead to declines in fertility, resolving Malthus's dilemma. Darwin, in emphasizing intra-species competition, drew further on Malthus's stress on the strategic role of marriage (or, in species terms, of mating). Reflecting on the problem of moral restraint, Darwin realized that controls over *which members* of a species are allowed to reproduce determines natural selection, as dominant members will be more likely to pass genetic characteristics to future generations. Evolution was generally conceived in terms of species and race progress, but Darwin conceded the point of William Rathbone Greg (1809–1881) and Alfred Russel Wallace (1823–1913) that in modern society the poor and improvident outbreed frugal and virtuous members of society, which in time could bring about degeneration. Similar hereditarian concerns were often expressed by demographers, from the vital statistics of Farr to the economics of Leroy-Beaulieu and Adolphe Landry (1874–1956). The decline of fertility in late nineteenth-century Europe appeared to add force to such concerns. Advanced civilizations again came to be associated with depopulation. Eugenicists went further: as fertility declines were much greater in the middle and upper classes, they concluded that a larger and larger proportion of the population was being produced from inferior genetic stock.

The view that laws of heredity determine social relations, however, presupposed simple answers to a difficult question that Darwin and modern genetics have yet to resolve: Which traits are transmitted through the selective effect of marriage on reproduction? Galton recognized that Quetelet's reformulation of error theory could be used to open up a new evolutionary demography: the possibility of defining genetic types by quantifying the range and variability of traits. The concepts of statistical correlation and regression he pioneered have, with time, become principal means of associating fertility and mortality trends with social and economic variables. But Galton's own applications, developed and extended by Karl Pearson (1857–1936), were vitiated by his assumption that social class is indicative of genetic worth. Although discredited by later developments, eugenics nonetheless exercised a continuing influence on twentieth-century occupational and other classification schemes.

Conclusion

The generative capacities of population and knowledge of them have occupied a critical position in attempts to define and govern human society since the sixteenth century. The prevailing view into the early nineteenth century conceived population primarily in terms of membership of a state, the fruits of members' interaction (moral, political, and economic), and the natural rights inherent in such association. In this view population trends, although subject to divine and natural forces outside human control, depend on the limitations and strengths of individual will and collective human government. In the course of the nineteenth century, a sustained but inconclusive effort was made to constitute a deterministic science of population based on systematic quantitative measurement. Major achievements of this era include the pervasive role population thinking acquired in public institutions; the myriad populations, trends, and differentials its methodology constructed; and the instrumental role it began to play in improving public health. Population statistics provided effective means of demonstrating major economic, social, and cultural divisions in society, and of differentiating and sometimes stigmatizing subpopulations. The traditional view of population as based in common membership, although reaffirmed at times, generally receded as much greater energy went into trying to identify determinants of enduring population differences. With this shift, nineteenth-century population thinking brought to the fore generative capacities of population, notably reproduction and its relation to other natural resources, which had previously been secondary to cohesive membership. As the century proceeded, the implications of statistical trends for government were increasingly seen in evolutionary and biological terms, with extreme interpretations (depopulation, degeneration, the disappearance of national cultures) leading to calls for selective action in favor of some populations over others. The need to reconcile concepts of population based in common membership with those emphasizing potential natural constraints, particularly of fertility, remained pressing as population thinking entered the twentieth century.

See also: *Bertillon, Jacques; Botero, Giovanni; Cantillon, Richard; Condorcet, Marquis de; Darwin, Charles; Demography, History of; Dumont, Arsène; Eugenics; Euler, Leonhard; Farr, William; Galton, Francis; Gompertz, Benjamin; Graunt, John; King, Gregory; Kőrösi, József; Landry, Adolphe; Literature, Population in; Malthus, Thomas Robert; Marx, Karl; Mill, John Stuart; Moheau, Jean-Baptiste; Petty, William; Quetelet, Adolphe; Süssmilch, Johann.*

BIBLIOGRAPHY

PRIMARY.

Botero, Giovanni. [1589–1596] 1956. *The Reason of State,* trans. P. J. Waley and D. P. Waley. London: Routledge and Kegan Paul.

———. [1588] 1956. *The Greatness of Cities,* trans. R. Peterson. London: Routledge and Kegan Paul.

Cantillon, Richard. 1755. *Essai sur la nature du commerce en général.* Paris. [Written originally in English between 1730 and 1734; only the French translation survived. English transl: *Essay on the Nature of Commerce in General.* New Brunswick, NJ: Transaction Publishers, 2001.]

Condorcet, Jean-Antoine-Nicolas de Caritat, marquis de. [1767–89] 1994. *Arithmétique politique: textes rares ou inédits,* ed. B. Bru and P. Crépel. Paris: l'Institut national d'études démographiques.

Franklin, Benjamin. 1755. "Observations Concerning the Increase of Mankind and the Peopling of Countries." Reprinted in *Population and Development Review* 11(1) 1985: 107–112.

Graunt, John. 1662. *Natural and Political Observations Made upon the Bills of Mortality.* London. (Reprinted 1973 in *The Earliest Classics: Pioneers of Demography,* ed. P. Laslett. Farnborough, Hants: Gregg International.)

Guillard, Achille. 1855. *Eléments de statistique humaine ou démographie comparée.* Paris: Guillaumin et Cie.

Hume, David. 1752. "Discourse Concerning the Populousness of Ancient Nations." In *Political Discourses.* Edinburgh: Sands, Murray and Cochran.

King, Gregory. 1696. *Natural and Political Observations and Conclusions upon the State and Condition of England.* (Reprinted 1973 in *The Earliest Classics: Pioneers of Demography,* ed. P. Laslett. Farnborough, Hants: Gregg International.)

Malthus, T. R. 1986. *Works,* ed. E. A. Wrigley and D. Souden. London: William Pickering. *Vol. I: An Essay on the Principle of Population* (1798); *Vol. II: An Essay on the Principle of Population* (1826, with variants from the 2nd ed. of 1803).

Moheau, M. 1778. *Recherches et considérations sur la population de la France.* (Reprinted 1994, ed. E. Vilquin. Paris: Institut national d'études démographiques and Presses Universitaires de France.)

Montesquieu, C. L. Secondat, Baron de. 1964. *Oeuvres Complètes.* Paris: Seuil.

Petty, William. 1690. *Political Arithmetic.* (Reprinted 1899 in *The Economic Writings of William Petty,* ed. C. H. Hull. Cambridge, Eng.: Cambridge University Press.)

Spencer, Herbert. 1852. "A Theory of Population, Deduced from the General Law of Animal Fertility." *Westminster Review* 57: 468–501.

Steuart, James. 1770. *Principles of Political Oeconomy.* Dublin: James Williams.

Süssmilch, Johann Peter. 1765 *Die Göttliche Ordnung.* Berlin: Realschule. French transl., *L'Ordre Divine, traduction orignale, avec des études et commentaires rassemblés par Jacqueline Hecht.* trans. J. Hecht, 3 Vols. Paris: Institut national d'études démographiques, 1979.

Wallace, Robert. 1753. *A Dissertation on the Numbers of Mankind in Ancient and Modern Times.* Edinburgh.

SECONDARY.

Bourguet, Marie-Noëlle. 1989. *Déchiffrer la France. La statistique départmentale à l'époque napoléonienne.* Paris: Editions des archives contemporaines.

Desrosières, Alain. 1993. *La politique des grands nombres. Histoire de la raison statistique.* Paris: Éditions La Découverte.

Dupâquier, Jacques, and Michel Dupâquier. 1985. *Histoire de la Démographie.* Paris: Libraire Académique Perrin.

Glass, David V. 1973. *Numbering the People.* Farnborough, Hants: Saxon House.

Hacking, Ian. 1990. *The Taming of Chance.* Cambridge, Eng.: Cambridge University Press.

Hecht, Jacqueline, 1987. "Johann Peter Süssmilch: A German Prophet in Foreign Countries." *Population Studies* 41(1): 31–58.

Hutchinson, Edward Prince. 1967. *The Population Debate: The Development of Conflicting Theories up to 1900.* Boston: Houghton Mifflin Co.

Kreager, Philip. 1991. "Early Modern Population Theory: A Reassessment." *Population and Development Review* 17(2): 207–227.

———. 1992. "Quand une population est-elle une nation? Quand une nation est-elle un état? La démographie et l'émergence d'un dilemme moderne, 1770–1870." In *Population: 1639–1656.* Paris: Institut National D'Études Démographiques

MacKenzie, Donald A. 1981. *Statistics in Britain 1865–1930.* Edinburgh: Edinburgh University Press.

Porter, Theodore M. 1986. *The Rise of Statistical Thinking, 1820–1900.* Princeton, NJ: Princeton University Press.

Rohrbasser, Jean-Marc, and Jacques Véron. 2001. *Leibniz et les raisonnements sur la vie humaine.*

Paris: Institut national d'études démographiques.

Spengler, Joseph J. 1942. *French Predecessors of Malthus.* Durham, NC: Duke University Press.

Stangeland, Charles. 1966. *Pre-Malthusian Docrines of Population* (1966). New York: A. M. Kelly.

Szreter, Simon, ed. 1991. "The General Register Office of England and Wales and the Public Health Movement 1837–1914." Special issue of *Social History of Medicine* 4(3): 401–537.

Teitelbaum, Michael S., and Jay M. Winter, eds. 1989. *Population and Resources in Western Intellectual Traditions.* In *Population and Development Review,* Suppl. to Vol. 14.

Wrigley, E. A. 1989. "The Limits to Growth: Malthus and the Classical Economists." *Population and Development Review,* Suppl. to Vol. 14.

Philip Kreager

POVERTY AND INCOME DISTRIBUTION

Poverty and income distribution have risen to the top of the list of social issues in many countries. Since the 1970s the United States and United Kingdom have experienced increases in both poverty and economic inequality. But these countries are not unique; many developed countries have experienced at least modest increases in the inequality of income. As economies and labor markets become more international and countries wrestle with the social and economic consequences of aging populations, increased market work by women, and marital dissolution, public interest has come to focus on how successfully different social policies cope with inequality, poverty, and joblessness.

Definitions and Measurement

Poverty is measured by a lack of resources relative to needs. Resources can be measured by consumption, assets, or income, though most analysts prefer income because of the availability and comparability of relevant statistics. Needs measures can be either relative or absolute. Relative deprivation is almost always the preferred measure, both nationally and cross-nationally, because it examines deprivation subject to a household's social and economic context. There is no single best measure of absolute poverty for precisely this reason. Depending on the country, period, and context, the World Bank uses poverty lines of US \$1.00, \$2.00, or \$3.00 per person per day. In contrast, the "official" poverty line for the United States is set at a level of \$10.00 to \$15.00 per person per day (depending on household size). Relative poverty can be defined using any of a variety of measures. The United States' "absolute" poverty line is approximately 40 percent of the median household income. Most international analysts, and many governments, choose a poverty line of 50 percent of the median. The European Union has chosen a line of 60 percent of the mean for measuring deprivation.

Since there are economies of scale in the consumption of most household goods, income and other measures of resources are usually adjusted for these differences by means of an equivalence scale. The equivalence scale measures the cost of providing an equal level of living for households that differ by characteristics such as household size or age of members. For instance, household size raised to the power 0.5 is a common equivalence scale adjustor. This adjustment says that if a single person needs 100 monetary units to be non-poor, a consumption group of four persons needs $100 \times 4^{(.5)}$ or 200 monetary units to be non-poor. Measures of poverty include the head count (the fraction poor), the poverty gap (the average additional income of those below the poverty line needed to bring them up to that line, and more sophisticated measures.

Income inequality refers to the distribution of income among households or persons. But the distribution of what, measured when, and among whom? Most analysts of inequality use a measure of *disposable money income.* For most households, the primary income source is market income, which includes earned income from wages, salaries, and self-employment, and other cash income from private sources such as property, pensions, alimony, or child support. In calculating disposable income, governments add public transfer payments (e.g., retirement, family allowances, unemployment compensation, welfare benefits) and deduct income tax and social security contributions from market income. Most analysts measure income on an annual basis. This may be too long an accounting period for families that are severely credit-constrained and too short for those that can smooth consumption over several years, but almost all available surveys report income for the calendar year.

The usual answer to the question "distribution among whom?" is "among individuals." Most surveys focus on the individual as the unit of analysis and the household as the unit of income sharing. A household is defined as all persons sharing the same housing unit, regardless of any familial relationship. One therefore estimates individual disposable income by aggregating the income of all household members and using an equivalence scale to arrive at individual equivalent income per person equivalent income. Equal sharing of incomes within the household is assumed.

There exist many different summary measures of inequality, most of them based on the Lorenz curve, or other variants. Their usage is demonstrated below.

Databases for Measuring Poverty and Inequality

A heightened interest in poverty and inequality has led to greater efforts to assemble comparable cross-national measures of economic inequality—not an easy task, because the data that exist are not uniform in nature or purpose. Some national surveys are designed to collect income data and some to collect expenditure data. Some are longitudinal household panel surveys, while others are cross-sectional income or labor force surveys. For some countries, data are derived from income tax or administrative records. Despite the difficulties, projects such as the Luxembourg Income Study (LIS) and, to a lesser extent, the International Social Survey Program (ISSP) are helping create a richer body of comparative economic studies. It has become possible to provide a more complete picture of cross-country differences at many points in the income distribution, instead of merely providing snapshot comparisons of the "average" or "typical" family in different countries. Researchers have not only been able to address the factual question of whether inequality has grown in a particular country, but also to start to probe more deeply into the factors explaining changes in economic inequality.

The LIS provides standardized measures of poverty and inequality for a set of 25 high-income countries over the period from 1979 to 1999. These figures can be found on the Internet. As of 2002 it is the only such database. Data on poverty and inequality compiled from a number of different country sources are typically not fully comparable. Trend data, which rely on changes in the same measure within a single country, are likely to be more reliable, assuming that there is no substantial change in survey design or measures. The set of estimates briefly summarized in Figure 1 is based on the LIS.

Relative Differences in Poverty and Inequality Across Nations

A large body of research has documented comparative levels of poverty and inequality among countries and also the substantial increases in inequality in many countries over time. How do countries measure up? Figure 1 compares the distribution of disposable income in 22 countries for various years around 1995. It highlights the relative differences between those at the bottom and those at the top of the income distribution. It shows the ratio of the income of a household at the 10th percentile (P10) and a household at the 90th percentile (P90) to median income for each country. This indicates how far below or above the middle of the distribution the poor and the rich are located on the continuum of income. Figure 1 also shows the ratio between the incomes of those at the 90th and 10th percentiles (the "decile ratio"). This illustrates the size of the gap between the richest and the poorest in each country. LIS also uses the most common (Lorenz curve-based) measure of inequality—the Gini coefficient.

Most measures of inequality, including those presented in Figure 1, are conducted on a relative basis within nations. (With careful use of Purchasing Power Parties, one may also be able to compare income distributions and percentiles of the distribution among similarly developed countries in real income terms.) The measures describe relative social distance. They are easy to understand but focus on only a few points in the distribution of income.

Figure 1 shows that the United States has an exceptionally large gap between the rich and the poor when compared to other advanced market economies. A low-income American at the 10th percentile in 1997 had an income that was 38 percent of median income, whereas a high-income American in the 90th percentile had an income that was 214 percent of the median. The high-income American had an income nearly six times as much as the low-income

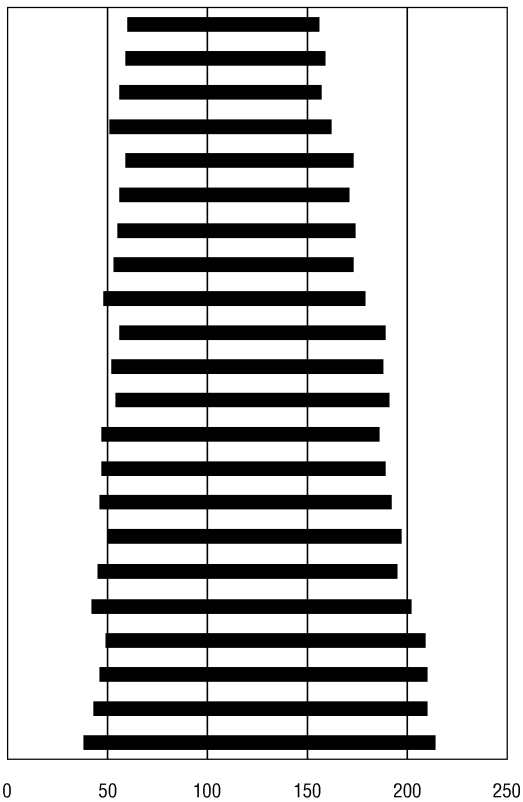
FIGURE 1

"Social Distance": Relative Income Comparisons Across 22 Countries, Mid-1990s

(Adjusted Disposable Income)

Country and Year	P10 (Low)	P90 (High)	P90/P10 (Decile Ratio)	Gini Index
Sweden 1995	60	156	2.61	0.221
Finland 1995	59	159	2.68	0.226
Norway 1995	56	157	2.83	0.238
Denmark 1997	51	162	3.15	0.257
Luxembourg 1994	59	173	2.92	0.235
Netherlands 1994	56	171	3.07	0.253
Germany 1994	55	174	3.18	0.261
Belgium 1997	53	173	3.26	0.255
Austria 1995	48	179	3.73	0.277
Taiwan 1995	56	189	3.38	0.277
Switzerland 1992	52	188	3.62	0.307
France 1994	54	191	3.54	0.288
Canada 1997	47	186	4.00	0.291
Poland 1995	47	189	4.04	0.318
Japan 1992	46	192	4.17	NA
Spain 1990	50	197	3.96	0.303
Australia 1994	45	195	4.33	0.311
Italy 1995	42	202	4.77	0.342
Ireland 1987	49	209	4.23	0.328
United Kingdom 1995	46	210	4.57	0.344
Israel 1997	43	210	4.86	0.336
United States 1997	38	214	5.57	0.372
Simple Average	51	185	3.75	0.288

Length of bars represents the gap between high and low income individuals



Note: Numbers for P10 and P90 are percent of median in each country.

SOURCE: Authors' calculations from LIS data and LIS "Key Figures" (http://www.lisproject.org/keyfigures.htm). Japan taken from Ishikawa (1996).

American, even after adjustment for taxes, transfers, and family size (the decile ratio is 5.63). In contrast, in the other countries in Figure 1, the income of the poor averaged 51 percent of the median income; that of the rich, 184 percent. The average rich person in these countries had only 3.6 times the income of the average poor person.

The countries in Figure 1 fall into clusters. Inequality is lowest in Northern Europe (the Scandinavian countries and Finland, and also Luxembourg and the Netherlands), where the income of those at the 10th percentile averages 57 percent of the median. A number of Central and Western European countries come next (Germany, Belgium, Austria, Switzerland, and France—plus Taiwan, included for comparison). Israel and the United Kingdom have the highest levels of inequality outside the United States. In some countries—Italy, Ireland, Israel, and the United Kingdom—the incomes of the richest people, those at the 90th percentile, are more than 200 percent of median income. This is not very different from the United States; the United States differs, above all, in the relative disadvantage of its poorest residents.

Table 1 shows poverty rates (fraction of persons below 50 percent of median income) in these same

TABLE 1

Percent Living in Poverty in the Total Population, among Children, and among the Elderly, in 20 Developed Countries, mid–1990s

Country	Year	Total Population	Children	Elderly
Luxembourg	1994	3.9	4.5	6.7
Finland	1995	5.1	4.2	5.2
Sweden	1995	6.6	2.6	2.7
Taiwan	1995	6.7	6.2	21.7
Norway	1995	6.9	3.9	14.5
Germany	1994	7.5	10.6	7.0
France	1994	8.0	7.9	9.8
Netherlands	1994	8.1	8.1	6.4
Belgium	1997	8.2	7.6	12.4
Denmark	1997	9.2	8.7	6.6
Switzerland	1992	9.3	10.0	8.4
Spain	1990	10.1	12.2	11.3
Austria	1995	10.6	15.0	10.3
Poland	1995	11.6	15.4	8.4
Canada	1997	11.9	15.7	5.3
United Kingdom	1995	13.4	19.8	13.7
Israel	1997	13.5	13.3	26.4
Italy	1995	14.2	20.2	12.2
Australia	1994	14.3	15.8	29.4
United States	1997	16.9	22.3	20.7
Simple Average		9 9	11.3	12.1

Note: The poverty line is defined as 50 percent of the median disposable income (adjusted) in each country.

SOURCE: Authors' calculations from LIS data and LIS "Key Figures" (http://www.lisproject.org/keyfigures.htm).

countries for all persons, children, and the elderly. Once again, these figures show that the United States stands apart from the other countries in the study, with the highest levels of poverty for the total population (16.9%) and for children (22.3%). In fact, more than one child in five fell below the poverty line in the United States in 1997. Only Australia had a higher percentage of elderly persons below the poverty line (nearly 30% of elderly Australians were living in poverty in 1994). At the other extreme, only 3.9 percent of Luxembourgers (1994), 2.6 percent of Swedish children (1995), and 2.7 percent of elderly Swedes were below the poverty line in their countries. Average 1990s poverty rates for the Table 1 countries apart from the United States are 9.5 percent for the total population, 10.8 percent for children, and 11.6 percent for the elderly.

Poverty and inequality measures differ across countries (e.g., compare the extremes, Luxembourg and the United States, in Figure 1). However, the Northern European countries tend to have the lowest levels of poverty, followed by Central Europe and then Southern Europe and the English-speaking countries (United States, United Kingdom, and Australia).

Extensions and Summary

Poverty and income distribution are concrete and valid measures of economic status. Broader measures of well-being may also include such items as health status and literacy, and are especially appropriate for developing countries. An example of such a measure is the Human Poverty Index, published in the United Nations Human Development Report. A broader analysis of global poverty is contained in the 2000/2001 World Development Report, issued by the World Bank. The effect of inequality and poverty on economic growth, crime, and related social outcomes is also a growing field of inquiry. Using measures such as those described above, and developing more datasets like the LIS, should provide a clear picture of how well the world does in combating poverty and in understanding the effects of both poverty and inequality on social well-being.

See also: *Cost of Children; Development, Population and; Economic-Demographic Models; Education; Residential Segregation.*

BIBLIOGRAPHY

Atkinson, Anthony B., Lee Rainwater, and Timothy M. Smeeding. 1995. "Income Distribution in OECD Countries: Evidence from the Luxembourg Income Study (LIS)." *Social Policy Studies* 18.

Gottschalk, Peter, and Timothy M. Smeeding. 2000. "Empirical Evidence on Income Inequality in Industrialized Countries." In *Handbooks in Economics,* Vol. 1: *Handbook of Income Distribution,* ed. Anthony B. Atkinson and François Bourguignon. Amsterdam: North-Holland.

Ishikawa, Tsuneo. 1996. Data runs conducted by the Ministry of Welfare, Japan.

Jäntti, Markus, and Sheldon Danziger. 2000. "Income Poverty in Advanced Countries." In *Handbooks in Economics,* Vol. 1: *Handbook of Income Distribution,* ed. Anthony B. Atkinson and François Bourguignon. Amsterdam: North-Holland.

Smeeding, Timothy M., Lee Rainwater, and Gary Burtless. 2002. "United States Poverty in a Cross-National Context." In *Understanding*

Poverty, ed. Sheldon H. Danziger and Robert H. Haveman. New York and Cambridge, MA: Russell Sage Foundation and Harvard University Press.

INTERNET RESOURCES.

Smeeding, Timothy M., and Lee Rainwater. 2001. "Comparing Living Standards Across Nations: Real Incomes at the Top, the Bottom and the Middle." Syracuse, NY: Luxembourg Income Study. <http://www.lisproject.org/publications/liswps/266.pdf.>.

United Nations Development Programme. 2001. "Human Development Report 2001." <http://www.undp.org/hdr2001/>.

World Bank. 2000. "World Development Report 2000/2001: Attacking Poverty." <http://www.worldbank.org/poverty/wdrpoverty/>.

David K. Jesuit
Timothy M. Smeeding

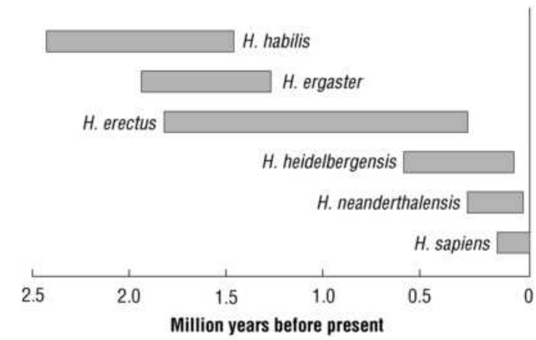
PREHISTORIC POPULATIONS

INTRODUCTION

Human prehistory is treated regionally in the series of articles that follow. The discussion mainly pertains to the modern (and only surviving) human species, *Homo sapiens,* which emerged little more than 100,000 years ago; however, other hominid species—ancestral or cognate lines of the genus *Homo*—are also referred to. Humans in this generic sense emerged over 2 million years ago. Depending on how human origin is defined, human prehistory thus covers all but a small fraction (95–99.7 %) of the duration of human existence.

FIGURE 1

Timelines of Major Hominid Species



SOURCE: Articles in this encyclopedia, supplemented by data from the Smithsonian Institution's Human Origins Progam.

An approximate time line of major hominid species is shown in Figure 1. The dating and in some cases even the species identifications are tentative, subject to revision as research progresses. The associated phylogeny—the relationships among these species—is even less securely founded.

AFRICA

The ancestors of modern human populations separated from those of humankind's nearest primate relatives some 5 million years ago on the African continent and by 2.5 million years ago were making stone artifacts that can be recognized as tools. Slightly less than 1.5 million years ago those kinds of tools appear outside Africa, marking the latitudinal expansion of people from the subtropics to more temperate zones. By 100,000 years ago African descendants of the earliest people were skeletally modern, and soon after that time they were marking stone, bone, and ostrich eggshell in ways that obviously are symbolic, if not artistic, long before such behavior was evident elsewhere.

Less than 50,000 years ago modern people began a further expansion, again emanating from Africa, crossing land bridges, occasionally making sea crossings, and entering arid, cold, and seasonal environments in a wave or waves that would eventually result in a nearly global distribution. Most of the early experiments in the domestication of plants and animals, metallurgy, urban development, and intercontinental trade seem to have originated outside Africa, but starting 500 years ago Africa experienced a return of its progeny in an extended colonial period whose effects have not yet been shaken off.

Several billion stone tools litter the African landscape, but of a billion or more African people who were alive during the period from 5 million to 0.5 million years ago there are the fragmentary skeletal remains of about 500 individuals at most. Only from the last 10,000 years is there anything approximating a decent sample, no more than a thousand or two individuals. Palaeoanthropologists refer to up to 15 species of hominids and 5 genera but rarely agree on the correct assignation of most fragments, and only in very rare cases are there nearly complete individuals, let alone useful numbers of contemporary conspecifics.

The discovery of ancient hominid remains in the currently desert environment of Chad, several thousand kilometers away from any other contemporary locality, has underlined the fragility of the current understanding of hominid distribution patterns. Are researchers looking merely at the absence of evidence rather than the evidence of absence? The sampling, dating, and empirical constraints on reconstructing African Pleistocene populations are so severe that anthropologists rarely mention issues such as population sizes, birth or mortality rates, life expectancy, life history patterns, and biogeographical range shifts, except in the most general terms. Demographic research requires much better observations.

Conclusions Drawn from Genetics and Morphology

There are, however, some interesting generalizations that can be made, although some of them depend as much on genetic and linguistic patterns or primate analogues as they do on skeletal or archaeological remains. In different ways genetic and linguistic patterns among current African populations reflect past movements, isolations, and distributions. History is written in the diversity of traces on the physical and social landscape. The application of sophisticated genetic techniques to fossil or subfossil hominid remains, though in its infancy, promises to expand considerably the conclusions that can be drawn from artifact distributions and morphological comparisons.

First, there is nearly universal agreement that through the Pleistocene African populations were becoming increasingly modern and formed the core group from which both archaic and modern people emerged. Although it is possible that early hominids are almost uniquely represented in the dolomite caverns of the south and the rift valley lake beds of the east purely because of good preservational circumstances, stone tool distributions offer an opportunity free of such taxonomic limitations.

African archaeologists now have a good idea of the technological and formal development as well as the approximate dating of artifact assemblages. All the earliest stone tool assemblages come from riverside or lakeside camps in savanna landscapes with moderate to low rainfall, whereas occupations in demonstrably arid, humid, rugged, or forested regions come much later. The savanna hypothesis for the origins of hominid adaptation, however, may have overestimated the terrestrial habit of early hominids at the expense of riverine fringe resource use. Presumably, early populations were expanding into more difficult resource areas, a movement that was facilitated by technological and social innovations and fueled by a growing intellectual capacity. Brain-specific nutrition, such as the fatty acids so abundant in freshwater and marine ecosystems, probably underwrote sustained, and energetically expensive, brain growth. Eventually, certainly by 1.5 million years ago, populations reached the boundaries of the continent in the Mediterranean climates of the north and the south. Only the route to the north led elsewhere.

Movement Out of Africa

The earliest human skeletal remains from outside the African continent date from a little more than 1 million or perhaps 1.5 million years ago in southern Europe and southwestern and southeastern Asia. These sites mark the first out-of-Africa movement, perhaps along productive and nutritionally rich coastal plains, although evidence is scarce. Palaeoanthropologists disagree on whether there were several later movements or a more or less continuous diffusion of population out of Africa after that time, but most support at least one recognizable expansion between 100,000 and 50,000 years ago.

Skeletal remains more or less indistinguishable from the modern form are found around the coastal fringes of southern Africa soon after 100,000 years ago, but their rarity at contemporary sites farther north could as easily be preservational, or even terminological, as evidential. It is possible that modern people evolved throughout Africa. Outside Africa almost all human populations after about 30,000 years ago are described as modern and appear to be ancestral to recent local populations. It appears increasingly likely that whereas African populations were evolving toward the modern condition, the archaic humans already living in Europe and Asia were not, though the significance of genetic separation and the potential for genetic reincorporation are controversial issues.

If these southern African populations really are part of the ancestral stock from which all modern humans evolved, their descendants soon became isolated by extreme aridity in the midlatitudes. By 70,000 years ago both the Saharan and the Kalahari-Namib arid landscapes had expanded under the influence of global glacial expansion, altered atmospheric circulation, and oceanic cooling. This diminished genetic and cultural links between equatorial and Mediterranean African groups at either end of the continent. At the Cape and in the Mediterranean, with similar latitudes and climates, people drifted genetically away from their subtropical relatives until terminal Pleistocene climate changes allowed more substantial connections across shrinking aridity barriers.

The implications of this for Cape populations at the southern tip of the continent are of course profound and quite different from those for their northern relatives living on the fringe of Eurasia. The blood group and other genetic parameters that distinguish broad groups of Africans seem to have been the result of late Pleistocene extreme aridity. As the glaciers melted, previously isolated groups began to reestablish contact, resulting in the complex social, linguistic, genetic, and political landscape that exists in the early twenty-first century.

During the Holocene period population movements within the African continent seem to have been associated with the sub-Saharan spread of farming and metallurgy during the last three millennia. In the early Holocene domesticated plants and animals in Africa were limited to the Mediterranean Basin, where the domestication process began, and to winter rainfall domesticates. Once the idea of domestication had been transferred to subtropical crops, probably in the highlands of Ethiopia, a process of diffusion to the south began. Although the Mediterranean domesticated animals remained the important ones, new plant species, significantly forms of millet and sorghum, were added to the domestic suite.

It was only after the conjunction of domesticated plants, animals, and metallurgy some 2,500 years ago that any kind of rapid population movement can be detected. This is most obviously reflected in the distribution of languages of the Niger-Congo family in western, eastern, and southern Africa. Within this grouping languages spoken by people separated by thousands of kilometers remain linguistically similar, suggesting a recent common ancestry. The most parsimonious explanation is one of recent rapid population movement, bringing Niger-Congo-speaking, metal-using farming communities east and then south through the parts of sub-Saharan Africa suited to millet and sorghum farming.

Understandably, many parts of the subcontinent were unattractive to people with domestic stock or crops, leading to the survival of hunting and gathering communities in regions that were too arid, rugged, or forested for some version of agriculture or pastoralism. Farmers moved preferentially into lands that were easily tilled without machinery, naturally watered, and suited to the requirements of both domesticated animals and cultivated crops. The wide distribution of very similar ceramic forms and decorative motifs from the Great Lakes region to the eastern parts of South Africa from about 2,500 to 1,500 years ago mimics the pattern of language similarities and almost certainly supports the notion of a rapid population movement.

Several hundred small, encapsulated groups of hunter-gatherer communities survived across Africa to provide case studies for nineteenth- and twentieth-century ethnographers. The most substantial residual hunting and gathering populations remained in place in the southwestern corner of the continent until very recently in the form of people referred to as bushmen or San. Their nearest geographic, cultural, and genetic relatives, the pastoralist Khoe or Quena (derogatively known as Hottentots), have been the focus of much debate. It appears likely that Khoe pastoralists were former San hunters and gatherers who had gained access to stock through contact with Niger–Congo-speaking mixed farmers who were penetrating the former San regions of southernmost Africa. They were subsequently able to replace or incorporate hunter-gatherer groups in areas where stock, particularly the fat-tailed sheep they herded, could thrive. This process, which essentially was confined to the arid western parts of the subcontinent, was contemporary with the spread of mixed farming in the east, where better rainfall and deeper soils made crop farming viable. These two expansions were complementary and effectively defined the population structure of modern southern Africa.

The Earliest Moderns?

What makes this historically and evolutionarily interesting is the confluence of linguistic, behavioral, and genetic patterns in the geographically well-defined Khoe and San people. Leaving aside earlier theories of the existence of a "Capoid race," it is surely significant that groups formerly dominant south of the Kalahari-Namib arid zone exhibit biological and cultural signs of extreme and long-lasting isolation. Implosive consonants ("clicks"), a highly noticeable feature of Khoesan languages, are unknown in regular speech anywhere else in the world; geneticists have detected ancient mitochondrial DNA lineages among modern Khoe and San people; and the survival of San hunter-gatherers into recent times coincides geographically with the distribution of the best evidence for early modern humans.

It is tempting to write a history of human populations at the Cape that views them as the earliest moderns, subsequently isolated from their relatives elsewhere, allowed by environmental factors and geographic marginality to remain relatively unaffected. It is appropriate that they should have survived to become the best ethnographically studied examples of a formerly pan-human hunting and gathering lifestyle. They are certainly not living fossils, but their study has unlocked the secrets of precolonial rock paintings, provided models for archaeological reconstructions, and graphically illustrated the details of a genocidal colonial era.

See also: *Archaeogenetics; Environmental Impact, Human; Evolutionary Demography; Hunter-Gatherers; Indigenous Peoples; Paleodemography; World Population Growth.*

BIBLIOGRAPHY

Klein, Richard. 1999. *The Human Career: Human Biological and Cultural Origins.* Chicago: University of Chicago Press.

Klein, Richard, and Edgar Blake. 2002. *The Dawn of Human Culture.* New York: Wiley.

John Parkington

ASIA

The vast majority of the paleoanthropological evidence from Asia, particularly most of the geologically-early evidence, derives from East and Southeast Asia, especially mainland China and Java. Relatively early fossil evidence has also been recovered from Narmada, India. South Asia—including Ceylon, Pakistan, Bangladesh, and especially India—has also played an important role in interpretations of Asian paleolithic archaeology as a whole. West Asia has yielded archaeological and fossil evidence of Neanderthals, early anatomically-modern *Homo sapiens,* and possibly *Homo erectus.*

Regional Continuity or Replacement Model Interpretation of Modern Asian Humans

There are two major antithetical theories about the origins of modern Asian populations. One theory, called *Replacement Theory* or "Out of Africa Theory," maintains that modern Asian populations descended from a geologically recent (ca. 100,000 to 50,000 years ago) migration from Africa that resulted in the total replacement of the indigenous hominids who had occupied Asia from close to or more than one million years ago. The Replacement Theory is based on mtDNA (mitochondrial DNA) studies that purport to show that all modern humans are descended from a single African female, "Eve," as she has been termed in the press. Diametrically opposed to this interpretation is the *Regional Continuity Theory,* which maintains that Asian *Homo erectus* evolved into the anatomically modern Asian *Homo sapiens.* Both theories agree that all hominids originated in Africa; they disagree about when hominids first left Africa and when extant populational distinctions originated.

Replacement proponents have argued that the "crude" nature of the Far East Asian tool kit is the product of the evolutionarily stagnant species *Homo erectus*. In this scenario, suggested by scholars such as Christopher Stringe and Bernard Wood, *Homo erectus* left Africa before the development of more sophisticated stone technologies such as the Acheulean "hand axe" and became a genetically-isolated evolutionary dead end, never passing beyond the technological sophistication of the earliest and most crudely made Oldowan artifacts of Africa. But neither the Asian paleontological evidence nor the paleolithic record documents morphological or cultural stagnation. Indeed, there is evident morphological change in the fossil record in the direction of modern Asians. Scholars such as Geoffrey Pope, Mulford Wolpoff and many others assert that both the archaeological and hominid fossil records support evolutionary continuity in Asia.

Culture and Technology

In the 1940s the archaeologist Hallam Movius (1907–1987) pointed out that there is a "line" of demarcation between hand axes of prehistoric South Asia and the crude, so-called "chopping-chopper" tools of the Far East. He believed that places like China and Java were cultural backwaters where human-like technology never evolved beyond the most simplistic levels. His work led to the concept of the "Movius Line," which has been used to demarcate evolving humanity from populations that had somehow become "stuck in time." Very few hand axes have ever been found in China despite long and concerted searches. L. Binford and Nancy Stone (1987) suggest that there is very little reliable evidence for any human-like culture in the artifact assemblages of ancient Asians.

In 1989, Pope countered Movius's resurrected argument with the observation that the "crude" Far Eastern tools coincide with the distribution of bamboo and a wealth of other non-lithic resources. The Pleistocene inhabitants of the region most certainly utilized these resources. Since *Homo erectus* (i.e., early to middle Pleistocene *Homo* in East Asia) was the first hominid to colonize both temperate (including seasonally frigid) as well as tropical environments and given its long presence in the region, it seems more reasonable to interpret the simple stone technology of Pleistocene Asia as complementary to sophistication in non-lithic resource utilization. The seemingly unchanging Asian paleolithic record, described (tongue in cheek) by one archeologist as "crude, colorless and unenterprising" (White 1977), is more parsimoniously attributed to an emphasis on non-lithic technology such as bamboo and other organic resources.

Agriculture in Asia seems to have developed independently at about 10,000 years ago in both China and northwest India. Mesopotamian agriculture may also have been of independent origin from the Fertile Crescent in Iraq. Some archaeologists have suggested that rice cultivation and pottery and/or polished stone tools seem to have diffused from China to other circum-Pacific regions. Similar diffusion processes may have existed for other cultigens in South and West Asia.

Hominid Morphology

The history of Far Eastern paleoanthropology begins in 1891 when Eugene Dubois (1858–1940) discovered the first *Homo erectus* skull cap and femur at Trinil, Java. Subsequent discoveries of other Javanese and Chinese hominids confirmed the hominid status of *Homo erectus,* as did the many discoveries made at the famous "Peking (Beijing) Man" site of Zhoukoudian Locality 1 in China. These finds are now considered to be representative of *Homo erectus.*

Anatomically, *Homo erectus* is defined primarily by its extremely thick cranial bones, a projecting and continuous brow ridge above the eye orbits, a sagittal "keel" of thickened bone running from the top of the skull to the back of the cranium, a thickened and angular occipital region, and a generally robust skeleton. These features are expressed most strongly today among indigenous populations of the southwest Pacific. *Homo erectus* also displays a much-debated dental anatomy including what have been called "shovel shaped" incisors, a trait that is most prevalent in modern "Mongoloid" and Mongoloid-derived populations. As Pope (1992) pointed out, other facial features also appear to connect this extinct species with modern East Asian and Native American populations.

Such morphological evidence is discounted by proponents of the Replacement Model, who point instead to the biomolecular results of mtDNA studies as an indication that this species and others from East Asia went extinct with the arrival of anatomically-modern *Homo sapiens.* These DNA interpretations can in turn call into question the many genetic assumptions which the model makes.

A number of anatomically more modern-looking hominids have also been recovered from both Java and China. Only one early hominid specimen has also been recovered from Narmada, India. "Archaic or Pre-modern" hominids all have larger cranial capacities than is typical of *Homo erectus,* as well as other features reminiscent of fully modern humans. The Solo (Ngandong) crania from Java look very much like scaled-up versions (in terms of cranial capacity) of *Homo erectus.* Whether these crania should be classified as *Homo erectus* or *Homo sapiens* is a matter of continuing debate, but they provide strong evidence of continuity between fossil and modern hominids.

By definition, separate species cannot interbreed and produce fertile offspring. Classic reasons for such barriers are geographical separation, anatomical–behavioral incompatibility, temporal separation, genetic incompatibility, or a combination of all or some of these factors. In Asia geographically-widespread hominids give rise to a number of specimens which look anatomically distinct from one another. Whether these differences represent species difference or an increase in variation within a species, is not known. In Pleistocene Asia, variation in appearance seems to increase over time. Since paleoanthropologists have only the bones and stone to study, they cannot tell if the morphological differences in fossils indicate species barriers that would prevent interbreeding or are reproductively unimportant. New forms may have arisen through interbreeding of once far-flung and isolated populations that came into contact again. In short, the relation between morphology and breeding can never be known for certain in fossil paleospecies.

Geography and Climate

The geography and climate that helped shape the anatomical traits and paleoecological adaptations of *Homo erectus* resulted in a large extent from the continuing tectonic collision of the South Asian Plate with the underbelly of the Asian mainland. This continuing collision produced the vast Himalayan mountain system that, in combination with the equatorial monsoons, has had a strong influence on hominid evolution in Asia. Worldwide climatic fluctuation, while no doubt influential in the formation of climates and topographies, did not, except indirectly, have the profound ecological influence on Asian climates that it had in glacial Europe. However, indirect influence in the form of the development of the loess areas of North China and the rise and fall of sea levels surrounding and alternately isolating and connecting the present islands of the Sunda Shelf certainly affected hominid evolution and dispersal.

The effects of the Himalayan uplift are also responsible for the modern loess plateaus, grabens, and mountains that form the past and present biogeographic regions, barriers, and biogeographic dispersal routes of Asia. Early hominids seem to have been confined to relatively low and thus warmer altitudes, where all of the early hominid finds in Asia have been located. Although the long and repeated occupation of sites such as Zhoukoudian Locality 1 testify to the ability of *Homo erectus* to endure marked seasonal fluctuations, it seems that cold temperature altitude was a definite limiting factor in the distribution of this species. Over the course of a million years, however, *Homo erectus* had become adapted to a number of varying environments. It is difficult to imagine that a tool-dependent hominid could have been completely replaced by invaders in all these ecological settings, which it had occupied for approximately one million years.

The influence of the Himalayan uplift also influences researchers' understanding of prehistoric archaeology in Asia. In South Asia and Western Asia, the run-off and resulting detritus from the Himalayan system may be the principal reason that only one early Pleistocene hominid (Narmada) has been recovered from South Asia.

Archaeologists have yet to discover the presence of early (Early Late Pleistocene) hominids in other countries of the Far East, such as the islands of Southeast Asia and Taiwan (and possibly Japan) that were periodically connected by land bridges at times of low sea level. Australia was never connected to Asia, and therefore its first colonization by around 40,000 or more years ago must have been over water.

Gene Flow

As early as 300,000 years ago, hominids that were physically very different from each other were living in the same geographic regions. This also happened in Europe, where Neanderthals lived side by side with modern humans for as much as 60,000 years and also shared (to judge from their artifacts) many of the same cultural attributes. It is rare, if not unknown, for modern hunters and gatherers to exchange only culture and not genes. Furthermore, there is no well-established evidence for one group of hunters and gatherers ever having completely replaced another. It is in this light that the later evolutionary evidence from Asia must be interpreted.

In China, recent finds of pre-modern *Homo sapiens* (such as Dali and Jinniushan) show a remarkable degree of variation that, on the basis of archaeologists' current knowledge, seems to exceed differences in other geographic areas. One interpretation, strongly supported by Pope and others, is that gene flow across Eurasia became increasingly more common as hominids increased in cultural complexity and technological prowess.

More generally, in the closing phases of the Pleistocene it seems likely that increased gene flow occurred between the eastern and western edges of Eurasia and the continent of Africa. The morphological "sameness" which has often been perceived in *Homo erectus* culminates in a variety of morphologies that indicate gene flow. Many scholars believe that the much more recent changes in lithic technology may indicate continued and even increased gene flow across the top of Eurasia, primarily proceeding in directions along an East-West axis, but also along a North-South axis.

Conclusion

To explain the origin of modern Asian peoples, one needs to recognize both indigenous development and transcontinental gene flow, and not simple regional continuity or replacement by geologically recent Africans. Physically, Asians are impossible to define as a single group unified by any ubiquitous morphologies. There are clines of differences such as in skin color, facial characteristics, or body type, reflecting regional adaptations. Repeated genetic exchange occurred from both near and far.

From the standpoint of physical anthropology and archaeology, anatomically modern Asian populations are the product of both local indigenous adaptation and extraregional gene flow. From a cultural standpoint, modern Asian groups result from continuing and ancient overlays of culture, religion, and ecological adaptations. Neither the fossil nor the archaeological evidence points to a single geographical or temporal origin of Asians.

See also: *Archaeogenetics; Paleodemography; World Population Growth.*

BIBLIOGRAPHY

Bellwood, Peter. 1994. "An Archaeologist's View of Language Macrofamily Relationships." *Oceanic Linguistics* 33: 392–406.

Binford, L. R, and Nancy M. Stone. 1987. "On Zhoukoudian. Reply to Comments." *Current Anthropology* 28(1): 102–105.

Cann, Rebecca L. 1988. "DNA and Human Origins." *Annual Review of Anthropology* 17: 127–143.

Jia, Lanpo, and Weiwen Huang. 1990. *The Story of Peking Man.* Beijing: Foreign Language Presses and Oxford University Press.

Keates, Susan. 2000. *Early and Middle Pleistocene Hominid Behavior in Asia.* Oxford: BAR International Series 863.

Movius, Hallam. 1944. "Early Man and Pleistocene Stratigraphy in Southern and Eastern Asia." *Papers of the Peabody Museum of American Archaeology and Ethnology* 19(3): 1–125.

Pope, Geoffrey G. 1984. *Hominid Evolution in East and Southeast Asia.* Ann Arbor: University Microfilms.

———. 1992. "The Craniofacial Evidence for the Origin of Modern Humans in China." *The Yearbook of Physical Anthropology* 35: 243–298.

———. 1997. "Asian Paleoanthropology." In *The History of Physical Anthropology, An Encyclopedia,* ed. Frank Spencer. New York and London: Garland Publishing.

———. 1997. "Java." In *History of Physical Anthropology, An Encyclopedia,* ed. Frank Spencer. New York and London: Garland Publishing.

Pope, Geoffrey, and Susan Keates. 1994. "The Evolution of Human Cognition and Cultural Capacity: A View from the Far East." In *Integrative Pathways to the Past,* ed. Robert Corrucini and Russel L. Ciochon. Englewood Cliffs, NJ: Prentice Hall.

Stringer, Christopher. 1992. "Replacement, Continuity and the Origin of Homo sapiens." In *Continuity or Replacement? Controversies in Homo sapiens Evolution,* ed. Günter Brauer and Fred H. Smith. Rotterdam: Balkama.

Swisher III, Carl, et al. 1994. "Age of the Earliest Known Hominids in Java, Indonesia." *Science* 263: 1,118–1,121.

Tungsheng, Liu, et al. 1985. *Loess and the Environment.* Beijing: China Ocean Press.

Turner, Christy G. 1990. "Major Features of Sundadonty and Sinodonty." *American Journal of Physical Anthropology* 82(3): 295–317.

von Koenigswald, Gustav H. R. 1962. *The Evolution of Man.* Ann Arbor: University of Michigan Press.

Wolpoff, Milford. 1999. *Paleoanthropology.* Boston: McGraw Hill.

Wood, Bernard. 1994. "Taxonomy and Evolutionary Relationships of Homo erectus." *Courier Forschunginsitut Senckenberg* 171: 159–165.

Geoffrey G. Pope

AUSTRALIA AND THE PACIFIC

Although hominids have been present on Sunda, the continental shelf of what are now islands in Southeast Asia, for more than 800,000 years, they appear to have been unable to regularly cross water barriers. *Homo erectus* traversed small ocean gaps to reach Flores in Indonesia, but was absent from islands further east. Consequently Australia and the Pacific islands were first colonized by modern humans. This observation has often been used as a measurement of the greater organizational capacity of *Homo sapiens* during the last 40,000 to 60,000 years, perhaps reflecting enhanced language abilities. Populating the Pacific required human groups to have adequate seacraft, but more importantly to have the means of storing and transmitting information about new environments. In each part of the Australian-Pacific region the first evidence of human occupation not only implies extensive seafaring skills but also includes the archaeological residues of complex social behavior: art and ornaments, burials, and well-organized settlement structures.

Exploration of the Australian continent and Pacific islands was a prolonged process, taking many millennia to complete. The colonizing process began in the west, and terminated in the remote eastern and southern Pacific Ocean. Australia is the landmass in the region with the earliest dates for human occupation.

Australia

Homo sapiens colonized the Australian continent more than 40,000 years ago, although there is extensive debate as to whether humans arrived as early as about 55,000 to 60,000 years before the present (abbreviated B.P.), or as late as 40,000 to 45,000 B.P. This debate hinges on different opinions as to the veracity of alternative dating techniques, as well as uncertainty about the extent of disturbance processes in early archaeological sites. Claims for occupation substantially earlier than 60,000 B.P. have been shown to be spurious. The uncertainty about the date of colonization makes reconstructions of the first settlement systems tenuous. For instance, if colonization took place prior to 40,000 B.P., so few sites are known that discussions of settlement are insubstantial. Furthermore, dating uncertainties make it impossible to evaluate the actual rate of colonization within Australia.

Some scholars have suggested that early settlement may have focused on coastal resources, but this seems unlikely in view of the growing evidence of occupation in arid and semi-arid inland landscapes. Lake Mungo is the most famous example of inland occupation, but hundreds of sites now reveal Pleistocene-era occupation, more than 10,000 years old, in a diverse range of inland landscapes. It is clear that people at least occasionally occupied many environments within Australia, and it is thought that population densities were higher in the zones of higher rainfall around the periphery of the continent. Early models of population change hypothesized fixed patterns of settlement during the Pleistocene, such as continuously low or high numbers of people in the arid core of Australia. These models have more recently been replaced by an image of fluctuating population in response to changing resource availability and discontinuous settlement in at least some landscapes. This is most dramatically illustrated in the glacial uplands of Tasmania, where humans abandoned the region permanently in the terminal Pleistocene, and in some arid landscapes, where some regions were abandoned during the glacial maximum, 14–18,000 B.P., while in other regions with favorable resource bases occupation continued throughout the glacial maximum.

During the late Holocene period (3000 B.P. to present), a larger number of archaeological sites were occupied in many regions of Australia, coastal and inland, islands and mainland. There was also an increase in the number of sites and the number of artifacts in many of those sites. Many archaeologists have interpreted this pattern as a reflection of population increase during the later prehistoric period in Australia. However, the magnitude of any population change has been difficult to evaluate. Calculations of the annual increase in site numbers and the rate of artifact discard show that both measures, in all regions, were well below 0.1 percent per year. It is feasible that this might be the approximate rate of population change, in which case the scale of change would be something like a tripling or quadrupling of population between 4000 and 1000 B.P.. The absolute size of the population during this period cannot be calculated.

Increases of population may have been greater in some regions than in others. For example, in the southeast (particularly in the densely populated Murray River Valley), high levels of anemia, parasitism, and infectious diseases have been inferred from skeletal markers, and perhaps indicate higher densities of people in these lands. This conclusion is consistent with the discovery of many densely-packed cemeteries in this region. Some researchers have therefore suggested that the river valleys of the southeast were more densely populated, but if so these regions also show the same archaeological evidence for increased site and artifact abundance.

If these archaeological patterns indicate minor but sustained population growth, the causes are unclear since this period was one of drier and variable climatic conditions. Some researchers have suggested that intensification of production driven by social competition led to population increase, but there is little support for this theory in the archaeological evidence. However, the cause of population change in this period need not be a dramatic process, since the growth rate discussed here would represent a minor departure from a long-term balance between births and deaths. Moreover, a number of archaeologists have cautioned that the change in the quantities of archaeological material (numbers of sites and artifacts) is probably not a reliable indicator of the magnitude of population change. The quantity of archaeological material preserved from any period is a reflection of many factors in addition to group size, including the destruction of sites and the wastefulness of the production system creating artifacts. Such factors would have exaggerated the observable abundance of material in the recent past. Consequently, while many archaeologists have concluded there were population increases in the late Holocene, the nature and size of those changes remains poorly defined.

Melanesia

Melanesia is that area of the western Pacific that includes New Guinea and a series of large and small islands stretching eastward. Lower sea levels during the Pleistocene meant that New Guinea was connected to northern Australia by an exposed portion of the shared continental shelf, and it is not surprising that the human occupation of New Guinea is thought to be of comparable antiquity to that of Australia. Archaeologists have dated the subsequent colonization of the islands to the east of New Guinea to more than 35,000 years ago, based on a series of archaeological sites in New Britain and New Ireland such as Buang Merabak, Yombon, and Matenkupkum. By about 30,000 B.P. people had reached the Solomon Islands, but here the colonization process halted for 25,000 years. This distribution of archaeological sites in Pleistocene Melanesia is limited to those islands separated by a water barrier of less than 250 kilometers, a distance that perhaps indicates the limits of the maritime journeys of the day. However, within the colonized zone of Melanesia there appears to have been considerable maritime interaction, including possible trade, which implies that longer oceanic journeys may not have been impossible. For whatever reason, more isolated islands were not colonized until much later, with the spread of people archaeologists call *Lapita.*

Lapita is a distinctive archaeological complex, marked in many sites by elaborate dentate stamped pottery, and by diverse economic practices including but not limited to the use of domesticated plants (yams, taro, banana, etc.) and animals (chicken, pig, dog). This archaeological material first appears in the Bismarck archipelago, east of New Guinea, about 3500 B.P. and spreads eastward throughout Melanesia within a short time. The proliferation of the Lapita Complex is likely to have involved not only the colonization of distant islands of Melanesia but also a region-wide increase in population.

Late Holocene increases in population size in many parts of Melanesia are often thought to reflect the introduction of agriculture that accompanied Lapita. However, the late Holocene population changes in Australia, where agriculture was never established, and the obvious late Holocene growth of populations on Polynesian islands, where agricultural abilities were known to the founding groups, represent parallel demographic trends. These similarities are as yet unexplained but imply processes other than or additional to the introduction of agriculture.

Polynesia

Polynesia is the vast expanse of the central Pacific Ocean covering nearly 30 million square kilometers. Within this area are a number of island groups, from Samoa and Tonga in the west to the Hawaiian Islands in the north, Easter Island in the east, and New Zealand in the southwest. The spread of people across this vast region appears to have taken place in a number of stages. Excavations on many islands suggest humans moved from the Samoa and Tonga island groups eastward into the central Polynesian region about 2200 years ago. After building an economic and demographic base in the Marquesas and Society Islands, people migrated northward to Hawaii and further east to Easter Island approximately 1500 to 1700 years ago. Still later, only within the last 800 years, another migration to the south produced the colonization of New Zealand. These movements of people were sometimes single, one-way voyages, but there is also evidence of return voyaging and secondary migrations, making the colonization process a complex one.

Population change in the Pacific islands has been measured by charting alterations in the abundance of dated habitation sites. For example, on a number of the Hawaiian Islands analysis of this archaeological evidence reveals an S-shaped population curve: there were few habitation sites dated to the period prior to 800 B.P. (1200 C.E.), then a tenfold increase in habitations during the period from 800 to 400 B.P. (1200–1600 C.E.), followed by a stabilizing or even decline in their number. The period of rapid increase is thought to have been caused by the development of intensive forms of food production such as irrigated field systems and fishponds. The cessation of population growth may have been a result of limits to agricultural intensification in some regions and of European contact and diseases. Population growth in the Hawaiian Islands is also entangled with sociopolitical change. In Hawaii's hierarchical political structure, the increased pools of labor could be directed by chiefs to create large-scale infrastructure projects that increased resources for the expanding population. As this process continued, the distinctions of rank and power became exaggerated. Warfare appears to have increased in frequency and severity as struggles over power and resources became more intense. This pattern of increasing warfare, sometimes accompanied by declining populations as human-induced environmental changes occurred, is a common one.

European Contact

In many areas of the Pacific and Australia, the introduction of diseases such as smallpox at the time of European contact led to marked reduction of population and subsequent reorganization of social, political, and economic practices. For this reason it is accepted that many historical observations of population density are poor indicators of precontact demographic conditions. It is likely that population densities in Australia and the Pacific during the late Holocene were substantially higher than observed historically, a pattern that matches well with archaeological evidence.

See also: *Archaeogenetics; Hunter-Gatherers; Paleodemography; World Population Growth.*

BIBLIOGRAPHY

Fagan, Brian. 1996. *The Oxford Companion to Archaeology.* New York: Oxford University Press.

Flood, Josephine. 1995. *Archaeology of the Dreamtime,* 3rd edition. Sydney: Angus and Robertson.

Kirch, Patrick Vinton. 1985. *Feathered Gods and Fishhooks.* Honolulu: University of Hawaii Press.

Irwin, Geoffry. 1992. *The Prehistoric Exploration and Colonisation of the Pacific.* Cambridge, Eng.: Cambridge University Press.

Meehan, Betty, and Neville White, eds. 1991. *Hunter-gatherer Demography: Past and Present.* Sydney: University of Sydney.

Spriggs, Matthew. 1997. *The Island Melanesians.* Oxford, Eng.: Blackwell Publishers.

PETER HISCOCK

EUROPE

Europe was the last continent of the Old World to be inhabited by modern humans, but the demographic prehistory of Europe is as long, as rich, and a lot better known that that of any other continent. In spite of the short history of human occupation in Europe, some of the most important evolutionary demographic events took place there.

The First Europeans

About 1.7 million years before present (B.P.), *Homo ergaster,* the earliest hominid species known in Europe, reached the Caucasus. However, it was a descendant of this species, *Homo heidelbergensis* that about 500,000 B.P. became the first true European. These hominids had a lasting influence, as can be seen from the morphological similarity between European *Homo heidelbergensis* and the Neanderthals who inhabited most of Europe between 250,000 and 30,000 B.P. Anatomically modern humans—*Homo sapiens sapiens*—only arrived in the region around 40,000 B.P. The Neanderthals adopted some technological skills from the anatomically modern human population, which indicates that the two groups of humans met and exchanged knowledge and probably genes as well.

There were never many Neanderthals in Europe—100,000 individuals at any one time is probably an absolute maximum size of the population. But the few specimens of identified Neanderthal DNA indicate that the size of the breeding population of Neanderthals was as large as that of anatomically modern humans, as shown by John Relethford (2001). The overall number of Neanderthals probably fluctuated along with changes in mean temperature during the glacial cycles. Eric Trinkaus, in his 1995 study, has concluded, based on a small sample, that the pattern of mortality was similar to that found in prehistoric anatomically modern groups, although the Neanderthals experienced a higher level of young adult mortality.

Anatomically modern man and Neanderthals coexisted in Europe for around 10,000 years. Around 30,000 B.P. the Neanderthals ceased to exist as a culturally and biologically distinct group. What happened to them is a source of considerable debate, but the available evidence is slightly in favor of the survival of some Neanderthal genes in the present European population, according to Relethford.

Anatomically modern man appeared in Europe at the beginning of the Upper Palaeolithic period—about 35,000 B.P.—a period marked by many new and well-made stone and bone tools. The rate of cultural innovation increased markedly at that time, making it possible to date archaeological sites more accurately than those of earlier times. Thus it is possible to track fluctuations in population size through the last stages of the last Ice Age. Climatic changes were the main driving force for changes in population size and distribution. The close association between the area occupied and climate indicates that human adaptive strategies remained basically unchanged over the 25,000 or more years (from around 35,000 to 10,000 B.P.) of the Upper Paleolithic. Only at the end of the Upper Paleolithic is there evidence for the use of a broader array of foods and environments, foreshadowing the subsequent early post-glacial Mesolithic period.

Economic Transitions

Since the end of the Ice Age (roughly 10,000 years ago) Europe has experienced two fundamental economic transitions. The first transition, the Neolithic Revolution, saw the earlier hunting-and-gathering way of life of the Mesolithic era replaced by subsistence agriculture as the dominant mode of production. In well-dated areas, such as southern Scandinavia, this transition took place over many centuries. Agriculture, which had originated in the Middle East, spread to Europe from east to west along the Mediterranean and southeast to northwest through Central Europe to the plains of Northern Europe. Agricultural communities appeared in Scandinavia some 3000 years after they first were seen in Greece. This peasant agricultural era spans much of the Neolithic and the Bronze and Iron Ages; it can be termed the Peasant Age.

The second transition was from subsistence to market production. This also took several centuries. It was marked by the development and growth of urban centers.

All parts of Europe have gone through Neolithic Revolutions and market transitions, and these transformations, not the absolute dating of various events, define the demographic prehistory of Europe. For example, the Sami of northernmost Europe entered the first transition at a time when the central parts of the Roman Empire were already entering the second transition.

Prehistoric Mortality

All post-glacial periods have yielded extensive cemeteries, the skeletal remains from which allow estimation of age at death distributions. Very rough rates of infant mortality, average late childhood (age 5 to 18 years) mortality rates, and levels of life expectancy can be inferred.

Table 1 summarizes the broad trends in European mortality in terms of the three indicators from the Mesolithic through the Neolithic revolution, the Peasant Age, and the market transitions to contemporary Europe, partly based on skeletal data from

TABLE 1

Levels and Patterns of Mortality in Europe, by Era

Era	Infant mortality (%)	Average late childhood mortality age 5 to 18 (%)	Life-expectancy, at birth (years)
Mesolithic	10–20	<0.5	35
Neolithic revolution	15	1.0	<35
Peasant Age	15	1.5	30
Early market transition	15	2.5	<25
Late market transition	25	1.0	35
Modern Europe	<5	<0.1	>70

SOURCE: Paine and Boldsen (2002).

Richard Paine and Jesper Boldsen published in 2002. Infant mortality is not as high during the Peasant Age as it later becomes. There is a significant increase in late childhood mortality across the Neolithic Revolution, a high plateau during the Peasant Age, and a decline when trade and urban communities became common.

In Scandinavia the change from subsistence to market production took place very late and can therefore be better described. The process seems to have gone through two steps. First there was a sharp increase in late childhood mortality when the market still was peripheral to the local rural communities, followed by a rapid decline as these communities became fully integrated in the network of market towns and trade relations, according to a 1997 study by Boldsen.

The Driving Force of Demographic Evolution

Although much remains to be learned about European population prehistory, it is clear that fluctuations were common. Phases with relatively steady growth were separated by episodes of collapse, when the population had exceeded the carrying capacity of the environment at the existing technological level. Over the millennia, Europe's population grew along with its technology.

When people became settled during the Neolithic Revolution, local environments became much more polluted with human and animal waste, which increased the risk of infection with gastrointestinal diseases. Such infections tend to affect people of all ages, not only infants and the elderly, and are the reason for the initial increase of late childhood mortality. Some infections left definite signs on skeletons but most did not.

With the growth of trade relations and urban centers, new avenues for the spread of infections were opened. Viral infections such as the great killers, measles and smallpox, could spread widely. These are diseases that leave a lasting immunity in survivors, so large human (host) populations are needed to sustain them as endemic or frequently recurrent diseases. However, all segments of the population were not at equal risk of exposure to the relevant pathogens. In small and relatively isolated rural communities, these crowd infections would die out, only to be reintroduced at a later time when the populations no longer had immunological experience with them. Viral infections striking such virgin populations tend to affect people at all ages and cause widespread mortality. Eventually, as contact with the trade network intensified, the reservoir for the pathogens expanded virtually region-wide and what had been the great killer diseases changed to the childhood diseases that affected European populations within living memory.

See also: *Climate Change and Population: History; Disease and History; Paleodemography; World Population Growth.*

BIBLIOGRAPHY

Boldsen, Jesper. 1997. "Patterns of Childhood Mortality in Medieval Scandinavia." *Revista di Antropologia* 74: 147–159.

Paine, Richard, and Jesper L. Boldsen. 2002. "Linking Age-at-Death Distributions and Ancient Population Dynamics: A Case Study." In *Paleodemography: Age Distributions from Skeletal Samples,* eds. Robert. D. Hoppa and James. W. Vaupel. Cambridge, Eng.: Cambridge University Press.

Relethford, John. 2001. *Genetics and the Search for Modern Human Origins.* New York: Wiley-Liss.

Trinkaus, Eric. 1995. "Neanderthal Mortality Patterns." *Journal of Archaeological Science* 22: 121–142.

JESPER L. BOLDSEN

THE AMERICAS

Unlike the Old World, where modern humans and their ancestors evolved and underwent a variety of demographic processes over a long period of time, the presence of *Homo sapiens* in the New World is a relatively recent occurrence, with the first migrations having taken place well after the emergence of anatomically-modern humans in the Old World. When these earliest migrations occurred, however, remains the subject of debate, particularly with respect to how and when people migrated to areas south of northwestern North America.

The Peopling of the New World

Researchers generally agree that the first humans in the New World came from Asia. Evidence for this movement comes from the analysis of biological traits such as tooth morphology and blood types as well as from linguistic relationships between contemporary and historical populations. The traditional assumption is that humans traveled from Siberia to Alaska over a land bridge that is now submerged beneath the Bering Strait.

During periods of glaciation, the last of which occurred about 10,000 years ago, this area, called Beringia, would have been dry land. Based on paleoclimatic reconstructions, it is known that Beringia was exposed from about 60,000 years ago to 18,000 years ago. However, that does not indicate when the first human populations migrated into North America or whether current North American aboriginal populations are descended from the early migrants or from subsequent waves of population movement. There is evidence of human occupation on the southern tip of South America from at least 12,500 years ago and perhaps even earlier; this means that the earliest movements into the New World through Alaska must have occurred substantially earlier than this date.

It is possible that humans came to the New World by water, but there is no evidence for this hypothesis. If this occurred, there should be coastal sites, now submerged under higher seas, that show evidence of human occupation.

Early sites of occupation. The evidence for early human migration into the New World comes from a few archaeological sites. On the basis of those clues, most researchers concede that humans were not present south of Alaska until after about 15,000 years ago. Although there may have been an ice-free corridor during the earliest period of migration into the New World, conditions were not suitable for big-game hunting, which would have been necessary for human survival, until after about 14,000 years ago. As a result, researchers have suggested that migrations southward via this ice-free corridor were not likely until that time.

A possible early human occupation site in the Yukon has been dated to between 12,000 and 27,000 years ago; it would be the oldest known human habitation site in the New World. Nearby, the Bluefish Caves site, also in the Yukon Territory, indicates human occupation through the presence of skeletal remains of mammoth, horse, bison, and caribou in association with stone tools. Radiocarbon dating for this site suggests a date between 15,000 and 12,000 years ago.

Linguistic evidence. Linguistic evidence has been used by Joseph Greenberg and Merritt Ruhlen (1992) to argue that there were three successive waves of migration into the New World. By examining and grouping hundreds of contemporary languages from both North America and South America, those researchers determined that there are three distinct language families. The first group is the Amerind family, which is found throughout Central America and South America and much of North America. The second is the Na-Dené family, which today includes Haida on the northwestern coast of Canada as well as Navaho and Apache in the southwestern United States and various Athapaskan languages. The third is the Inuit-Aleut family. These researchers have suggested that since each of these three groups has a closer relationship to an Asian language family than to any language families in the New World, there were three distinct migrations to the New World from Asia, with the Inuit-Aleut language reflecting the last migration, perhaps some 4000 years ago.

Biological and genetic evidence. Biological evidence from teeth has supported Greenberg and Ruhlen's hypothesis. Christy G. Turner (1989) looked at a variety of morphological aspects of teeth from various New World populations. He noted the presence of common Asian traits, such as shovel-shaped incisors—where the lingual side of the central teeth has a scooped-out or shovel-like appearance—in many New World populations. On the basis of population grouping of similarities, Turner suggested that the distribution of traits fell into the same three distinct groupings identified by Greenberg and Ruhlen from the linguistic evidence.

Genetic analyses have been used to shed light on early migrations. Some have suggested that the Inuit-Aleut population group may in fact have split from Na-Dené in the New World. A number of studies of the distribution of mitochondrial DNA groups and of Y-chromosome haplogroups have suggested that there were one or two major migrations to North America from Asia. However, the distribution of genetic patterns in contemporary New World populations is complicated by admixtures with European and other groups in more recent historical times. This can make it difficult to distinguish ancestral but rare traits from recent rare traits without some collaborative evidence (for example, the interactions of indigenous groups with Europeans) from ethnohistorical sources.

Early Peoples of the New World

The first undisputed human populations in North America are referred to as the Palaeo-Arctic tradition. The earliest well-documented Palaeo-Arctic sites have been identified from stone tools and date to between 8000 B.C.E. and 5000 B.C.E. Human populations reflecting the Palaeo-Arctic tradition occur throughout Alaska, the southwestern Yukon, and the Queen Charlotte Islands in British Columbia. Next there is the movement of human populations into the eastern Canadian Arctic and Greenland, sites denoted archaeologically as the Arctic Small Tool tradition. This tradition evolved into the Norton tradition in Alaska and the Dorset culture in the eastern Arctic. The later Thule tradition developed from the Norton tradition in the area around the Bering Strait. It is the Thule tradition that subsequently spread across the entire Arctic region with the exception of the Aleutian Islands.

By 11,000 years ago the evidence that humans were living in North America south of Canada is clear. Archaeological evidence for the Clovis tradition, named after the first site identified near Clovis, New Mexico, can be found in many areas of North America. After that time there is also some evidence from human skeletal remains. One site has been argued to be pre-Clovis: the Meadowcroft Rockshelter in Pennsylvania, where the lower stratum dates between 19,600 and 8,000 years ago. There are clear indications of human occupation at that site that date to about 12,800 years ago.

Archaeological evidence in the form of tools found in association with the remains of butchered animals provides some clues that can help reconstruct these early populations. For example, the Olsen-Chubbuck site in Colorado is a bison kill site that is reflective of a highly organized population. Joe Wheat (1978) has estimated that the nearly 200 bison remains would have produced as much as 25,000 kilograms (55,500 pounds) of meat and may have been recovered from one kill—enough to feed almost 2,000 people for a month. However, these early populations did not continue to subsist on large mammals.

The archaeological evidence for these earliest Paleo-Indian populations in North America before about 8000 B.C.E. remains sparse, and reconstructions point to very small groups of a few adults and children with low population densities. Their survival depended on their dispersal over large territories, with these groups slowly moving into territories farther east. However, it is known through the presence of trade goods and large-scale kill sites that groups would have come together on a regular basis, forming long-term social networks with each other. Sites, such as Debert in Nova Scotia, that date to around 8600 B.C.E. suggest a group size of fifteen to fifty people who probably subsisted on caribou and sea mammals.

In later times, in conjunction with climatic change and perhaps extinctions of many of the larger mammals in the New World, there is evidence of populations exploring new subsistence strategies. Nevertheless, bison remained an important source of food among the plains populations, with archaeological sites such as Head-Smashed-In in Alberta showing that bison drives were used over a 7000-year span. Although the decreasing availability of big game may have been a factor, population growth may have put additional pressure on food sources. Stress on local carrying capacity probably resulted in the frequent fission of groups that dispersed into new territories. This rapid expansion of Paleo-Indian populations is reflected archaeologically by rapidly diversifying cultural assemblages. Survival would have been heavily dependent on game resources for subsistence, and although it fluctuated locally with irregular peaks, overall population growth would have been steady, with regional differences from western to eastern North America.

Mark Nathan Cohen (1989) has argued that the world was increasingly filling up with hunter-gatherer populations, and this may have forced them to exploit other, less desirable sources of food. Many researchers have argued, however, that the bulk of population growth throughout the world came about after people began to settle down and develop an agricultural subsistence base. Some support for this theory comes from anthropological studies of contemporary groups that show a reduction in the typical birth spacing in sedentary populations compared with nomadic populations.

The Paleo-Indian populations gave way to Archaic populations after about 8000 B.C.E. For many thousand years after that time North American groups continued to develop as regionally distinct populations. Early large-scale settlements in North America are best exemplified by the Mississippian culture after about 200 C.E., which evolved from the earlier Archaic groups in the Midwest and the South. Characteristic of these early chiefdoms are the large earthenworks and burial mounds associated with their permanent, sedentary communities. Although many were networks of smaller communities, a few settlements, such as Cahokia and Moundville, represent large political centers in the region, housing at their peak perhaps as many as 30,000 inhabitants. Within three centuries the area had been abandoned.

Large-scale population centers emerged in Mesoamerica later than they did in the Old World; this probably was related to the later development of agriculture in the New World. About 500 B.C.E. in the Valley of Oaxaca in southern Mexico there was a unification of individual villages to form larger centers. For example, the city of Monte Albán grew to house about 30,000 people. Slightly later the city-state of Teotihuacán in northeastern Mexico emerged, reaching its height around 2000 years ago. Again, this center probably developed from small, scattered farming villages on the slopes south of the Teotihuacán Valley that were inhabited by a few hundred people each.

Around 500 B.C.E. there seems to have been a population shift to settlements on the floor of the valley, with the emergence of distinct centers within the next few centuries. Between about 150 B.C.E. and 500 C.E. the population of the region grew rapidly from several thousand individuals to well over 100,000. Using skeletal samples, Rebecca Storey (1986) has argued that infant and childhood mortality in Teotihuacán was high, with over one-third of infants dying before age one year. This pattern is consistent with large, overcrowded preindustrial urban centers in Europe, where a variety of diseases had become endemic within the population.

Somewhat later the Mayan city of Copán emerged in what is now Honduras, with classic plazas, pyramids, and temples spanning an area of 30 acres. Estimates have suggested that it experienced rapid population growth, doubling in size every hundred years. Reaching its height between 700 and 850 C.E., Copán would have been home to perhaps 20,000 people. Several other Mesoamerican state societies also developed in the highlands and lowlands of what are now Guatemala and the Yucatán Peninsula. Although they once were thought to be less densely populated than Teotihuacán, it is now believed by archaeologists that the extent of Mayan culture has been underestimated, largely because of the dense tropical forest that now covers much of the remains of Mayan civilization.

Between 800 and 1000 C.E. many lowland Mayan cities were abandoned. The reasons for this collapse are unclear; suggestions include population pressure and resource depletion. Others believe that disease played a role, including an increased incidence of yellow fever as a result of deforestation creating larger breeding grounds for mosquitoes.

Large sedentary populations emerged in South America around 8000 years ago along the coast of Peru. Although estimates of population size vary, archaeological evidence points to long periods of high population density in some areas followed by demographic collapse and decline before the arrival of Europeans. Reconstructions of demographic patterns suggest very high infant and childhood mortality, with up to 50 percent of all children dying under 15 years of age. At its height the Incan empire of Peru had a population of some six million to 13 million people. This population was reduced drastically after European contact in the mid-sixteenth century.

Depopulation

Epidemic diseases introduced by Europeans, such as measles and smallpox, probably played a major role in causing a drastically increased level of mortality among New World populations. Estimates of the scale of depopulation depend on estimates of the total population of the New World before European contact, which range from eight million to over 100 million people. The overall distribution of populations throughout the New World varies, but estimates would place a large portion (over half and as much as three quarters) of the total in Mesoamerica.

Although European contact was certainly devastating, many New World populations had already reached a size at which they could support a variety of endemic diseases. Increased population densities and poor sanitation in many large urban centers, such as Cahokia in North America and the Maya city-states in Mesoamerica, would have imposed on them a variety of health burdens, much like their European counterparts. However, rapid colonization and new diseases, in conjunction with warfare, resulted in extremely high mortality and drastic depopulation among many New World peoples.

See also: *Archaeogenetics; Climate Change and Population: History; Environmental Impact, Human; Hunter-Gatherers; Paleodemography; World Population Growth.*

BIBLIOGRAPHY

Adovasio, James M., with Jack Page. 2002. *The First Americans: In Pursuit of Archaeology's Greatest Mystery*. New York: Random House.

Cohen, Mark Nathan. 1989. *Health and the Rise of Civilization.* New Haven, CT: Yale University Press.

Crawford, Michael. 1992. *The Origins of Native Americans: Evidence from Anthropological Genetics.* Cambridge, Eng.: Cambridge University Press.

Fagan, Brian.1987. *The Great Journey: The Peopling of the New World.* London: Thames and Hudson.

———. 1991. *Ancient North America.* London: Thames and Hudson.

Fiedel, Stuart J. 1992. *Prehistory of the Americas.* Cambridge, Eng.: Cambridge University Press.

Greenberg, Joseph H., and Merritt Ruhlen. 1992. "Linguistic Origins of Native Americans." *Scientific American* (November) 94–99.

Kirk, Robert, and Emőke Szathmáry, eds. 1985. *Out of Asia: Peopling of the Americas and the Pacific.* Canberra, Australia: Journal of Pacific History.

Larsen, Clark Spencer. 1997. *Bioarchaeology: Interpreting Behavior from the Human Skeleton.* Cambridge, Eng.: Cambridge University Press.

Paine, Richard R., ed. 1997. *Integrating Archaeological Demography: Multidisciplinary Approaches to Prehistoric Population.* Occasional Paper 24. Carbondale: Center for Archaeological Investigations, Southern Illinois University at Carbondale.

Steckel Richard H., and Jerry C. Rose, eds. 2002. *The Backbone of History: Health and Nutrition in the Western Hemisphere.* Cambridge, Eng.: Cambridge University Press.

Storey, Rebecca. 1986. "Perinatal Mortality at Pre-Columbian Teotihuacán." *American Journal of Physical Anthropology* 69: 541–548.

Szathmáry, Emőke J. E. 1993. "Genetics of Aboriginal North Americans." *Evolutionary Anthropology* 1: 202–220.

Turner, Christy G., II. 1989. "Teeth and Prehistory in Asia." *Scientific American* 260(2): 88–91, 94–96.

Verano, John W., and Douglas H. Ubelaker, eds. 1992. *Disease and Demography in the Americas.* Washington D.C.: Smithsonian Institution Press.

Webster, David, and Ann Corinne Freter. 1990. "The Demography of Late Classic Copan." In *Precolumbian Population History in the Maya Lowlands,* ed. T. P. Culbert and D. Rice. Albuquerque: University of New Mexico Press.

Wheat, Joe. 1978. "Olsen-Chubbuck and Jurgens Sites: Four Aspects of Paleo-Indian Bison Economy." *Plains Anthropologist* 23: 82(2): 84–89.

Robert D. Hoppa

PRIMATE DEMOGRAPHY

Primate demography is the study of population processes in species most closely related to humans. Primates include the prosimians (lemurs, lorises, galagos, etc.) and the anthropoids (monkeys and apes). Prosimians differ from the rest of the primate order in their largely nocturnal habits, reliance on smell rather than vision, and because they generally live in smaller groups. For these reasons and for human relevance this article is focused on the anthropoid primates. Knowledge of primate demography provides the context for understanding how human demography is constrained by general mammalian and ancestral primate patterns of birth, death, and movement. Some of these patterns are specific to primates and some reflect broader mammalian patterns. Primate demography provides a backdrop against which uniquely human characteristics may be discerned. Human lineage probably diverged from that of the other great apes some five to six million years ago. Humans and chimpanzees, however, still share many life history traits such as male philopatry (females leave their natal home range at maturity while males remain) and prolonged post-weaning dependency of young on their mother. Humans differ from chimpanzees in that humans have longer pre-reproductive periods than would be expected for a mammal of similar body size, delayed reproductive maturity for body size, relatively short interbirth intervals, and have probably always had a sizeable proportion of individuals with long post-reproductive life spans. While quantitative demographic information on wild primate populations is limited, there is a useful literature on primate life history that relates to demographic processes.

Life history traits are suites of co-evolved traits affecting reproduction, growth and development, patterns of social organization, and mortality. Just as the sources of mortality and physiological constraints on reproduction strongly influence life history, life history also affects birth and death rates and patterns of movement.

Although primates are mammals and share many demographic patterns arising from the constraints of mammalian reproduction (e.g., lactation leads to primarily maternal care of infants in most mammals, larger species tend to live longer and reproduce more slowly, etc.), their demography differs in many ways. The origin of primates in the tropical forests, their frugivorous (fruit eating) diets, evolution of larger brains, and complex social groupings, resulted in divergence from mammalian norms. Primates live longer than expected for mammals of similar body size and have low reproductive rates due to delayed maturity, singleton births, and prolonged dependency of young. Primates exemplify what Harvey and Promislow termed the "slowed down" life histories that are unusual for mammals and thus require special explanation. Primates as a group have larger brains than expected in a mammal of their body size. Within the order, positive selection for brain size is indicated by the fact that brain size increased faster than body size—a relationship that is not observed in most orders of mammals.

Social Organization

With a few exceptions (some prosimians, orangutans) primates live in long-term social groups that are kin-based. Polygyny is the most common mating system, but monogamy (a single male mates with a single female), polyandry (one female mates with multiple males) and polygynandry (multiple females mate with multiple males) are also represented within the order. In most Old World monkeys, males disperse while females remain in their natal groups. Apes show the full range of sex-differential dispersal: Both sexes leave natal home ranges among the monogamous lesser apes (gibbons), the solitary orangutans, and the polygynous gorillas; while female chimpanzees most often disperse. Dispersal patterns are even more varied among New World monkeys with long-lived Cebus (capuchin monkeys) demonstrating many of the life history traits—including female emigration—more common among Old World monkeys. Essentially all primate groups are dominance structured. Group size, composition, and social status are often related to both reproductive success and mortality. In 2001, Carey and Judge proposed that reduced levels of mortality and fertility are related through increased intergenerational transfers.

Fertility

Birth of singleton young is the ancestral primate norm. Singleton births of slow growing young take place at annual or longer intervals that correlate with body size. Young are most commonly carried in the mouth (prosimians), cling ventrally, or ride on the back of the mother. Primate fertility increases with age to a peak after the first reproduction and subsequently shows senescent decline. However, as in the vast majority of mammals, true menopause is absent in nonhuman primates studied to date.

Several small bodied groups of prosimians and New World monkeys have secondarily evolved litter sizes of two to three young that are produced at less than annual intervals. In the small New World marmosets and tamarins, group members, other than the mother, most frequently carry the multiple infants and juveniles, thus facilitating the ability of the females to produce two litters per year, which is a substantially higher reproductive rate than observed in larger primate species.

Most of the fertility data for New World monkeys come from captive marmosets and tamarins (Callithricidae). As noted, the members of these groups are small bodied and unusual in terms of litter size (greater than 1), early reproduction (beginning at approximately 1 year of age), short interbirth intervals (less than one year), and also in the predominance of allomaternal care (care by group members other than the mother). These traits are not characteristic of most of the New World monkeys and, thus, the demography of New World monkeys is ripe for additional research.

The models for Old World monkeys are based on several species of macaques. These monkeys begin to reproduce at the age of two years and produce one offspring every one to two years. In most species, female offspring remain in a natal troop of dominance ranked matrilines (a grouping of related female lineages) and male offspring disperse at adolescence. In contrast, apes have longer immature periods after controlling for body size, which is related to the four to five year length of their interbirth intervals. Unlike other apes, human interbirth intervals are not long given their body size. Hawkes, O'Connell, and their colleagues related this to the prevalence of allomaternal care, mainly by older female relatives, especially grandmothers. Gage estimated total fertility for all three groups of non-human anthropoid primates at approximately six—similar to that of contemporary populations of humans in developing countries prior to the fertility transition.

Sugiyama's 1994 study of demographic patterns in a wild female population of common chimpanzees in Bossou suggested similarities in reproductive parameters to those of humans in some hunter-gatherer populations. Age at first birth varied between 12 and 14 years and fertility increased to peak at an average of 0.33 per year at 20 to 23 years of age. Mothers over 40 years of age produced very few infants, none of whom survived. The mean interbirth interval after a surviving offspring was 5.1 years. Gage suggests that the earlier age, compared to humans, of first reproduction and the similar age-related decline in fertility mean that chimpanzees have longer reproductive life spans than do humans and that this is probably related to different patterns of immature mortality.

Mortality

Primates demonstrate many aspects of the mammalian pattern of high neonatal mortality, followed by a mortality decline to a pre-reproductive lifetime minimum, after which mortality rises at an increasing rate into old age. Human mortality departs from that of non-human primate patterns in the relatively low immature mortality achieved as a result of lower infant mortality and a more rapid decline in age-specific mortality of human juveniles relative to infants. Mortality increases at sexual maturity and there is evidence, especially in low mortality populations, of an early-adulthood mortality hump both among non-human primate and human males, often attributed to accidents. In Bossou, Guinea, 73 percent of chimpanzee infants survived to age four, 71 percent survived from age four to age eight, and 22 percent survived from age eight to age 12. The last of these values suggests unusually high mortality that may be conflated by female outmigration. But this is not entirely an artifact of measurement: In all natural populations, outmigration from the natal home range is associated with an increase in age-specific mortality in early adulthood.

While models suggest that life expectancy is quite low among wild chimpanzees and that life expectancy at sexual maturity is only an additional 15 years on average (with approximately 35 years of age as the outside age limit), these models are based on increasing mortality rates with age. There is evidence, however, that mortality rates of non-human primates as well as of humans level off, rather than continuing to increase, in very old age; indeed, there are numerous chimpanzees in the wild that are estimated to be well past 45 years of age. Clearly there is much yet to be learned about the mortality scenarios of older primates in natural populations.

New World monkeys generally have the shortest lives and the earliest reproduction, with the important exception of the genus Cebus. Old World monkeys both live, and delay maturity, longer than New World monkeys. The apes, all of which are Old World, exceed Old World monkeys in life span and in age at maturity; the longest lived and latest maturing primate after controlling for body size is the human. The survivorship curves become increasingly rectangular (i.e., exhibit prolonged survivorship followed by rapid decline at old age) over the same phylogenetic gradient. This picture is undoubtedly over-simplified if for no other reason than the paucity of data and the limited New World taxa for which demographic data are available.

Migration

Male emigration from natal groups, similar to that in most mammals, is temporally associated with increases in mortality. This mortality may be due to risks associated with poorer knowledge of resource distribution in new areas, with greater vulnerability to predators, and with intraspecific competition, particularly male–male competition in polygynous species. Research regarding sex-specific mortality associated with emigration in male versus female philopatric species is needed. Even in semi-captive groups of female philopatric species, young adult males are more likely to disappear from censuses than are other age classes or females. Unlike most mammals, female rather than male chimpanzees emigrate at puberty or early adulthood; interestingly, high-status female chimpanzees do not necessarily leave their natal ranges. Demographic research on New World species will be enlightening since females, or both sexes, emigrate in many of these groups. The common human practice of female outmarriage (the practice of women moving further from their natal family than men at marriage) often results in females leaving their natal communities at sexual maturity; however, sex differentials at young adult ages among humans still exhibit excess male mortality. Sources of mortality risks in young adulthood may include ecological (resource levels, predation risks) and social (e.g., male–male competition for mates) factors.

See also: *Animal Ecology; Evolutionary Demography.*

BIBLIOGRAPHY

Austad, Steven N., and Kathleen E. Fischer. 1992. "Primate Longevity: Its Place in the Mammalian Scheme." *American Journal of Primatology* 28(4): 251–261.

Carey, James, and Debra Judge. 2001. "Life Span Extension in Humans is Self-reinforcing: A General Theory of Longevity." *Population and Development Review* 27(3): 411–436.

Caro, Tim M., Daniel W. Sellen, et al. 1995. "Termination of Reproduction in Nonhuman and Human Female Primates." *International Journal of Primatology* 16(2): 205–220.

Dunbar, Robin I. M. 1984. *Reproductive Decisions: An Economic Analysis of Gelada Baboon Social Strategies.* Princeton, NJ: Princeton University Monographs.

Fedigan, Linda M., and S. Zohar. 1997. "Sex Differences in Mortality of Japanese Macaques: Twenty-one Years of Data from the Arashiyama West Population." *American Journal of Physical Anthropology* 102: 161–175.

Gage, Timothy B. 1998. "The Comparative Demography of Primates: With Some Comments on the Evolution of Life Histories." *Annual Review of Anthropology* 27: 197–221.

Harvey, Paul H., Daniel E. L. Promislow, et al. 1989. "Causes and Correlates of Life History Differences among Mammals." In *Comparative Socioecology,* eds. V. Standen and R. A. Foley, Oxford, Eng.: Blackwell Scientific Publications 305–318.

Hawkes, Kristen, James F. O'Connell, et al. 1998. "Grandmothering, Menopause, and the Evolution of Human Life Histories." *Proceedings of the National Academy of Sciences USA* 95(3): 1336–1339.

Hill, Kim, Christopher Boesch, et al. 2001. "Mortality Rates among Wild Chimpanzees." *Journal of Human Evolution* 40: 437–450.

Judge, Debra S., and James R. Carey. 2000. "Postreproductive Life Predicted by Primate Patterns." *Journal of Gerontology: Biological Sciences* 55A: B201–B209.

Kappeler, Peter M., and E. W. Heymann. 1996. "Nonconvergence in the Evolution of Primate Life History and Socio-ecology." *Biological Journal of the Linnean Society* 59(3): 297–326.

Pusey, Ann, J. Williams, et al. 1997. "The Influence of Dominance Rank on the Reproductive Success of Female Chimpanzees." *Science* 277: 828–831.

Sugiyama, Y. 1994. "Age-specific Birth Rate and Lifetime Reproductive Success of Chimpanzees at Bossou, Guinea." *American Journal of Primatology* 32: 311–318.

DEBRA S. JUDGE

PROJECTIONS AND FORECASTS, POPULATION

Population size and structure can be projected into the future based on current knowledge about population size; age and sex composition; and rates of birth, death, and migration; and on assumptions about how these rates may change over time. The projection may cover very different geographic areas, time horizons, or population characteristics, and they may be targeted for a number of different uses. Spatial dimensions can range from local areas such as counties or cities to the entire world. Local-area projections tend to use shorter time horizons, often ten years or less, whereas national and global projections typically extend decades into the future—in some cases, for more than a century. Short- and medium-term projections are more likely than long-term (50-plus-year) projections to include more detail than just the size and age and sex composition of the future population. They may project such socioeconomic characteristics as educational and labor force composition, ethnicity, urban residence, or household type.

While individual researchers and national statistical institutions have made significant contributions to the methods used to project population, especially at the national level (or below), global projections have been the province of relatively few institutions: principally, the United Nations (UN) Population Division, the U.S. Bureau of the Census, the World Bank, and the International Institute for Applied Systems Analysis (IIASA). These institutions have different ways of dealing with uncertainty, make varying assumptions about future fertility, mortality, and migration trends, and begin with slightly different estimates of current population size

Projection Techniques

While some projections for individual countries or regions have been made with other techniques, long-term global population projections commonly employ the cohort-component method. Initial populations for countries or regions are grouped into cohorts defined by age and sex, and the projection proceeds by updating the population of each age- and sex-specific group according to assumptions about the three components of population change: fertility, mortality, and migration. Each cohort is "survived" forward to the next age group according to assumed age-specific mortality rates. Five-year age groups (and five-calendar-year time steps) are commonly used (although IIASA uses single years of age and time) for long-range projections. As an example, the number of women in a particular population aged 20 to 25 in 2005 is calculated as the number of women aged 15 to 20 in 2000 multiplied by the assumed probability of survival for women of that age over the period from 2000 to 2005. This calculation is made for each age group and for both sexes and is repeated for each time step as the projection proceeds. Migration can be accounted for by applying age- and sex-specific net migration rates to each cohort as well, and, in the case of global projections, by ensuring that immigration equals emigration when summed over all regions. The size of the youngest age group is calculated from the number of births during the most recent time period by applying an appropriate survival rate. For example, those under age five in 2005 will be the survivors of births during the preceding five years. Births are calculated by applying assumed age-specific fertility rates to female cohorts in the reproductive age span. An assumed sex ratio at birth is used to divide total births into males and females.

Development of this approach was a major innovation in the evolution of projection methodology, bringing it beyond the mere application of growth rates to an unstructured population. It was first proposed by the English economist Edwin Cannan in 1895. The technique was elaborated by demographer Pascal K. Whelpton in the 1930s, and the method was first employed in producing a global population projection by demographer Frank W. Notestein in 1945. Prior to the mid-twentieth century, the few global population projections that had been made were based on extrapolations of the population growth rate applied to estimates of the total population of the world or by application of some mathematical formula, such as the logistic function.

Since Notestein's 1945 projection, the cohort-component method has become the dominant means of projecting population and has remained essentially unchanged, except for extensions to multistate projections and innovations in characterizing uncertainty. The cohort-component method is nothing more than a particularly useful accounting scheme: It works out the numerical consequences of the size and age structure of the population at the beginning of the period and the fertility, mortality, and migration rates assumed to prevail over the projection period. This was once a laborious operation, but computers have greatly simplified the mechanics of preparing projections. The real work in producing projections lies not in carrying out the necessary calculations but in estimating the population size and age structure in the base period and in selecting appropriate assumptions for specifying future trends of fertility, mortality, and migration. Demographers can draw on specialized knowledge of each of these components of population change to inform projections, and institutions therefore normally project trends in vital rates based on expert opinion. Often, however, it has been difficult to determine precisely how knowledge has been applied in making the assumptions for such projections.

In general, fertility has the greatest effect on the trajectory of a population over time because of its multiplier effect: Children born today will have children in the future, and so on. The fertility component of population projections is summarized by the total fertility rate (TFR), the average total number of children a woman will have assuming that current age-specific birth rates remain the same throughout her childbearing years. In long-term projections the TFR generally reflects the assumption that fertility will eventually stabilize at a specific level in a country or region and an assumption about the time path the TFR will follow in reaching that level. Once fertility stabilizes at that level, assuming mortality and migration rates also remain the same, the population age structure will eventually stabilize as well. Thereafter, the population size will change at a constant rate. If there is no net migration (that is, if the number of in-migrants is canceled out by the number of out-migrants), and the TFR stabilizes at replacement level (when mortality is low, a little more than two children per woman), the growth rate will eventually be zero. Both the projected pace of fertility decline and the assumed eventual fertility level are important in determining trends in population size and age structure. The two factors also interact: The lower the assumed eventual fertility level, the more important the pace of fertility decline becomes in determining the long term projected population size.

Mortality projections are based on projecting life expectancy at birth—that is, the average number of years a child born in a given year can expect to live if current age-specific mortality levels continued in the future. Projections of mortality must specify how the distribution of mortality over different age and sex groups may change over time. Changes in mortality at different ages have different consequences for population growth and age structure. When child and infant mortality decline, for example, a greater proportion of babies will survive to adulthood to have their own children and contribute to future growth. Mortality declines among the older population have a smaller effect on population growth because the survivors are already past reproductive age.

Future international migration is more difficult to project than fertility or mortality. Migration flows often reflect short-term changes in economic, social, or political factors, which are impossible to predict. And, because no single, compelling theory of migration exists, projections are generally based on past trends and current policies, which may not be relevant in the future.

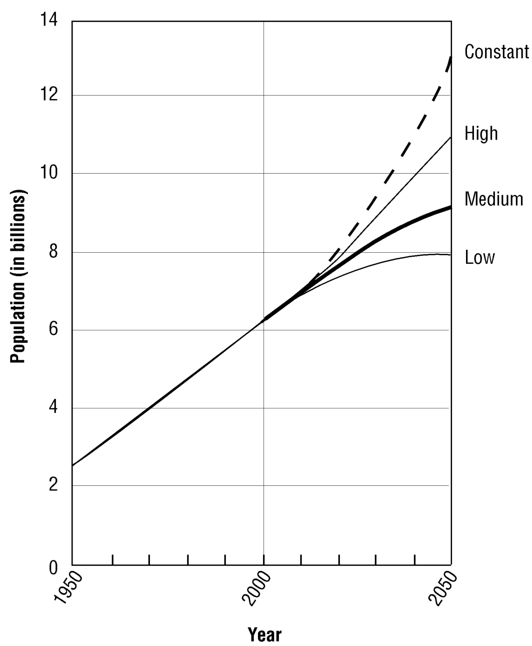
Projection Results and Uncertainty

Projection results are generally produced in one of three forms: as a single projection, as a set of scenarios, or as probability distributions. Many projections present to their users just one path of future population, which is considered most likely at the time of the production. Population projections according to alternative scenarios, called variants in some cases, show what the future population would be if fertility, mortality, and migration follow different paths. Some scenarios are purely illustrative—such as the UN's constant fertility scenario, which projects world population assuming that fertility remains constant at its current level. In other cases, users are given a "plausible" range as indicated by some high and low scenarios or variants. The best known among such projections are those of the UN (revised every two years), which are elaborated in three variants: "medium," "high," and "low." Figure 1 shows the results of these three variants (along with the constant-fertility scenario) on the global level for the period 2000 to 2050 as progressively divergent continuations of the estimated 1950 to 2000 trend. In these UN projections, the four population paths differ only by the fertility trends assumed while disregarding mortality and migration uncertainty. Users of population projections sometimes require projections that conform to various "story lines." For example, population projections might form just part of a scenario of future energy use and greenhouse gas emissions that presuppose particular socioeconomic, technological, or political developments.

Presenting just one best guess projection (e.g., as done by the World Bank and the U.S. Bureau of

FIGURE 1

Estimated and Projected Population of the World by Projection Variant, 1950–2050



Note: Projection variants reflect assumptions on levels of fertility beyond 2000.

SOURCE: United Nations Population Division.

the Census) may satisfy the needs of most users, but it does not convey the message that this future path is uncertain. The scenario approach also has several weaknesses. The most important is that users cannot interpret the probability that population will actually follow a higher or lower scenario or lie within that range. The UN provides little information about the likelihood of a particular scenario, except that it suggests that both the high and low scenarios are unsustainable over the very long run. These scenarios produce a global population that doubles or is halved every 77 years. Theoretically, they would eventually lead to implausible crowding or to extinction. In the real world, however, fertility will almost certainly not stay constant over extended period but rather show some ups and downs.

Another shortcoming of scenario approaches lies in the fact that they have usually been used to represent the uncertainty induced by only one of the three components, mostly fertility. But mortality and migration uncertainties also significantly influence population outcomes. For example, Figure 2 shows IIASA probabilistic projections for the proportion above age 80 in Western Europe over 2000–2100, taking into account uncertainty in fertility, mortality, and migration. The proportion is not expected to change much over the first two decades but, after 2030, it increases significantly while at the same time the uncertainty range widens dramatically, with the 95 percent uncertainty interval covering a range from 3 to 43 percent aged 80+ by 2100, due mainly to high uncertainty in the future path of old age mortality. In contrast, the most recent UN long range projections for 2100 foresee a proportion above age 80 that ranges from 7 percent in the high scenario to 17 percent in the low scenario, with the other UN scenarios all lying within this narrow interval. Because the UN projections do not include mortality uncertainty, they significantly underestimate the uncertainty in the number of elderly.

Finally, aggregation of the low and high scenarios to regional and global totals is typically based on the highly unlikely assumption that these extreme paths occur in all countries of the world simultaneously, an approach termed probabilistically inconsistent by the U.S. National Research Council (NRC).

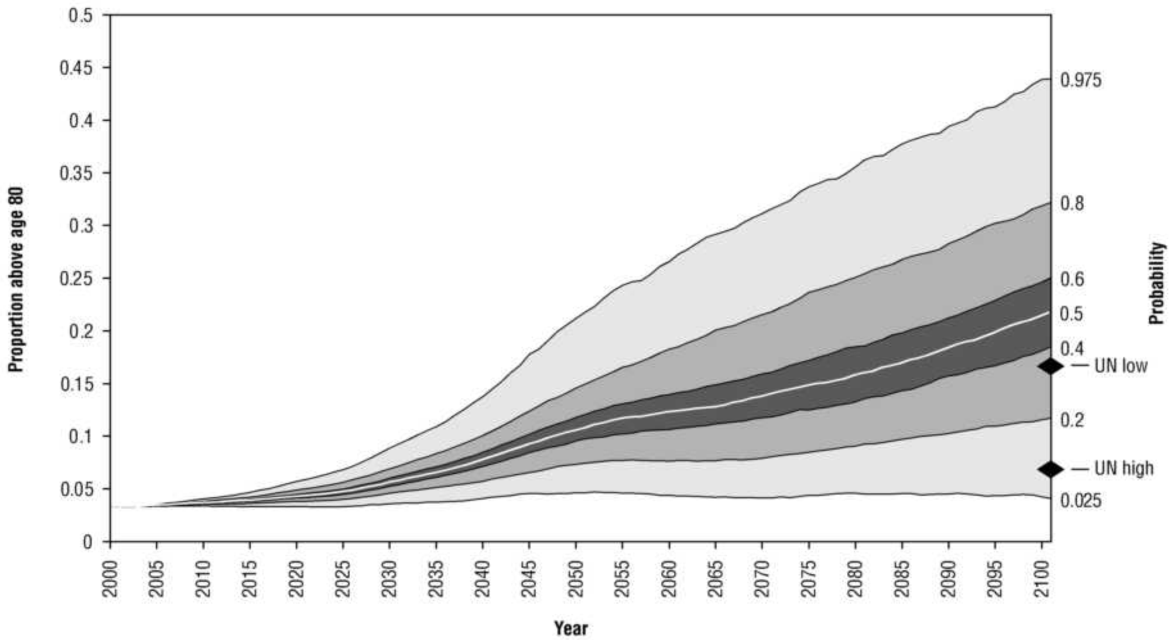
An alternative way to communicate the uncertainty in population projection results is to derive probability distributions for the projected size and characteristics of a population by using a range of different fertility, mortality, and migration rates. There have been three main bases for determining the probabilities associated with vital rates: expert opinion, statistical time series analysis, and analysis of errors in past projections.

Researchers at IIASA pioneered a methodology for assessing uncertainty in population projections based on asking a group of experts to give a likely range for future fertility, mortality, and migration rates—that is, that the vital rates for a given date would be within the specified range 90 percent of the time. Thousands of cohort-component projections are then produced, drawing from these distributions. Unlike other methods, this approach is also applicable in geographic areas where data on historical trends are sparse.

The expert opinion approach has several drawbacks. For example, the task of deciding who constitutes an expert will always be problematic, and research has shown that, on average, experts tend to be too conservative in their expectations for future

FIGURE 2

Proportion of Population above Age 80 in Western Europe According to Alternative Projections, 2000–2100



Note: Figures on right side are the probabilities that the proportion above age 80 will lie below the level indicated. "UN low" and "UN high" indicate proportions above age 80 in U.N.'s 2000 projection series.

SOURCE: IIASA 2001 population projections.

changes. Demographer Ronald D. Lee has questioned whether experts can meaningfully distinguish between different confidence levels they may place on estimates of future vital rates. He also argued that the original IIASA methodology, which was based on (piece-wise linear) random scenarios, excluded the possibility of fluctuations in vital rates that deviate from a general trend, which could underestimate uncertainty in outcomes.

Statistical analysis of historical time series data can be used either to project population size directly or to generate probability distributions for population size or vital rates assuming no structural changes. While statistical methods also employ expert judgment, they do not rely on it as much as the purely expert-based method. Statistical analysis methods based on times series have been applied to some national projections but not to global projections because their wide application is severely constrained by lack of data.

Population projections made in the past can be evaluated for how well they forecast the actual population, and these errors—the difference between the projected and actual population size—can be used to calculate probability distributions for new projections. An NRC report issued in 2000 calculated probability distributions from the errors of UN medium-variant projections for 2000 that were made between 1957 and 1998. The NRC found the UN was somewhat more likely to overestimate than to underestimate future population size at the world level, although the size of the error was small. Errors were much greater for projections of country populations, but these errors tended to cancel out over the long term at the global level. The average error in UN projections for individual countries varied from 4.8 percent for five-year projections to 17 percent for 30-year projections, according to the NRC report.

In general, projections of population size tend to be more uncertain, or less accurate, under particular circumstances. They are less accurate for:

1. Less developed countries than for more developed countries, partly because less developed countries tend to have limited and

less reliable data and, because they are still in the process of demographic transition, their demographic outlook is very sensitive to the timing of fertility decline;

2. Smaller countries than for larger ones, perhaps stemming in part from the greater attention devoted to larger countries and from greater heterogeneity within large countries, which allows errors at the level of sub-populations to cancel;
3. Younger and older age groups than in middle age groups, because incorrect assumptions about fertility and mortality have a greater effect at older and younger ages; and
4. The country level than at regional or global levels, because errors at the country level partly cancel each other when aggregated to regions or to the world.

These three methods of producing probabilistic projections are not mutually exclusive. Early-twenty-first-century projections from IIASA combine all three elements: Expert opinion is used to define a central path for fertility, mortality, and migration in all world regions. It is also used, in conjunction with historical errors, to define the uncertainty ranges for these values. Time series methods are used to generate paths for each variable that can show realistic short-term fluctuations over time.

Current Projections

Given the difficulties of estimating baseline data accurately and the inherent uncertainty in projecting trends in vital rates, different population projections can produce widely varying population sizes, age structures, and distributions. Nevertheless, the U.S. Census Bureau and World Bank projections, the medium or "most likely" projection from the UN, and the median future population from IIASA's probabilistic projection are similar in some respects. The Census Bureau foresees a world population of 9.1 billion in 2050, compared with 9.3 billion for the 2000 medium UN series (reduced to 8.9 million in the 2002 series) and 8.7 billion for the World Bank, while IIASA's median value for 2050 is 8.8 billion.

Differences between the UN medium variant and the median path of IIASA's probabilistic long-range projections increase over time. By 2100, projected world population differs by 11 percent: IIASA projects a median population of 8.4 billion that is already declining by 2100, whereas the UN projects a population of 9.5 billion that is nearly stable. For total population size, the UN high and low variants span a wide range (of undefined probability) that is also generally higher than the IIASA 95 percent uncertainty range. The UN projects a global population of five billion to 16 billion by 2100, based on its low and high variants, while IIASA projects a 95 percent uncertainty interval of 4.3 to 14.4 billion. IIASA's projections are generally lower primarily because they assume that fertility will, in the long run, fall below replacement level in all world regions.

Projections following different scenarios differ less in the short term than in the long term because they generally start from the same base population, and because it takes years for changes in vital rates to alter the built-in momentum that drives population growth. Momentum refers to the effects of population age structure on demographic trends: In a population with a young age structure, even if fertility falls sharply, the numbers of children will continue to increase for about a generation as the large cohorts of young people pass through their reproductive years. As a result, such populations will continue to grow for decades even if fertility were to be instantly reduced to replacement level. In contrast, some low-fertility industrialized countries are subject to negative population momentum. Because of past fertility decline, their populations have relatively small cohorts under age 30 and, therefore, even if fertility were to rise to replacement level, population size would decline for some time.

Under any plausible scenario for future growth, the world age structure will grow older, greater percentages of people will live in urban areas, and the regional balance will shift. These changes will be more dramatic further into the future. In 2000 the global population below age 15 was about three times the size of the population age 60 or older. The proportion age 60 or older is projected to swell in all scenarios, while the proportion below age 15 shrinks. World population is youngest under the higher fertility rates in the UN high-variant projections. In the UN medium-variant and the IIASA median, the proportion age 60 or older is likely to surpass the proportion below age 15 by the middle of the twenty-first century.

Based on the high and low projections prepared by these institutions, however, the older age group could overtake the below-15 age group as early as

2030 or as late as the twenty-second century. This reflects the uncertainty in the rates of change in each of these age groups considered separately. While in all cases the proportion of the population below 15 is expected to fall, it could reach anywhere from 10 percent to 22 percent of the total population in 2100. Similarly, while the percentage age 60 or older will grow, the figure could be as low as 22 percent or as high as 44 percent of the population by the end of the century.

All of the global projections show that the regional balance of world population will shift over time. Under the UN long-range projections, the share of the global population made up by the current more developed countries of North America and Europe declines from 17.2 percent in 2000 to about 10 percent in 2100. Africa's share of the total grows the most over this period, from 13.1 percent to about 23 percent, while the population share of China actually falls from 21 percent to 14 percent. These conclusions are qualitatively consistent across other scenarios, as well as across institutions.

See also: *Cannan, Edwin; Cities, Future of; Momentum of Population Growth; Multistate Demography; Notestein, Frank W.; Pearl, Raymond; Thompson, Warren S.; Whelpton, P. K.; World Population Growth.*

BIBLIOGRAPHY

Cannan, Edwin. 1895. "The Probability of a Cessation of the Growth of Population in England and Wales during the Next Century." *Economic Journal* 5(20): 505–515.

Frejka, Tomas. 1996. "Long-Range Global Population Projections: Lessons Learned." In *The Future Population of the World: What Can We Assume Today?* 2nd edition, ed. Wolfgang Lutz. London: Earthscan.

Lee, Ronald D., and Shripad Tuljapurkar. 1994. "Stochastic Population Projections for the United States: Beyond High, Medium, and Low." *Journal of the American Statistical Association* 89: 1175–1189.

Leslie, P. H. 1945. "On the Use of Matrices in Certain Population Mathematics." *Biometrika* 33: 183–212.

Lutz, Wolfgang, ed. 1996. *The Future Population of the World: What Can We Assume Today?* 2nd edition. London: Earthscan.

Lutz, Wolfgang, Warren C. Sanderson, and Sergei Scherbov. 2001. "The End of World Population Growth." *Nature* 412: 543–546.

Lutz, Wolfgang, James W. Vaupel, and Dennis A. Ahlburg, eds. 1999. *Frontiers of Population Forecasting,* Supplement to Volume 24 of *Population and Development Review.* New York: Population Council.

National Research Council. Committee on Population. Panel on Population Projections. 2000. *Beyond Six Billion: Forecasting the World's Population,* ed. John Bongaarts and Rodolfo A. Bulatao. Washington, D.C.: National Academy Press.

Notestein, Frank W. 1945. "Population: The Long View." In *Food for the World,* ed. Theodore W. Schultz. Chicago: University of Chicago Press.

O'Neill, Brian C., Deborah Balk, Melanie Brickman, and Markos Ezra. 2001. "A Guide to Global Population Projections." *Demographic Research* 4(8): 203–288.

O'Neill, Brian C., Sergei Scherbov, and Wolfgang Lutz. 1999. "The Long-Term Effect of the Timing of Fertility Decline on Population Size." *Population and Development Review* 25: 749–756.

United Nations. 2001. *World Population Prospects: The 2000 Revision,* Vol. 1: *Comprehensive Tables.* New York: United Nations.

United Nations. Population Division. 2000. *Long-Range World Population Projections: Based on the 1998 Revision.* New York: United Nations.

U.S. Bureau of the Census. 1999. *World Population Profile, 1998.* Washington, D.C.: U.S. Government Printing Office.

Whelpton, Pascal K. 1936. "An Empirical Method of Calculating Future Population." *Journal of the American Statistical Association* 31: 457–473.

World Bank. 2000. *World Development Indicators, 2000.* Washington, D.C.: World Bank.

Brian C. O'Neill
Wolfgang Lutz

PROXIMATE DETERMINANTS OF FERTILITY

See *Fertility, Proximate Determinants of*

PUBLIC HEALTH

See *Environmental Health; Health Systems; Health Transition; Mortality Decline; Reproductive Health*

PUBLIC OPINION ON POPULATION ISSUES

Public attitudes toward global population issues have been more closely surveyed in the United States than in other countries; therefore this article focuses on the United States.

An overwhelming majority of the U. S. population correctly perceives the world's population as growing and believes that world population growth is a significant problem. This majority is divided, however, as to how serious and pressing the problem is. There is also evidence of some decline in the sense of urgency. A very strong majority supports the U.S. government providing aid to assist people in poor countries with family planning. Support is more modest, however, when the goal is framed in terms of getting developing countries to reduce their birthrates; Americans are more comfortable with the goal of helping women plan their families.

Perception of the Problem

In a September 1998 Belden and Russonello poll, 83 percent of respondents described the world population as growing. Seventy-one percent agreed (43 % strongly) that "too much population growth in developing countries is holding back their economic development."

But this majority is divided as to how serious or pressing the problem of population growth is. In a June 2002 Chicago Council on Foreign Relations (CCFR) poll, 86 percent thought "world population growth" a threat "to the vital interests of the US in the next ten years." However, that majority was divided between 44 percent who thought the threat "critical" and 42 percent who thought it "important but not critical." Similarly, in an October 1999 Gallup poll, 88 percent said that "population growth internationally" is a problem; 47 percent, however, said it was "a major problem now," while 41 percent characterized it as "not a problem now, but likely to become a problem for the future." In a February 1994 Belden and Russonello poll, 73 percent said that population growth would have a negative impact on the global environment, with 46 percent saying it would have a very negative impact and 27 percent, a somewhat negative impact.

In most cases, a plurality or majority takes the more dire perspective. In an October 1999 Pew poll, which posed a pair of arguments, 56 percent chose the one that said that the growing population "will be a major problem because there won't be enough food and resources to go around"; 42 percent chose the one that said that it "will not be a major problem because we will find a way to stretch our natural resources."

Modest Decline in Sense of Urgency

There is some evidence that the issue of overpopulation evoked less of a sense of urgency at the end of the 1990s than it did in the early 1990s—perhaps because some of the public has become aware that global population growth has slowed in the developed world. In Gallup polls, the proportion saying that population growth is a major problem now dropped from 29 percent in 1992 to 18 percent in 1999. Those holding the less urgent view that it "was not a problem now, but likely to be a problem in the future" rose from 45 percent to 59 percent.

Nevertheless, the argument that birth rates in developed countries have become too low is not popular with the public. Belden and Russonello's 1998 survey tested the statement, "People in the developed, wealthier countries are having too few babies," and found only 22 percent in agreement, with 62 percent disagreeing.

Overwhelming Support for Family Planning

Beldon and Russonello's 1998 survey also indicated that there is broad consensus among Americans that family planning services should be universally available. A near-unanimous 92 percent agreed (69 percent strongly) that "all couples and individuals should have the right to decide freely and responsibly the number, spacing and timing of their children and to have the information and the means to do so." In the same poll, 68 percent agreed with the proposition that family planning services were not "already available to most people in all parts of the world today."

Foreign Aid for Family Planning

A strong majority supports the idea that facilitating family planning is an appropriate purpose for U.S. foreign aid. The Program on International Policy Attitudes reported that, "when asked to rate how high a priority family planning should be in U.S. foreign aid programs on a scale of 1 to 10, with 1 meaning the lowest priority and 10 a top priority, family planning ranked quite high. In a February 2000 poll, the objective of 'making birth control available to people in other countries so they can choose the number of children they have' received a mean rating of 6.9, with 39 percent rating it at 10."

When asked directly about providing aid for family planning, support tends to be very high, especially if it is spelled out that family planning does not include abortion. In a 1998 Belden and Russonello poll, 80 percent said they favored (45% strongly) "the US sponsoring voluntary family planning programs in developing countries" when this distinction was spelled out (18% were opposed). In February 1994, the same question was asked, but the exclusion of abortion was not specified; a much lower proportion, 59 percent, favored such programs, with 37 percent opposed.

In a January 1995 poll by the Program on International Policy Attitudes (PIPA), respondents were given information about the cost of U.S. foreign aid for family planning. The poll found that 74 percent wanted to increase (36%) or maintain (38%) the level of funding.

A majority prefers giving aid for family planning through United Nations (UN) population programs. In October 1999 a NBC/*Wall Street Journal* poll asked if "nations should share resources and information through groups such as the United Nations to promote birth control, or should nations determine their own population and family planning programs?" Only 40 percent chose the statement that nations should determine their own family planning programs, whereas 54 percent preferred the statement that nations should share resources through the UN to promote birth control.

Ambivalence about the Goal of Reducing Birth Rates

While support for assistance for family planning is high, the support for using aid for the goal of reducing birth rates is more mixed. More than 80 percent support aid for family planning, whereas aid for limiting population growth finds a modest majority. The reason for this ambivalence may well be found in the response to a 1998 Belden and Russonello question that asked: "Do you agree more with those who say the United States should encourage developing countries to lower their birthrates, or more with those who say it is inappropriate for us to do this because it may offend other people's cultures?" A slight majority of 52 percent thought it was inappropriate; 42 percent thought it was appropriate.

There is a strong consensus that there should not be any encroachment on the right to have children. In September 1998, 76 percent agreed (50% strongly) with the statement: "People should feel free to have as many children as they can properly raise" (23% disagreed). Presumably the response to this question is colored by a rejection of coercive birth control practices, such as those associated with China's one-child program, but it is also an indication that Americans feel that the United States should not take the position of pressuring individuals to refrain from having children.

Family Planning and Abortion

Most Americans do not make a link between family planning and abortion. A September 1998 Belden, Russonello, and Stewart (BRS) poll asked respondents in open-ended questions what came to mind when they heard the terms "family planning" and "birth control." In both cases, only very small minorities volunteered that these terms included abortion.

The Program on International Policy Attitudes reported that

> Only a small minority thinks that an increase of family planning services in a developing country is likely to lead to an increase in abortions there. The same 1998 BRS poll asked: "If family planning were made widely available in a country where it had not been, would you expect the number of abortions to fall, or to rise, or would having family planning widely available make no impact on abortion rates?" Only 15 per-

> cent said they would expect the number of abortions to rise, while a slight majority, 52 percent, said they expected abortions would go down and 27 percent thought it would make no difference ("Americans and the World").

Americans are divided on whether the United States should help fund the performance of abortions abroad. When asked whether they would favor "US aid programs contributing the funding" of "voluntary, safe abortion as part of reproductive health care in developing countries that request it," 50 percent favored this and 46 percent opposed it. Likewise, the public is divided on the question of whether the United States should fund organizations that discuss the option of abortion with their clients. In an April 1998 PIPA poll, 50 percent thought "the US should withhold US funds from family planning organizations that discuss abortion," while 46 percent thought it should not.

A strong majority, however, opposes making the payment of UN dues by the United States contingent on the UN having such a policy. In the PIPA question just mentioned, respondents who said the U.S. Congress should withhold funds (or "don't know") were told there was a good chance that if the restriction was added to the bill to pay U.S. back dues to the UN, the bill would not pass. Twenty-four percent of the total sample shifted to rejecting the restriction, making a total of 70 percent opposed.

See also: *Mass Media and Demographic Behavior.*

BIBLIOGRAPHY

Adamson, David M., Nancy Belden, Julie DaVanzo, and Sally Patterson. 2000. *How Americans View World Population Issues: A Survey of Public Opinion.* Santa Monica, CA: Rand.

INTERNET RESOURCE.

Program on International Policy Attitudes (Stephen Kull, Director). "Americans and the World" website. <http://www.americans-world.org>.

STEVEN KULL

Q

QUALITY OF POPULATION

Population quality is the overall level of certain desirable traits in a specific population. The members of a population do not contribute equally to the size of the next generation: The distribution of births, especially in low-fertility populations, varies markedly across the adult members. Because the data seem to show family resemblances across generations in these traits (the traits are familial whether they are transmitted genetically or socially), the question arises whether their overall level is going up or down as a result of this unequal distribution of births.

Increasing the Incidence of Desirable Traits

In most discussions of population quality the traits in question are health, intelligence, and what the scientist Sir Francis Galton, the coiner of the term *eugenics,* called "moral character"; this is frequently interpreted by modern psychologists as the personality traits of conscientiousness and altruism. However difficult it may be to define and assess such qualities in ways that command wide agreement, let alone consensus, it is obvious that people want to live in a society whose members are healthy, intelligent, conscientious, considerate, and civil toward others and prefer not to live in a society whose members are on the whole unhealthy, unintelligent, dishonest, lazy, and uncivil. The question, then, is how social policies in a specific population could be devised to increase the frequency of members with high amounts of the good traits and decrease the frequency of those with low amounts and whether such policies should even be sought.

A commonly discussed method of increasing the frequency of those with the good traits and decreasing the frequency of those without them is eugenics. Eugenic methods are applicable when the trait in question is inherited in some fashion, and many of those traits seem to be. What Richard Lynn (2001) calls "classical eugenics" seeks to increase the reproductive rates of those with higher levels of the desired traits and decrease the reproductive rates of those without them. This would counteract the tendency, perceived by many observers, of people who are better endowed with intelligence or the personality traits of conscientiousness and civility to replace themselves in the next generation at lower rates than those of people with low intelligence or minimal conscientiousness or civility.

Problems with Eugenics

There are problems with a program of eugenics. Assuming that agreement about desirable and undesirable traits can be reached, probably the most important problem is time. Generation length (the average time between two successive generations) among human beings is between 25 and 30 years, and for males it is often even longer. Because eugenics programs propose changing the frequency of a trait in the next generation, such programs would take 20 or more years to have an effect. This may be too long in comparison to other changes affecting human populations.

The eugenicist Hermann Muller (1890–1967), a Nobel Prize winner in medicine, wrote about this problem, noting the "creeping pace" of dysgenic trends compared to the "fast growing menaces presented by our cultural imbalances" (Muller 1973, p. 128). Konrad Lorenz (1903–1989), also a Nobel Prize winner, worried about the genetic quality of the human species. Late in his life, however, he allowed that cultural deterioration proceeds much more rapidly than does genetic deterioration (Lorenz 1976). This argument against the efficacy of eugenics has not been answered.

Of course, if change in the quality of a population is due in large part to the environment in which the members of that population live, change can take place considerably faster than the slow pace of genetic change. However, Richard Lynn has shown in his books *Dysgenics* (1996) and *Eugenics* (2001) that important traits such as intelligence, conscientiousness, altruism, and a psychopathic personality have significant inherited components. That conclusion strongly suggests that public policies consider eugenic measures despite the problems.

Population quality was a significant concern to an earlier generation of demographers. The goal of the Population Association of America (PAA) is defined in its constitution as the study of population in its "quantitative and qualitative aspects." Many of the founders of the PAA were eugenicists (Kiser 1981). Although the constitution of the International Union for the Scientific Study of Population (IUSSP) does not contain the phrase "population quality," the proceedings of its early conferences indicate a strong interest in the subject (Sanger 1927, Pitt-Rivers 1932). That contraception might be confined to or more prevalent among the more fit was a real concern. Arguably, the problem then identified by some demographers—the low fertility of those with large amounts of desirable traits relative to the fertility of those with low amounts—persists to this day.

The phrase, "population quality," has largely disappeared from recent demographic writings, partly because of its association with Nazi eugenic theories and programs. However, the decline of interest in population quality, and thus in eugenics, began before there was full awareness of what happened in Germany and in German-occupied lands in the Nazi era. Therefore, the reasons for the eclipse of the study of population quality in contemporary demography are not well understood.

Policies and Population Quality

A few countries have instituted demographic policies designed to cause a higher level of population quality. In China mentally retarded persons and those with genetically transmitted diseases are actively discouraged from having children. In Singapore more highly educated women are actively encouraged and given substantial financial incentives to have more children. These policies have been noted in the West but derided and not emulated. In the West persons with mental retardation, which is known to have an inherited component, are not discouraged from having children and highly educated men and women are not encouraged to reproduce.

A host of artificial methods of reproduction are existent or on the horizon, such as embryo selection and genetic engineering, that will allow parents to choose certain genetic qualities of their offspring. So far the high cost and unavailability of these methods have allowed society to avoid confronting the questions raised by what Sinsheimer (1969) calls the "new eugenics": genetic selection governed not by top-down eugenic policies but by the choices of individuals.

However, it is doubtful that consideration of these issues can be avoided much longer. There has never been a technology that has not attracted users. Any country that opted to allow and encourage the widespread employment of such technologies, as Raymond Cattell (1972, 1987) points out, would potentially render itself ascendant in light of what is already known about the heritability of various desirable traits (Lynn 1996, 2001) that are of interest to people. Less desirably, taking that option may create social problems that in the early twenty-first century are only dimly perceived.

See also: *Eugenics; Family Size Distribution; Galton, Francis; Genetic Testing; Reproductive Technologies: Modern Methods, Ethical Issues.*

BIBLIOGRAPHY

Cattell, Raymond. 1972. *A New Morality from Science: Beyondism.* New York: Pergamon.

———. 1987. *Beyondism: Religion from Science.* New York: Praeger.

Galton, Francis. 1869. *Hereditary Genius.* London: Macmillan.

Kiser, Clyde. 1981. "The Role of the Milbank Memorial Fund in the Early History of the Association." *Population Index* 47: 490–494.

Lorenz, Konrad. 1976. "Konrad Lorenz Responds to Donald Campbell." In *Konrad Lorenz: The Man and His Ideas,* ed. Richard Evans. New York: Harcourt Brace Jovanovich.

Lynn, Richard. 1996. *Dysgenics: The Genetic Deterioration in Modern Populations.* Westport, CT: Praeger.

———. 2001. *Eugenics: A Reassessment.* Westport, CT: Praeger.

Muller, Hermann. 1973. "What Genetic Course Will Man Steer?" In *Man's Future Birthright: Essays on Science and Humanity by H. J. Muller,* ed. Elof Carlson. Albany: State University of New York Press.

Pitt-Rivers, George, ed. 1932. *Problems of Population: Being the Report of the Proceedings of the Second General Assembly of the International Union for the Scientific Investigation of Population Problems.* London: George Allen.

Sanger, Margaret, ed. 1927. *Proceedings of the World Population Conference, Geneva.* London: E. Arnold.

Sinsheimer, Robert. 1969. "The Prospect of Designed Genetic Change." *Engineering and Science* 32: 8–13.

Daniel R. Vining, Jr.

QUETELET, ADOLPHE

(1796–1874)

Born in Ghent, Belgium, mathematician and demographer Adolphe Quetelet earned a doctorate in mathematics at the age of twenty-three and was elected, one year later, to the *Académie royale des sciences et belles-lettres.* The Belgian academy became the central place from which Quetelet directed most of his activities for the rest of his life. He worked in a variety of disciplines such as astronomy, meteorology, physical geography, development psychology, demography, and statistics. Quetelet's work was profoundly influenced by early probability theory. From astronomer and mathematician Pierre-Simon Laplace (1749–1827), Quetelet learned that measurement errors are normally distributed around the true value; this information allowed him to detect systematic errors in early social science data. His notion of *l'homme moyen* also stems from Laplace's theory. However, Quetelet was never exclusively preoccupied by averages, and whenever possible he presented complete distributions. One of his contributions to demography is his presentation of age-specific rates for vital events or for other phenomena (e.g., crime), and his construction of time series. In fact, the materials brought together in his *Physique Sociale* (1835) mark the beginning of the statistical study of the life cycle. Quetelet's interpretation of population distributions of social characteristics announced the advent of sociology as a new science, according to which the entity called "society" could be studied and analyzed with objective methods. In contrast to philosopher Auguste Comte (1798–1857), Quetelet never developed a general plan for this new discipline, but his influence on sociology remained strong throughout the nineteenth century, as is evidenced in the work of French sociologist Émile Durkheim (1858–1917).

Quetelet's contribution to demography started in the 1820s. Together with E. Smits, he noted, like several others before him (e.g., French military engineer Sébastien Vauban [1633–1707] and German demographer Johann Peter Süssmilch [1707–1767]) that the numbers and age distributions of vital events in the Low Countries showed a remarkable degree of stability over time. In *Physique Sociale,* Quetelet argued that only major disturbances were capable of producing temporary distortions. By contrast, *les causes constantes* would re-establish the dominant pattern. This is a view similar to that of the homeostatic demographic regime of the economist T. R. Malthus.

Quetelet's other contributions to demography deal respectively with census taking and life table construction. These two areas were intimately related since no direct measurement of probabilities of dying (i.e., the q_x-function of a life table) was available at that time. Hence, like all other investigators before him, Quetelet depended on the stationarity assumption that permitted the linkage of ved age structures to the L_x-function (numbers of person-years lived in an age interval). Quetelet explicitly discussed the properties of stationary populations, and showed that the hypothesis of constant mortality could be relaxed. In fact, he was on the way to showing that there is a *neutral* pattern of mortality decline (i.e., a reduction in age-specific death rates which does not alter the shape of the population age distribution). (For the proof, see A. J. Coale, 1972: 33–36.) Quetelet was never able to develop a model for a stable population with a constant growth rate different from zero. He also failed to recognize the significance of the logistic curve developed by one of his younger colleagues, Belgian mathematician and demographer Pierre-François Verhulst (1804–1849). In actual practice, Quetelet remained a master of comparative statics rather than of social dynamics.

Quetelet did not comment on the numerous social developments in Belgium, which began in the 1860s. After suffering a stroke in 1855, his scientific innovativeness ended. However, until his death in 1874, Quetelet continued to inspire statistical applications in other many fields, and to promote international comparability of statistical information. In the words of mathematician Alain Desrosières, "Quetelet was the orchestra conductor of nineteenth century statistics" (Derosières, p. 95).

See also: *Demography, History of; Life Tables; Population Thought, History of; Verhulst, Pierre-François.*

BIBLIOGRAPHY

SELECTED WORKS BY ADOLPHE QUETELET.

Quetelet, Adolphe. 1835. *Sur l'homme et le développement de ses facultés ou essai de physique sociale.* Paris: Editions Bachelier. English transl.: *A Treatise on Man and the Development of His Faculties.* Edinburgh: Chambers, 1842.

———. 1848. *Du système social et des lois qui le régissent.* Paris: Guillaumin et Cie.

——— 1849. "Nouvelles tables de mortalité pour la Belgique." *Bulletin de la Commission Centrale de Statistique* 4: 1–22.

SELECTED WORKS ABOUT ADOLPHE QUETELET.

Académie Royale de la Belgique. 1997. *Actualité et universalité de la pensée scientifique d'Adolphe Quetelet.* Classe des Sciences, Actes du Colloque 24–25.10.96, Brussels, Belgium.

Coale, Ansley J. 1972. *The Growth and Structure of Human Populations—A Mathematical Investigation.* Princeton, NJ: Princeton University Press.

Desrosières, A. 1993. *La politique des grands nombres—Histoire de la raison statistique.* Paris: Editions La Decouverte. English edition: *The Politics of Large Numbers: A History of Statistical Reasoning.* Cambridge, MA: Harvard University Press. 1998.

Lesthaeghe, R. 2001. "Quetelet, Adolphe (1796–1874)." In *Encyclopedia of the Social and Behavioural Sciences.* Oxford: Elsevier Science Ltd.

Ron Lesthaeghe

R

RACIAL AND ETHNIC COMPOSITION

Ethnicity is a socially important demographic marker throughout the world. In many countries, however, it is not collected or reported in official population statistics, typically for reasons of social policy. *Race* is a concept with a contentious history and is no longer in use in anthropology. But in the United States, both concepts have long been, and continue to be, prominent features of population statistics. This article is therefore focused on the U.S. case.

The racial and ethnic composition of the U.S. population has changed markedly since the founding of the nation as successive waves of immigrants arrived from an ever-shifting array of countries around the world. Classifying persons as members of particular racial or ethnic groups is, however, far from straightforward, not only because of the increasingly complicated mix of identities among children whose parents, grandparents, or great-grandparents were members of different groups, but also because social definitions of race and ethnicity have changed through time. Despite these complexities, it is clear that the racial and ethnic composition of the U.S. population has been becoming increasingly diverse especially since the 1970s, and this trend is projected to continue.

The Racial and Ethnic Classification System

Ethnicity can be defined as a social boundary between groups reflecting distinctions made by individuals in their everyday lives based on cultural differences, such as language, religion, dress and food preferences, and entertainment and artistic expression, as well social and physical differences between members of specific groups. Scientists long ago abandoned the search for rigid biological distinctions between races, but insofar as racial distinctions continue to be drawn in everyday life, race can be viewed as a particular type of ethnicity in which social perceptions regarding physical characteristics play an important role in characterizing group membership.

Reflecting their socially constructed nature, racial and ethnic categories differ substantially across societies, and from time to time within particular societies, as individuals assimilate across boundaries, as boundaries erode with intermarriage or through the adoption of cultural practices across boundaries, or as new groups enter a society through immigration. A long historical perspective on the changing racial and ethnic classification system of the United States is provided in the series of population censuses conducted every ten years. Questions in past censuses designed especially to identify key groups have focused on country of birth (along with year of immigration, citizenship status, and language), ancestry, and race and Hispanic origin.

Cultural differences between the foreign-born and native-born populations have long been prominent. Country of birth was asked in each census since 1850, and mother's and father's countries of birth were asked in the censuses between 1870 and 1970. The latter provide the basis for distinguishing the second generation from the foreign-born and from third- and later-generation Americans. Responding to the great wave of immigration from Europe between 1880 and 1930, the censuses asked additional questions about year of immigration (1890–1930), citizenship status (1900–1950), and language spoken (1900–1940). With the blurring of ethnic distinctions among European Americans who were the grandchildren of those immigrants, questions on father's and mother's countries of birth were replaced with a question on ancestry beginning in the 1980 census. With the second great wave of immigrants after 1960, mainly from Latin America and Asia, questions were reintroduced asking about language spoken (1960–2000), year of immigration (1970–2000), and citizenship (1970–2000).

Questions seeking to ascertain race have the longest history in U.S. census data collection. The censuses from 1790 to 1820 distinguished free whites, other free persons, and slaves; the category ''free colored persons'' was added in 1830. Whites and blacks (referred to as Negro between 1930 and 1960) were each identified in every census since 1850. The mixed-race category of mulatto was included between 1850 and 1890 and again between 1910 and 1920, while the 1890 census also sought to distinguish among mulatto (a person with three-eighths to five-eighths black ancestry), quadroon (a person of one-quarter black ancestry), and octoroon (a person of one-eighth or any trace of black ancestry). American Indians (Native Americans) have been identified since 1860. With the admission of Alaska and Hawaii as states in 1959, the terms Eskimo and Hawaiian were introduced in 1960, and Aleut was introduced in 1970.

Successive waves of immigrants from Asia and the Pacific islands were identified not only through the country of origin question but also with new explicit racial categories on the census form: Chinese (1860–2000), Japanese (1870–2000), Filipino (1930–2000), Korean (1930–1940 and 1970–2000), and Samoan, Guamanian, and Vietnamese (1980–2000). Asian Indians were distinguished beginning in 1980 but had also been identified in two earlier censuses (1930 and 1940) under the rubric of Hindu. Mexicans were included as a racial category once, in 1930. With increasing immigration from Latin America, ethnic identifiers specific for that region were introduced in census data collection: Spanish surname in 1960 (for the five southwestern states only) and Hispanic origin (with categories including Mexican, Puerto Rican, and Cuban) from 1970 to 2000. (The Hispanic category refers only to Latin American countries.)

Thus, persons of European origin were identified only through country of origin and related questions until the introduction of the ancestry question in 1980. But persons with origins in Africa, Asia, and Latin America have been identified both through immigration-related questions and, typically from early in their presence in substantial numbers in the United States, through questions regarding race or ethnicity. These specific racial or ethnic categories, however, usually refer to countries, such as Mexico, Cuba, China, Japan, the Philippines, or Korea. The most important innovation in the 2000 census was the provision for the choice and reporting of more than one race for an individual, that is, multiple- or mixed-race reporting.

Historical Transformations in Racial and Ethnic Composition

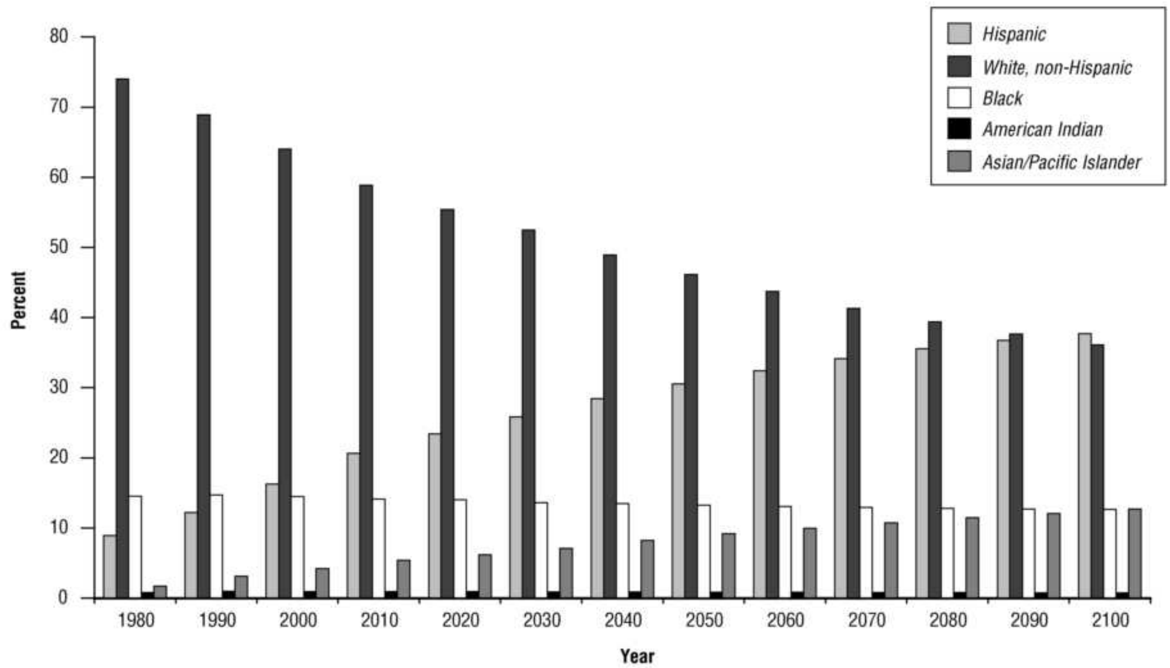
In 1790 more than one-half of the population (56%) within the then geographic boundaries of the United States had origins in Great Britain, and an additional one-fifth (19%) had origins in other northwestern European countries. As the number of immigrants per decade rose steeply from 143,000 in the 1820s to an average of 4.5 million in the 1880s and 1890s, the flow from Britain fell far short of the Irish immigration between 1820 and 1860 and the German immigration between 1830 and 1900. The Irish and Germans were commonly viewed as racially inferior to and/or religiously and linguistically incompatible with the native-born U.S. population of predominantly British origin.

This first great wave of immigration involved a dramatic shift in countries of origin at the end of the nineteenth century. During the two decades from 1900 to 1920, the majority of the 15 million immigrants entering the United States were from southern and eastern Europe. Anthropologists, scientists, and policymakers of the era shared the public sentiment that these southern and eastern European immigrants were racially distinct from earlier arrivals and that they were likely to dilute the racial and the cultural character of the American population of the time with its mainly northwestern European origins. The Irish, Germans, and southern and eastern Europeans were each, in turn, treated with often intense hostility and more than occasional discrimination.

Ethnic assimilation can be defined as a form of ethnic change taking place on one or both sides of the ethnic boundary involving a diminution of cultural, social, or physical distinctions. By the end of the twentieth century differences among European Americans on many measures, including language

FIGURE 1

Racial and Ethnic Composition of the United States Population, 1980–2100—Census Estimates and Middle-Series Projections



SOURCE: Population Projections Program, Population Division, U.S. Census Bureau (issued January 13, 2000).

spoken, fertility, and socioeconomic measures such as educational attainment, had largely disappeared. For European Americans, assimilation occurred as race and ethnic boundaries were blurred, stretched, and otherwise altered through intermarriage and through the expansion of mainstream culture to accommodate cultural differences.

While European-American ethnic groups have maintained some distinctive patterns, these are now slight compared to other, historically long-standing, racial and ethnic boundaries, most notably those separating non-Hispanic whites from American Indians, blacks, and Hispanics. In 1830, whites accounted for about 82 percent of the U.S. population but made up only 65 percent of the population within the territory now encompassed by the continental United States. With the continuing decimation of American Indians, the abolition of slave trade, and increasing immigration from Europe, the proportion of whites in the United States grew to 86 percent in the 34 states constituting the United States in 1860, and to 90 percent during the period from 1920 to 1950. Blacks accounted for most of the remaining 10 to 14 percent during these years.

Recent and Projected Transformations in Racial and Ethnic Composition

Following a sharp drop in the number of immigrants during the Great Depression, steady increases occurred during each decade between the 1940s and 1970s, followed by much larger influxes during the 1980s and 1990s. During the 1960s, 54 percent of immigrants came from Mexico, other western hemisphere countries (excluding Canada), and Asia. This proportion rose to 79 percent during the 1970s and 85 percent during the 1980s. In the 1980s Mexico and other western hemisphere countries (excluding Canada) accounted for 47 percent of all immigrants and Asia for an additional 37 percent. Most of these immigrants and their children are counted among the racial and ethnic minorities of the U.S. population.

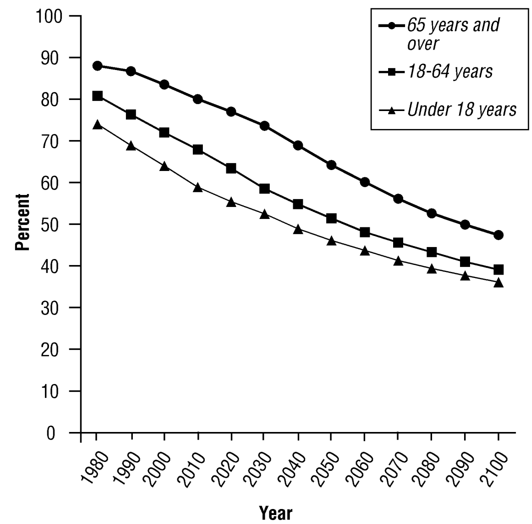
Dramatic growth in the number of immigrants and major shifts in countries of origin are rapidly transforming the racial and ethnic composition of the United States. Non-Hispanic whites declined sharply from 83.5 percent to 69.1 percent of the population between 1970 and 2000. Most of this 14 percentage-point-drop is accounted for by the 8 percentage-point-rise in Hispanics, from 4.6 percent to 12.5 percent of the total population. Non-Hispanic Asians and Pacific Islanders also grew substantially, from 1.6 percent in 1980 to 4.1 percent in 2000. Meanwhile, non-Hispanic blacks increased slightly, from 10.9 percent in 1970 to 12.1 percent in 2000, and American Indians continued to account for less than 1 percent of the population. An additional 1.6 percent of non-Hispanics listed two or more races in the 2000 census: These people are not included in the single-race categories noted.

Looking to the future, the U.S. Bureau of the Census projects that most U.S. population growth during the twenty-first century will occur through immigration and births to immigrants and their descendants. Thus the proportion of the population belonging to the current racial and ethnic minorities is projected to continue expanding to about 50 percent by mid-century and 60 percent by century's end, with a corresponding decline in the non-Hispanic white proportion. The emergence of racial and ethnic minorities as (in combination) the majority of the population is occurring most rapidly and will first become a reality among children. Census Bureau projections indicate that the proportion of children who are Hispanic, black, Asian, or of some other racial minority will rise above 50 percent before 2040, up from 31 percent in 1990 (see Figure 1).

Differences in the rates of change by age have important consequences. In 2030 the baby-boom generation born between 1946 and 1964 will be in the retirement ages of 66 to 84 years old. The Census Bureau's projections indicate that by that year, 74 percent of the elderly will be white, non-Hispanic, compared to only 58 percent of working-age adults and 52 percent of children (see Figure 2). The growing elderly population of the predominantly white (non-Hispanic) baby-boom generation will increasingly depend for its economic support during retirement on the productive activities and the civic participation (i.e., voting) of working-age adults who are members of racial and ethnic minorities, many of whom lived in immigrant families as children. Consequently, research and public policy addressing education, the labor force, and health should increasingly attend to the circumstances of racial and ethnic minorities.

FIGURE 2

Projected Proportions of Non-Hispanic Whites in the United States Population, by Broad Age Group, 1980–2100



SOURCE: Population Projections Program, Population Division, U.S. Census Bureau (issued January 13, 2000).

To what extent will members of various racial and ethnic minorities, including immigrants and their children, experience economic advance or constitute a permanent underclass during the coming decades? Four major scenarios (pluralist, structural, segmented assimilation, and traditional assimilation) provide different answers to this question. Taken together, these scenarios suggest that the outcomes experienced by racial and ethnic minorities, both as individuals and as groups, will depend on external factors, such as racial and ethnic stratification and discrimination, the availability of economic opportunities, and residential and educational segregation; as well as factors intrinsic to the group, such as the group's human and financial capital, cultural patterns of social relations, and community organization and infrastructure.

Will various racial and ethnic minorities of the twenty-first century experience the improved life chances associated with assimilation that benefited generations of white (non-Hispanic) groups during the twentieth century as the boundaries between these groups and the mainstream blurred? Or will the racial and ethnic minorities of the twenty-first century experience severely constrained opportunities and deprived circumstances similar to those that confronted many American Indians, blacks, and Hispanics throughout the twentieth century? The social, economic, and political future of the United States will be profoundly shaped by the answers to these questions.

See also: *African-American Population History; Census; Chinese, Overseas; Ethnic and National Groups; Immigration Trends; Residential Segregation.*

BIBLIOGRAPHY

Bennett, Claudette. 2000. "Racial Categories Used in the Decennial Censuses, 1790 to the Present." *Government Information Quarterly* 17: 161–180.

Goldstein, Joshua R., and Ann J. Morning. 2000. "The Multiple-Race Population of the United States: Issues and Estimates." *Proceedings of the National Academy of Sciences* 97: 6,230–6,235.

Harrison, Roderick J., and Claudette E. Bennett. 1995. "Racial and Ethnic Diversity." In *State of the Union: America in the 1990s,* vol. 2: *Social Trends,* ed. Reynolds Farley. New York: Russell Sage Foundation.

Heer, David. 1996. *Immigration in America's Future: Social Science Findings and the Policy Debate.* Boulder, CO: Westview Press.

Hernandez, Donald J., and Evan Charney, eds. 1998. *From Generation to Generation: The Health and Well-Being of Children in Immigrant Families.* Washington, D.C.: National Academy Press.

Hernandez, Donald J., and Katherine Darke. 1999. "Socioeconomic and Demographic Risk Factors and Resources among Children in Immigrant and Native-Born Families: 1910, 1960, and 1990." In *Children of Immigrants: Health, Adjustment, and Public Assistance,* ed. Donald J. Hernandez. Washington, D.C.: National Academy Press.

Lieberson, Stanley, and Mary C. Waters. 1988. *From Many Strands: Ethnic and Racial Groups in Contemporary America.* New York: Russell Sage Foundation.

U.S. Bureau of the Census. 1975. *Historical Statistics of the United States, Colonial Times to 1970,* bicentennial edition. Washington, D.C.: U.S. Government Printing Office.

———. 2000. *DP-1 Profile of General Demographic Characteristics: 2000 Data Set,* Census 2000 Summary File. Washington, D.C.: U.S. Government Printing Office.

Zhou, Min. 1997. "Growing Up American: The Challenge Confronting Immigrant Children and Children of Immigrants." *Annual Review of Sociology* 23: 63–95.

INTERNET RESOURCES.

Gibson, Campbell J. 1999. "Historical Census Statistics on the Foreign-born Population of the United States: 1850–1990, Population Division Working Paper no. 29." Washington, D.C.: U.S. Bureau of the Census. <http://www.census.gov/population>.

Yax, Laura K. 2000. "1980–2100 Projections." Washington, D.C.: U.S. Bureau of the Census. <http://www.census.gov>.

DONALD J. HERNANDEZ

RATZEL, FRIEDRICH

See *Lebensraum*

REFUGEES, DEMOGRAPHY OF

According to the 1951 Convention Relating to the Status of Refugees and its 1967 Protocol, a refugee is a person who has:

> a well-founded fear of persecution for reasons of race, religion, nationality, membership [in] a particular social group or political opinion, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such events, unwilling to return to it.

Most refugees flee in large groups to neighboring countries, where they often live in crowded refugee camps. Refugee-receiving states that are party to the convention are obliged to provide protection to refugees until they can safely return to their country of origin, integrate into the host society, or be resettled elsewhere.

Asylum seekers are people who have fled their countries of nationality and are seeking protection and immunity from forcible return by the government of the country in which they request asylum. Put differently, asylum seekers are, for the most part, refugees who are requesting that the authorities of a state grant them the legal status, and rights, of refugees according to the convention. Asylum seekers present themselves individually or as a family group to the relevant national authorities after arrival at the border or on the national territory. Every state has a slightly different application and recognition process, though in general receiving countries require asylum seekers to prove that they have a well-founded fear of persecution in their country of origin, in line with the definition set out above. If the asylum seekers' claims are accepted, they are granted refugee status and all the associated protections under national and international law. If a claim is not accepted, the asylum seeker is either subject to deportation or granted some form of "complementary protection" (where such status exists) allowing legal residence for "humanitarian reasons." Such protection is usually given for a limited period of time and does not grant the full range of rights and protections of "convention" status.

This article outlines the basic demography of refugees and asylum seekers worldwide since the end of World War II. It provides estimates of total numbers and briefly discusses major causation factors and policy changes affecting and resulting from refugee flows.

The 1950s

Immediately following World War II and the communist takeover of Eastern Europe, there were approximately 2.2 million refugees and stateless persons in Europe. These persons were mainly Jews, Roma, and other peoples uprooted during the war or fleeing political or religious persecution. Owing to the nature of the threats from which they fled, these refugees were largely unable and unwilling to return home even after the war had ended or after the Iron Curtain had solidified. In response, in 1950 the Office of the United Nations High Commissioner for Refugees (UNHCR) was established. An international legal mechanism was also needed to deal with the long-term protection needs of refugees and to allow for interstate understanding of their position. That mechanism was the 1951 refugee convention, which specified that the obligations of signatories extended only to those who became refugees as a result of "events occurring in Europe before 1 January 1951."

The convention fulfilled its intended initial mandate, as most of these refugees were integrated into host societies or resettled in other countries, notably in the United States, Canada, and Australia, by 1960.

The 1960s

By the mid-1960s, however, it became clear that the time and geographical limitations of the refugee convention were no longer sufficient to deal with the issues presented by the "newer" refugees, the vast majority of whom were from countries outside of Europe, particularly developing countries, and who were fleeing persecution for reasons unassociated with World War II. (An exception was the exodus from Hungary of some 200,000 refugees after the defeat of the 1956 uprising and a steady trickle of refugees from East to West Germany. Both resulted in speedy resettlement and integration of the refugees in the receiving Western countries.) By around 1970, there were nearly 1 million refugees fleeing wars of independence and postcolonial civil wars in countries such as Sudan, Ethiopia, Mozambique, Angola, Guinea-Bissau, India, and Pakistan. Therefore a protocol was added to the convention in 1967, removing the time reference and, except for those states that opted to keep them, the geographical specifications of the original convention. Additionally, the worldwide scope of refugee protection was broadened in 1969 by the Convention Governing the Specific Aspects of Refugee Problems in Africa (also called the OAU [Organization of African Unity] Convention), which noted that the increasing numbers of refugees in Africa necessitated that African states not only adhere to the refugee convention and its protocol but also develop common standards for refugee treatment. Additionally, the OAU Convention expanded the definition of a refugee to include:

> every person who, owing to external aggression, occupation, foreign domination or events seriously disturbing public order in either part or the whole of his country of

> origin, is compelled to leave his place of habitual residence in order to seek refuge in another place outside his country of origin or nationality.

Together, the protocol and the OAU Convention increased the number of persons considered refugees as they expanded the geographical scope of areas of concern (beyond Europe) as well as the reasons predicating the granting of refugee status (beyond World War II).

The 1970s and 1980s

Three major refugee crises took place between the signing of the 1967 protocol and the end of the Cold War. The first involved the Vietnamese "boat people" who fled their country after the break-up of South Vietnam in 1975. Due largely to their mode of transport as well as direct American involvement in the crisis, the boat people, unlike other, less visible, refugee streams, attracted significant international attention. Beginning in 1975, almost 850,000 people would eventually flee Vietnam claiming political, religious, or ethnic persecution (though by the late 1980s it was clear that many new boat people were in fact economic migrants rather than refugees). Of this total, 250,000 fled to Malaysia, 210,000 to Hong Kong, and 160,000 to Thailand. The Philippines and Brunei also received large numbers. As most of these countries of first asylum were themselves relatively poor countries with their own social tensions, they were unwilling to permanently resettle such large numbers of refugees. As a result, they successfully lobbied the international community, particularly the United States and Australia, to resettle the majority of Vietnamese who had sought refuge on their shores. Between 1975 and 1991, nearly half a million Vietnamese were permanently resettled in industrialized countries.

For various reasons, refugees fleeing Afghanistan after the Soviet invasion of that country in 1979 drew much less international attention than the boat people, and they in fact remained the world's single largest refugee problem 23 years later. Between 1979 and 2002, an estimated one in four Afghans became a refugee. The Afghan refugee emergency had two major peaks, the first between 1988 and 1991, when there were 3.5 million Afghan refugees in Pakistan, 2 million in Iran, and nearly 1 million more in other areas of the world. The crisis subsided for a short while in the early 1990s as many Afghans returned home after the break-up of the Soviet Union, but the civil war that flared up shortly thereafter caused another mass exodus, totaling approximately 5 million refugees by early 2000.

The third major refugee crisis of the 1980s occurred in Central America as a result of the various wars and political conflicts in Nicaragua, Guatemala, and El Salvador. Though such conflicts did not produce the same numbers of refugees as Vietnam and Afghanistan, they resulted in the creation in 1984 of the Cartagena Declaration on Refugees. Like the OAU Convention of 1969, this nonbinding declaration also expanded the refugee definition, in this case to better suit the nature of refugee problems in Central America, stating that:

> it is necessary to consider enlarging the concept of a refugee . . . the definition or concept . . . to be recommended for use in the region is one which, in addition to containing the elements of the 1951 Convention and the 1967 Protocol, includes among refugees those persons who have fled their country because their lives, safety or freedom have been threatened by generalized violence, foreign aggression, internal conflicts, massive violation of human rights or other circumstances which have seriously disturbed public order.

Post–Cold War Era

The end of the Cold War marked the beginning of "modern" refugee crises as many, mostly developing, countries found themselves embroiled in often violent conflicts after they lost the support of their superpower backer. Most of these conflicts were internal and created huge new (or increased, in the case of Angola and Afghanistan) refugee movements in countries such as Liberia, Bulgaria, and Romania. Other massive refugee crises occurred throughout the 1990s in locations as geographically diverse as Sudan, the Democratic Republic of the Congo (then Zaire), Rwanda, Burundi, Iraq, Indonesia, Ethiopia, Eritrea, and the former Yugoslavia (see Table 1). Further, the political incentive for many Western states to accept refugees was greatly reduced by the end of the Cold War, and it consequently became difficult for many of these states to adjust their policies to accept refugees and asylum seekers in whom they had a less clearly defined political interest. An increase in economic migration from several of the

TABLE 1

Major Refugee Populations and Host Countries, c. 2001

Country of Origin	Main Countries of Asylum	Number of Refugees (thousands)
Afghanistan	Pakistan, Iran	3,580
Burundi	Tanzania	568
Iraq	Iran	512
Sudan	Uganda, Democratic Republic of the Congo, Ethiopia, Kenya, Central African Republic, Chad	490
Bosnia–Herzegovina	Yugoslavia, Croatia, United States, Sweden, Netherlands, Denmark	478
Somalia	Kenya, Ethiopia, Yemen, Djibouti	448
Angola	Zambia, Democratic Republic of the Congo, Namibia	433
Sierra Leone	Guinea, Liberia	401
Eritrea	Sudan	376
Vietnam	China, United States	370

SOURCE: UNHCR, "Refugees by Numbers" (2001).

same countries and regions led many citizens and government officials in receiving countries to question the motives of asylum seekers and therefore be less willing to grant protected status under the terms of the refugee convention. This attitude was perhaps most clearly illustrated by the response of western European states to the Balkan crises of the 1990s. Rather than accepting Bosnian and Kosovar refugees (*prima facie*) as a predetermined group or even allowing them to submit asylum applications, most receiving states granted them only temporary protection, determined that they would be repatriated as soon as conditions in the country of origin allowed.

This combination of larger numbers of refugees and asylum seekers and less willingness on the part of states to accept them has led many to question the continuing effectiveness of the refugee convention. Statistical estimates on the size of refugee and asylum flows between 1980 and 2000 shown in Table 2 suggest the magnitude of the refugee problem and the pressures on the international refugee protection system at the dawn of the twenty-first century.

Refugees in Developing Countries

The vast majority (approximately 95%) of all refugees flee developing countries to seek protection in other developing countries nearby. Thus it is states such as Pakistan—which has hosted the largest refugee population of any country in the world for over a decade—as well as Iran, Jordan, Tanzania, Sudan, Kenya, India, and many more developing countries as well as the Israel-occupied Palestine territories that bear the brunt of the increased refugee populations, even though such states have limited resources with which to support their new guests who, in turn, often suffer severe and prolonged deprivations materially and by criteria of human rights and dignity. For the most part, countries receive refugees because of geographic proximity and/or cultural and religious ties—for example, most Afghan refugees flee to Pakistan or Iran and most Burundians to Tanzania. Pressures on the receiving states are great, as many struggle to support their native populations and must rely on the international community—mainly through the UNHCR and other governmental or voluntary organizations—to help care for the refugee populations.

Asylum Seekers in Industrialized Countries

Industrialized countries have also seen increases in the number of people seeking protection, most of whom arrive under their own power as asylum seekers rather than as refugees resettled through predetermined government-sponsored programs. Overwhelmed bureaucracies in most industrialized receiving countries were unable to keep up with the increased flow of asylum seekers during the 1990s, often taking so long to process applications that asylum seekers became de facto residents. As a result, many citizens of these host countries came to regard the asylum process as just another form of economic migration. Public frustration with what is often perceived as a "flood" of "bogus" asylum seekers has been the driving factor behind many of the reforms that have been adopted or advocated in countries of asylum since the mid-1990s. In the United States, these reforms entailed delinking the asylum application process from the immediate receipt of a work permit and increasing the numbers of staff assigned to processing asylum-seeking applications. In Europe, however, the changes have meant that fewer and fewer applicants are actually granted—or even allowed to apply for—asylum. Instead, applicants are given some form of temporary protection and may remain in an uncertain legal status for prolonged periods.

Refugees and Displaced Persons in 2001

At the beginning of 2001, nearly 22 million people —approximately 80 percent of whom are women and children; 50 percent of whom are children and adolescents—were classified as "persons of concern" by the UNHCR; roughly one out of every 275 people on Earth. The majority of these people were refugees, asylum seekers, or part of the rapidly growing number of "internally displaced persons" (IDPs). IDPs are people who, much like refugees, have fled their homes because of conflict or persecution. Unlike refugees, however, IDPs have not crossed an international border and therefore do not fall within the scope of the refugee convention. Because of their growing numbers as well as their lack of protection under a single international instrument, IDPs are of increasing concern to many within the refugee protection field, and debate continues as to which international organizations are best equipped and mandated to deal with their particular needs. The largest populations of internally displaced persons are found in Sudan (approximately 4 million in 2001), Colombia (over 2 million in 2001), and Afghanistan (from 750,000 to 1.5 million immediately following the U.S.-led campaign to oust the Taliban regime in 2001–2002).

See also: *Asylum, Right of; Ethnic Cleansing; Forced Migration; Immigration, Unauthorized; Resettlement.*

TABLE 2

Asylum Applications in Europe, North America, Australia, New Zealand and Japan, 1980–2000

Year	Total (thousands) (37 countries)	European Union	North America
1980	180	149	28
1981	199	130	65
1982	140	93	38
1983	115	71	35
1984	160	98	35
1985	203	157	30
1986	247	190	45
1987	254	167	64
1988	353	215	109
1989	439	283	122
1990	573	402	110
1991	661	492	89
1992	856	674	142
1993	769	550	164
1994	515	302	168
1995	529	308	181
1996	465	260	154
1997	530	291	178
1998	577	340	140
1999	652	414	121
2000	569	390	102

SOURCE: UNHCR Statistic Division (2001).

BIBLIOGRAPHY

Ager, Alistair, ed. 1999. *Refugees: Perspectives on the Experience of Forced Migration.* London: Continuum.

Loescher, Gil. 2001. *The UNHCR and World Politics: A Perilous Path.* New York: Oxford University Press.

Loescher, Gil, and Laila Monohan, eds. 1989. *Refugees and International Relations.* Oxford: Clarendon Press.

Nicholson, Frances, and Patrick Twomey, eds. 1999. *Refugee Rights and Realities: Evolving International Concepts and Regimes.* Cambridge, Eng.: Cambridge University Press.

United Nations. Treaty Series. 1954. "The 1951 Convention Relating to the Status of Refugees." July 28, 1951. *Treaties and International Agreements Registered or Filed or Reported with the Secretariat of the United Nations* 189(2,545).

———. 1969."Convention Governing the Specific Aspects of Refugee Problems in Africa." September 10, 1969. *Treaties and International Agreements Registered or Filed or Reported with the Secretariat of the United Nations* 1001 (14691).

United Nations High Commission for Refugees. 2001. *Asylum Applications in Industrialized Countries, 1980–1999.* Geneva, Switzerland: UNHCR, Population Data Unit.

———. 2001. *Global Report 2000: Achievements and Impact.* Geneva, Switzerland: ATAR Rotopresse.

———. 2001. *The 1951 Refugee Convention: Questions and Answers.* Geneva, Switzerland: UNHCR, Public Information Section.

———. 2001. "Refugees by Numbers, 2001." Geneva, Switzerland: UNHCR, Statistics Division.

———. 2001. "2000 Global Refugee Trends: Analysis of the 2000 Provisional UNHCR Population Statistics." Geneva, Switzerland: UNHCR, Population Data Unit.

U.S. Committee for Refugees. 2001. *World Refugee Survey 2001.* Washington, D.C.: Immigration and Refugee Services of America.

INTERNET RESOURCES.

"Cartagena Declaration on Refugees." November 22, 1984. <http://pbosnia.kentlaw.edu/services/chicago/legal_aid/treaties/cartagena.htm>.

Women's Commission for Refugee Women and Children. <http://www.womenscommission.org/wc_factsheet.pdf>.

ERIN PATRICK

REGISTRATION, POPULATION

See *Population Registers; Vital Statistics*

RELIGIONS, POPULATION DOCTRINES OF

The questions about religious doctrine of interest in the field of population studies have usually been those referring to its effects on reproductive behavior. Two kinds of effects have been studied: the direct effects of doctrines about reproductive behavior itself, and the indirect effects on this behavior of doctrines that concern the status of women. This essay reviews doctrines of both kinds in the five religions that together represent the dominant religious affiliations in countries containing over two-thirds of the world's population. These religions are Judaism, Christianity, Islam, Hinduism, and Buddhism. The first section presents a summary of each religion's doctrine on sexual and reproductive behavior. In each case, this is the version believed to represent the official or conventional doctrine. Often of course this may have little in common with the doctrine understood by lay adherents and even less with their conduct. Each description is preceded by an outline of the origin of the religion and of the core beliefs regarded by those who espouse them as legitimating its doctrines. In subsequent sections, the views of sociologists on the social functions of the doctrines are described.

Doctrines

Introducing an encyclopedia of the world's religions, R. C. Zaehner divides them into two main traditions. *Western* religions—Judaism, Christianity, and Islam—are those that were born in the Near East and owe their origin, directly or indirectly, to the Jews. *Eastern* religions—largely Hinduism and Buddhism—are those that either originated in India or have been profoundly influenced by Indian thought. Zaehner notes the profound difference in content between the two traditions. Each of the Western religions claims that it is a direct revelation of the one true God to humans, that he created the world, that his sovereignty is absolute and his will must be obeyed, that life on this earth is a preparation for an immortal life to come, and that the nature of that life will be determined by God's judgment of the individual's conduct during the life on earth. In contrast, salvation in the Eastern tradition means escape, by one's own efforts or with the grace of a God, from the process of reincarnation. The dominant preoccupation is not with duty to God, but with the deliverance of the immortal soul from the bondage of the body. Given the immense differences between these two worldviews, notable differences might be expected in their doctrines on sexual and reproductive behavior. In the event, it is the similarities that are more striking.

Judaism

Judaism is the religion of Jewish believers in Israel and throughout the world. It also played a formative role in the early history of Christianity and Islam. According to traditional belief, God revealed himself to the ancestors of the people of Israel three and a half millennia ago, using the prophet and leader Moses to communicate teaching and commands that became embodied in the Hebrew bible. Over the centuries, biblical teaching has been interpreted and supplemented by rabbis—Judaism's teachers and scholars—and they continue to be the source of guidance on conduct that will conform to God's will. The diverse and changing circumstances that Jews have encountered, especially since the late-eighteenth century, have led to the creation of separate movements within Judaism that differ in what they will accept as an interpretation of divine will.

The Hebrew Bible idealized a patriarchal and pronatalist model of the family, and this ethos is evident in the contemporary doctrines of orthodox Judaism. It is a religious duty for men (but not women) to marry. The man also bears responsibility for procreation. The couple is expected to have at least one child of each sex, in conformity with the biblical injunction to "be fruitful and multiply."

Premarital sex is forbidden. Adultery is forbidden. Divorce is permitted but requires the husband's consent if sought by a woman. Abortion is permitted to save the life of the mother, but there is contention about other possible justifications; life is considered to begin at birth. Contraception is permitted if the motive is acceptable and if the method (unless used for medical reasons) does not impede full sexual union. On all these issues, non-orthodox movements within Judaism are more permissive than the orthodox and more likely to leave decisions to the individual.

Christianity

Christianity had its origin in a Jewish movement that emerged after the death around 30 C.E. of the Jewish preacher Jesus of Nazareth, later known as Jesus Christ or simply Christ ("Messiah") and believed by Christians to be an incarnation of God. The religious doctrines are based on accounts of the life of Christ written by disciples after his death and forming the core of the New Testament which, with the Old Testament (essentially the Hebrew Bible), became the authorized scripture of Christianity. According to traditional Christian doctrine, the way of securing salvation from the consequences of sin and ensuring that death will be followed by eternal life in paradise is to accept God's grace and to follow the teaching and example of Christ. Essentially this requires the adoption of a way of life dominated by love of God and obedience to his will, and by love of one's fellow human beings. In the early twenty-first century, the main institutions of Christianity—inheritors of the disciples' function of propagating Christ's teaching—are the Roman Catholic Church, the Eastern Orthodox Church, and a large number of Protestant churches.

In most respects, Christianity's early teaching on sexual and reproductive behavior, which was based on the Old and New Testaments, reiterated the traditions of Judaism, though with divorce and remarriage after divorce added to the forms of conduct that were condemned, and with celibacy newly valued as a way of expressing a special devotion to God. Early Christian teaching continues to be endorsed to this day by the Roman Catholic Church. A valid marriage is a divinely established institution and is indissoluble. It is written within marriage that conjugal love achieves its divine purposes, that of uniting the couple and endowing them with children. Premarital sex and adultery are prohibited. Abortion at any time is prohibited because life is believed to begin at conception. Any act, including sterilization, specifically intended to prevent procreation is prohibited. Periodically these doctrines have been elaborated by holders of the office of Pope, in whom the ultimate authority of the Roman Catholic Church is vested. For example, in his 1968 encyclical *Humanae Vitae,* which was widely greeted with dismay, Pope Paul VI stressed ". . . an act of mutual love which impairs the capacity to transmit life . . . frustrates His [God's] design which contradicts the norm of marriage, and contradicts the will of the Author of life." In an apparent concession to changing times, and one regarded within and outside the Church as a major innovation, couples with acceptable motives for wanting to avoid conception have increasingly been encouraged to restrict intercourse to the infertile period of the menstrual cycle. It is claimed that this method acknowledges the inseparable connection between the unitive and procreative purpose of intercourse, and enriches the couple's relationship by promoting dialogue, mutual respect, shared responsibility, and self control.

In the eleventh century, as a result of doctrinal differences and a refusal by the Eastern part of the church to accept that authority should be vested in a single head, the Eastern and Western parts separated and the former became the Eastern Orthodox Church. Like its Roman counterpart, the Eastern Church maintains a strong commitment to the ideas of the early Church. Great emphasis is placed on the importance of home and family. Sexual intercourse must be confined to marriage. Divorce and remarriage are allowed, but remarriage in church is possible only if church authorities have granted the divorce as well as the state. Abortion and permanent sterilization are condemned. Previously, contraception was also prohibited but the views coming to prevail are that the responsible use of contraception within marriage is acceptable, and that decisions on family size should be left to the individual couple, according to the guidance of their own consciences.

In the sixteenth century, a reform movement within Christianity led to the establishment of a Protestant branch of the religion that rejected the authority of the Roman Catholic Church and many of its beliefs and practices, though not its view that procreation was the principal purpose of marriage. Protestantism spawned many denominations, which differ among themselves and from Catholicism in their population-related and other doctrines. Until the 1930s, the doctrines of Protestantism about contraception had been as rigorous as those of the Roman Catholic Church. The break with tradition started with the Lambeth Conference of the Church of England in 1930, when the use of contraception was allowed if abstinence was not practicable. After another three decades, the 1958 conference rejected the primacy of procreation as the purpose of marriage and approved the use of contraception by methods "admissible to the Christian conscience." Similar changes have since occurred in the doctrines of other mainstream denominations. The Anglican and other denominations have also become more tolerant of divorce and remarriage. Some of the relaxations in doctrine, including those allowing the acceptability of abortion in some cases, have been vigorously opposed by the more conservative denominations.

Islam

Islam was founded by the prophet Muhammad (570–632 C.E.) who reported a series of revelations from God. Embodied in the Quran, these revelations, together with the collected accounts of the Prophet's life and teaching, are the principal source of the beliefs and practices of Muslims. According to the Quran, Muhammad was the last in a line of prophets (that included Moses and Jesus) who, like him, had received revelations from God and had been required to propagate them. As individuals and as a community, Muslims are required to submit to divine will, as revealed (with the help of Muslim scholars) in the Quran and accounts of the prophet's teaching.

Like Judaism and Christianity, Islam in its classical form endorses the biblical injunction to "be fruitful and multiply" and to do so only within marriage, an institution recommended to everyone able to afford it. Sexual intercourse outside marriage is forbidden. A husband may divorce his wife simply by declaration, though he is required to be considerate in his behavior toward her in the process. A wife may obtain divorce with the husband's agreement or by other procedures if he does not agree. Islam allows a man to have up to four wives, but only if he believes he can treat them equitably. Contemporary scholars stress that the teaching did not commend polygyny, but permitted it in some circumstances. It is thought to be a way of providing a husband for a woman who would otherwise be without one, including widows with children.

Birth control is not prohibited and the majority view among contemporary Muslim scholars is that the use of contraception is permissible with the wife's consent. Sterilization is seen as contrary to divine will, and is approved for medical reasons only. According to some scholars, abortion is permitted if it takes place before the fetus acquires a soul or to save the mother's life, but there is disagreement about the stage of fetal development at which ensoulment occurs. Others argue that, in the light of modern scientific knowledge about the early stage at which human life can be recognized in utero, abortion is always unacceptable unless carried out to save the mother's life or prevent the birth of a severely handicapped child.

Hinduism

Hinduism has no single founder and no orthodox version. Instead it comprises a family of related traditions and customs that have developed in the Indian subcontinent over a period of at least 3000 years. It encompasses a wide variety of beliefs and practices, has a vast store of sacred scriptures, and acknowledges numerous deities but (usually) one God as the creator and preserver of the universe. Some core beliefs are common to most versions of Hinduism. The most important is the conviction that all living things (human, animal, insect) have the same kind of soul—one that is destined, when the body dies, to be reborn in a different body. The particular form of the latter will depend on the individual's *karma,* the effect of good and bad deeds in the life that has ended and in previous lives. Accumulating merit by living dutifully increases the probability that the next life will be an improvement on the current one. The ultimate aim is liberation from the cycle of death and rebirth.

Like the religions of near-Eastern origin, Hinduism accords fundamental importance to the family and views it from a male-oriented perspective. Women are regarded as subordinate to men, though Hindu codes urge that women be treated with kindness and respect, especially if they are mothers. Premarital chastity for women is highly valued. Marriage is a sacred and, ideally, indissoluble relationship, but hallowed texts specify various circumstances in which wives may be replaced. Childbearing, especially the bearing of sons, has been accorded importance in the Hindu tradition from earliest times. Traditionally, failure to bear a son was a justification for the husband to take another wife. Because life is believed to begin at conception, abortion is not approved, though it may be permitted if the continuation of the pregnancy would put the mother's health at risk. Hinduism is permissive toward contraception and sterilization. Methods of avoiding conception were mentioned in its earliest texts.

Buddhism

Buddhism was founded in India in the sixth century B.C.E. by Siddhartha Gautama, who later became known as the Buddha ("enlightened one" or "awakened one"). According to the scriptural accounts, the prospective Buddha, like the philosophers of Hinduism, searched for a way of escaping the suffering that the endless cycle of death and rebirth imposed on humankind. Having eventually found it, he undertook to teach others how they too might find enlightenment. To this end he established a monastic order, the members of which continue to act as teachers and advisers to lay Buddhists.

According to the Buddha's teaching, life is permeated with suffering and this is caused by craving. The extinction of craving, and therefore of suffering, can be achieved by adopting a way of life that requires virtuous conduct, meditation, and finally the achievement of the transcendental wisdom necessary for liberation. The process takes numerous cycles of death and rebirth, but serenity and insight can eventually be achieved in a final lifetime, when the notion of the permanent self is seen for what it truly is—an illusion. Death is then followed by *nirvana,* a permanent state of transcendent liberation. Virtuous conduct entails not taking life, avoiding sexual misconduct, and developing ways of thought that will encourage selflessness and moral and compassionate behavior toward others.

It seems to be generally agreed by experts on its doctrines that Buddhism does not regard marriage and childbearing as sacred obligations. On the other hand, the encouragement to act virtuously and the concept of rebirth could help to sanctify the observance of whatever norms of family formation and reproductive behavior prevail in the Buddhist's own social setting. There is no doctrinal bar to contraception and sterilization, but there is contention about abortion. The most common view is that because life (the transmigration of consciousness) begins at conception, abortion entails killing, but other positions have been proposed.

The Social Functions of Religion

The sociology of religion is concerned with the social functions of religious belief and practice. One main tradition of enquiry has focused on the general significance of religion for society. The other main tradition has been concerned with the interaction between religious belief and actual social experience. Both traditions can illuminate the social significance of the doctrines described above.

The first of the traditions mentioned was established by the French sociologist Emile Durkheim (1858–1917). Writing at the end of the nineteenth century, he proposed that the latent function of religious worship in a society was to encourage veneration of society's institutions. In his classic and influential work, *The Elementary Forms of the Religious Life* (1912), he argues that a society necessarily and naturally generates a collective and sacred ideal of itself. This ideal is symbolized and sustained by religion, the doctrines of which express the nature of sacred things and of the relationships they sustain with each other and with profane things. From Durkheim's standpoint, the doctrines described above could be seen as epitomizing religion's function: encouraging veneration of marriage and procreation and a collective commitment to the social order. For him, falling birth rates and rising divorce rates—evidence of the weakening of domestic solidarity and therefore of social solidarity in general—reflected the social malaise that had befallen European societies in the process of their development.

Sociologists who have focused on the relationship between religion and the material conditions of life often have a different perspective on doctrine. In his treatment of the historical development of the family, Friedrich Engels (1820–1895) sees monogamous marriage as closely connected with the emergence of private property, and enforced by religion and law to secure the stable transmission of property between generations. In his study of the relationship between the development of capitalism and Protestant asceticism, Max Weber (1864–1920) emphasized its rigidly biblical view of the purpose of marriage. A contemporary sociologist, Bryan Turner, draws on these and other sources to argue that religion has been important historically for the distribution and control of property in society, and has had its effect by providing beliefs and institutions that support the control of children by parents and women by men. A similar view is taken by those who, on behalf of women, campaign against constraints on their autonomy and status and maintain that religious and related doctrines often serve the interests of men at the cost of women's control over their sexual and reproductive lives.

Procreation and the Sacred in Modern Societies

It is a commonly held view that, with the waning of attachment to traditional doctrines, religion has lost its social significance in modern societies. Against that view, Thomas Luckmann argues that all societies, including modern societies, necessarily generate sacred beliefs that have the social function of explaining the ultimate relevance of the social world and human conduct. From a similar standpoint it can be argued that, because the reproduction of the social world and its sacred beliefs depends on a continuing commitment to procreation, it is reasonable to expect procreation itself to be the subject of sacred beliefs. The form these take in modern societies may continue to owe something to traditional doctrine, but may be experienced primarily as collective reverence for parenthood as a feature of a particular and hallowed way of life.

See also: *Animal Rights; Euthanasia; Future Generations, Obligations to; Induced Abortion: Legal Aspects; Population Thought, History of; Reproductive Rights; Reproductive Technologies: Ethical Issues.*

BIBLIOGRAPHY

Berer, Marge, and T. K. Sundari Ravindran. 1996. "Fundamentalism, Women's Empowerment and Reproductive Rights." (Introduction to collection of articles on this subject). *Reproductive Health Matters* 8: 7–10.

Coward, Howard G., Julius J. Lipner, and Katherine K. Young. 1989. *Hindu Ethics: Purity, Abortion, and Euthanasia.* New York: State University of New York Press.

Dorff, Elliot, and Louis Newman, eds. 1995. *Contemporary Jewish Ethics and Morality: A Reader.* New York: Oxford University Press.

Durkheim, Emile. 1888. "Suicide et natalité: Etude de statistique morale." *Revue Philosophique* 26. Transl. H. L. Sutcliffe 1992: "Suicide and Fertility: A Study of Moral Statistics." *European Journal of Population* 8: 175–197.

Durkhem, Emile. 1912. Les formes élémentaires de la vie religieuse: le système totémique en Australie (Paris: Alcan). Trans. J. W. Swain 1915: *The Elementary Forms of the Religious Life.* London: Allen & Unwin.

Feldman, David M. 1968. *Birth Control in Jewish Law: Marital Relations, Contraception, and Abortion as Set Forth in the Classic Texts of Jewish Law.* New York: New York University Press. (Also in paperback as *Marital Relations, Birth Control, and Abortion in Jewish Law.* New York: Schocken Press.)

Hathout, Hassan. 1991. "Islamic Concepts and Bioethics." In *Theological Developments in Bioethics, 1988–1990,* ed. Baruch A. Brody and B. Andrew Lustig. *Bioethics Yearbook,* Vol. 1. Dordrecht: Kluwer Academic.

Luckmann, Thomas. 1967. *The Invisible Religion.* London: Macmillan.

Maguire, Daniel C. 2001. *Sacred Choices: The Right to Contraception and Abortion in Ten World Religions.* Minneapolis: Fortress Press.

Morgan, Peggy, and Clive Lawton, eds. 1996. *Ethical Issues in Six Religious Traditions.* Edinburgh: Edinburgh University Press.

Noonan, John T. 1986. *Contraception: A History of its Treatment by the Catholic Theologians and Canonists.* Enlarged edition. Cambridge, MA: Harvard University Press.

Omran, Abdel-Rahim. 1992. *Family Planning in the Legacy of Islam.* London: Routledge.

Pope Paul VI. 1970. *On Human Life: Encyclical Letter—Humanae Vitae.* 1968. London: Catholic Truth Society.

Reich, W. T., ed. 1995. *Encyclopedia of Bioethics.* rev. edition. New York: Simon and Schuster Macmillan.

Simons, John. 1999. "The Cultural Significance of Western Fertility Trends in the 1980s." In *Dynamics of Values in Fertility Change,* ed. R. Leete. Oxford: Oxford University Press.

Smith, Janet E. 1991. *Humanae Vitae: A Generation Later.* Washington, D.C.: Catholic University of America Press.

Turner, Bryan S. 1991. *Religion and Social Theory.* 2nd edition. London: Sage.

Ware, Timothy. 1997. *The Orthodox Church.* New York: Penguin.

Zaehner, R. C. 1977. "Introduction." In *The Concise Encyclopedia of Living Faiths,* ed. R. C. Zaehner. London: Hutchinson.

Zaehner, R.C., ed. 2001. *Hutchinson Encyclopedia of Living Faiths.* Oxford: Helicon.

INTERNET RESOURCES.

Hughes, James J., and Damien Keown. 1995. "Buddhism and Medical Ethics: A Bibliographic Introduction." *Journal of Buddhist Ethics* 2: 105–124. <http://jbe.gold.ac.uk>.

Pope Paul VI. 1968. *Humanae Vitae.* Rome: The Vatican. Available at <http://www.vatican.va>.

JOHN SIMONS

RELIGIOUS AFFILIATION

There are estimated to be some 10,000 distinct and separate religions in the early twenty-first century. Information on the size and characteristics of their membership can be drawn from the various religious authorities themselves and from government data.

The Religion Megacensus

Major efforts are put into the collection of statistics by individual religious bodies. For example, Christian denominations periodically undertake a decentralized and largely uncoordinated global census of their members. The most extensive of these inquiries is conducted by the Roman Catholic Church, whose bishops are required annually to submit a detailed statistical report on their work. The entire data collecting operation, performed to some degree by all religious bodies, has been termed the religion megacensus.

Government Censuses

Since the twelfth century, the world's governments also have collected information on religious populations and practice. A question related to religion is asked in the decennial population censuses of over 120 countries (not including the United States and a number of European countries). Before 1990, this number was slowly declining as developing countries began dropping the question because it was deemed too expensive, uninteresting, or sensitive. Subsequently, the trend appears to have reversed. Thus Britain—which produced the world's first national census of religious affiliation (the Compton Census, in 1676)—included a religion question in the census of 1851 but none thereafter, until it reintroduced the question in the 2000 census. The question was considered the best way to get reliable data on non-Christian minorities.

A Summary Global Table

These two approaches, the religion megacensus and government censuses with questions about religious affiliation, produce an enormous volume of data. Table 1 presents a compact global overview derived from these data, showing estimated number of adherents by major religion for 1900, 1970, and 2000.

Categories and Data Problems

The starting point in any analysis of religious affiliation is the United Nations 1948 *Universal Declaration of Human Rights,* Article 18: "Everyone has the right to freedom of thought, conscience and religion; this right includes freedom to change his religion or belief, and freedom, either alone or in community with others and in public or private, to manifest his religion or belief in teaching, practice, worship and observance." Since its promulgation, this group of phrases has been incorporated into the state constitutions of a large number of countries across the world and applied in census-taking practice. If a person states that he or she is a Christian (or Muslim, Hindu, Buddhist, etc.), then no one has a right to say he or she is not. Public declaration or profession must be taken seriously. The result should be a clearcut assessment of religious profession.

Data on religious affiliation obtained from government censuses can be strikingly different from those collected by the religious bodies themselves. For example, in Egypt, where the great majority of the population is Muslim, in government censuses every 10 years for the last 100 years some 6 percent of the population are reported to be Christians. However, based on church censuses the number of Christians affiliated to churches in Egypt amounts to 15 percent of the population. The main reason for this discrepancy appears to be a misclassification of Christians as Muslims in the government census, perhaps through pressure on the Christian minority.

TABLE 1

Adherents of the World's Major Religions, 1900, 1970 and 2000 (Estimated Numbers and Percentage of World Population)

	1900		1970		2000	
Religion	Number (million)	%	Number (million)	%	Number (million)	%
Christians	558	34	1236	34	2000	33
Muslims	200	12	553	15	1188	20
Hindus	203	13	463	13	811	13
Chinese folk-religionists	380	24	231	6	385	6
Buddhists	127	8	233	6	360	6
Ethnoreligionists	118	7	160	4	228	4
New-Religionists	6	–	78	2	102	2
Sikhs	3	–	11	–	23	–
Jews	12	1	15	–	14	–
Spiritists	–	–	5	–	12	–
Baha'ís	–	–	3	–	7	–
Confucionists	1	–	5	–	6	–
Other religions	9	1	9	–	14	–
Doubly-counted religionists	–	–	−4	–	−14	–
Nonreligious/atheists	3	–	697	19	918	15
Total	1620	100	3696	100	6055	100

Note: – = less than 0.5 million or less than 0.5%

SOURCE: Barrett and Johnson (2001), p. 384.

Changes in Affiliation

Changes in total numbers of persons by religious affiliation result from the combination of three factors: (1) births and deaths—that is, natural increase; (2) conversion and defection; and (3) population movement.

Natural increase. The primary mechanism of change in religious affiliation globally is births and deaths. Children are usually counted as being of the religion of their parents (this is the law in Norway, among other countries). The change over time in any given community is most simply expressed as the number of births into the community minus the number of deaths. Many religious communities around the world experience little else in the dynamics of their growth or decline.

Conversion and defection. Nonetheless, it frequently happens that individuals (or even whole villages or communities) change allegiance from one religion to another (or to no religion at all). In the twentieth century, this change has been most pronounced in two general areas: (1) Tribal religionists, more precisely termed ethnoreligionists, have converted in large numbers to Christianity, Islam, Hinduism, and Buddhism; and (2) Christians in the Western world have defected in large numbers to become nonreligious (agnostics) or atheists. Both of these trends, however, had slowed considerably by the dawn of the twenty-first century.

Population movement. At the country level, it is equally important to consider the movement of people across national borders. From the standpoint of religious affiliation, migration can have a profound impact. In the colonial era in the nineteenth century, small groups of Europeans settled in Africa, Asia, and the Americas. In the late-twentieth century, people from these regions migrated to the Western world. Thus, in the United States, religions such as Islam, Hinduism, and Buddhism are growing faster than either Christianity or the nonreligious and atheists. This growth is almost entirely due to the immigration of Asians. In the Central Asian countries of the former Soviet Union, Christianity has declined significantly every year since 1990, due to the emigration of Russians, Germans, and Ukrainians.

Methodology Employed

Tables similar to Table 1 but giving more detailed categories, breakdowns of change over time, and projections for several decades ahead have been prepared for every country. These data tables and detailed descriptions of methodology—explaining how the formidable technicalities were resolved—can be found in *World Christian Trends, AD 30–AD 2200* (Barrett and Johnson, 2001) and *World Christian Encyclopedia* (Barrett, Kurian, and Johnson, 2001). The underlying demographic data incorporate the updates (every two years since 1950) of the United Nations population database for all countries from 1950 to 2050, and for some 100 variables each. A summary report on the religion megacensus has been published annually in *Encyclopaedia Britannica's Book of the Year* since 1987.

See also: *Ethnic and National Groups; Languages and Speech Communities.*

BIBLIOGRAPHY

Annuario Pontificio. Annual. Citta del Vaticano: Tipografia Poliglotta Vaticana.

Barrett, David B., and Todd M. Johnson. 2001. *World Christian Trends, AD 30–AD 2200: Interpreting the Annual Christian Megacensus.* Pasadena, CA: William Carey Library.

Barrett, David B., George T. Kurian, and Todd M. Johnson. 2001. *World Christian Encyclopedia: A Comparative Survey of Churches and Religions in the Modern World,* 2nd edition, 2 Vols. New York: Oxford University Press.

Eliade, Mircea, et al., eds. 1986. *The Encyclopedia of Religion.* New York: Macmillan.

Statistical Yearbook of the Church. Annual. Citta del Vaticano: Secretaria Status.

Todd M. Johnson
David B. Barrett

REMOTE SENSING

Information on characteristics of landscape and human settlement can be derived from aerial photography and satellite imagery. The technology and procedures involved are known as remote sensing.

Resolution and Bandwidth

The images produced by remote sensing can be classified by resolution and bandwidth. Resolution refers to the size of the image captured by the smallest pixel (picture element) in the image. The highest resolution data commercially available from satellite-based sensors as of around 2000 is one meter—that is, the smallest pixel in the image corresponds to an area of 1m by 1m on the ground. More detailed imagery typically requires the use of aerial photography. Bandwidth refers to the wavelengths recorded by the sensor. They may be panchromatic (producing black-and-white images) or specific to certain parts of the spectrum, such as visible red, green, blue, and near-infrared bands, or other (longer or shorter) bands that are not visible to the naked eye. If information is recorded for two or more wavelength bands, the image is described as multispectral.

Each of the various land cover categories on the earth's surface, whether natural or built, has a distinctive "spectral signature," the combination of wavelength values characteristic of that category of surface (such as bare soil, a specific type of vegetation, water, or an impervious surface like asphalt or concrete) but not of others. The aim in using remotely sensed data is to associate each pixel with a particular type of land cover. The higher the resolution (i.e., the smaller the pixel size), the more likely it is that the pixel will include only one type of land cover, and hence can be unambiguously categorized. The process of categorization is a crucial operation involving sophisticated statistical procedures, including new approaches drawing on "fuzzy" analysis.

Major producers of high resolution panchromatic and multispectral satellite imagery include the Landsat Thematic Mapper images and IKONOS (USA), Spot (France), Indian Remote Sensing (India), and Spin-2 (Russia). The Earth Observing-1 (EO-1) satellite launched by NASA in 2000 is capable of measuring 220 spectral bands at 30m resolution.

Remote Sensing in Demographic Analysis

For demographic analysis it is necessary to combine the data from remotely sensed images with local-level information from censuses, vital statistics, surveys, or administrative data. This is done within a geographic information system (GIS), which allows the matching of two or more sources of data for each small geographic area such as a census tract.

Remote sensing has been used in a variety of ways in demographic analysis, particularly for estimating population size and distribution, assessing the human impact on the natural environment, and examining characteristics of urban settlement.

A number of remotely sensed characteristics can be used to indicate the spatial distribution of population. The visible and near-infrared emissions of nighttime lights is one such indicator. A broader array of characteristics was drawn on in producing the LandScan Global Population 1998 Database developed by Oak Ridge National Laboratory, Tennessee. This database has a resolution of 30 arc seconds—approximately 1 km^2. Population data for larger geographic units come from ground-based sources, but the allocation over these 1 km cells is made on the basis of remotely detected characteristics of those cells: land cover, road proximity, slope, and nighttime lights.

Monitoring changes in the natural environment is one of the major uses of remote imagery. Such changes are often linked to expansion of human settlement and economic activity. The important case of deforestation in the Amazon region is explored by Tom Evans and Emilio Moran (2002) and Steven Walsh and Kelly Crews-Meyer (2002).

In urban applications, by use of a variety of indicators remote imaging allows the specification of gradations of "urbanness," avoiding the conventional urban-rural dichotomy. The ways in which remote sensing can be used in urban areas are summarized by Jean-Paul Donnay, Michael Barnsley, and Paul Longley (2001). A case study of Cairo is given by Tarek Rashed and colleagues (2001).

Remote sensing cannot reveal what people on the ground are doing. It offers only clues to that behavior, and proxies for variables such as the level of economic development or degree of urbanization that in turn may be predictors of that behavior. Its usefulness is as a tool that extends the spatial scope of social science analysis.

The value to demography of remotely sensed imagery depends not only on the quality and quantity of data that can be derived but also on the uses to which it can be put. To expand the latter requires further investigation of the connection between built and social environments and a better understanding of the spatial dimensions of human behavior. These are active areas of research. Advances in GIS techniques and applications will also promote greater use of remote sensing. It seems likely that remote sensing imagery will eventually be seen as a routine additional source of demographic information.

See also: *Geographic Information Systems; Geography, Population.*

BIBLIOGRAPHY

Donnay, Jean-Paul, Michael J. Barnsley, and Paul A. Longley. 2001. *Remote Sensing and Urban Analysis.* London: Taylor and Francis.

Entwisle, Barbara, Ronald R. Rindfuss, Stephan J. Walsh, Tom P. Evans, and Sara R. Curran. 1997. "Geographic Information Systems, Spatial Network Analysis, and Contraceptive Choice." *Demography* 34: 171–188.

Evans, Tom P., and Emilio F. Moran. 2002. "Spatial Integration of Social and Biophysical Factors Related to Landcover Change." In *Population and Environment: Methods of Analysis,* Supplement to *Population and Development Review,* Vol. 28, ed. Wolfgang Lutz, Alexia Prskawetz, and Warren C. Sanderson. New York: Population Council.

Jensen, John R., and Dave C. Cowen. 1999. "Remote Sensing of Urban/Suburban Infrastructure and Social-economic Attributes." *Photogrammetric Engineering and Remote Sensing* 65: 611–624.

Liverman, Diana, Emilio F. Moran, Ronald R. Rindfuss, and Paul C. Stern, eds. 1998. *People and Pixels: Linking Remote Sensing and Social Science.* Washington, D.C.: National Academy Press.

Rashed, Tarek, John R. Weeks, M. Saad Gadalla, and Allan G. Hill. 2001. "Revealing the Anatomy of Cities Through Spectral Mixture Analysis of Multispectral Imagery: A Case Study of the Greater Cairo Region, Egypt." *Geocarto International* 16: 5–16.

Sutton, Paul. 1997. "Modeling Population Density with Night-Time Satellite Imagery and GIS." *Computing, Environment and Urban Systems* 21: 227–244.

Walsh, Steven J., and Kelly Crews-Meyer, eds. 2002. *Linking People, Place, and Society.* Boston: Kluwer Academic Publishers.

Weeks, John R., M. Saad Gadalla, Tarek Rashed, James Stanforth, and Allan G. Hill. 2000. "Spatial Variability in Fertility in Menoufia, Egypt, Assessed Through the Application of Remote Sensing and GIS Technologies." *Environment and Planning* A32: 695–714.

INTERNET RESOURCE.

LandScan Global Population Database. Oak Ridge National Laboratory. 1998. <http://www.ornl.gov/gist/projects/LandScan/SIMPLE/smaps.htm>.

JOHN R. WEEKS

RENEWAL THEORY AND THE STABLE POPULATION MODEL

Deaths deplete a population and births add new individuals, with the overall effect being a renewal of population numbers. A mathematical analysis of this process is called, accordingly, a theory of renewal. At its core, this theory is a bookkeeping scheme to describe changes in a population over time, a goal achieved by tracking the time course of births. Tracking births over time is the same as tracking every cohort, that is, every group of individuals born at the same time. Because the number of individuals of a given age in the population is just the cohort of that age, the theory also tracks the age composition of a population. Finally, the theory combines the age composition (the result of past births) with fertility rates by age to obtain current births, thereby completing the accounting process. As will be seen below, this theory provides a powerful tool for the analysis of population composition and change.

Population renewal theory has origins in the work of the Swiss mathematician Leonhard Euler (1707–1783) in 1760 and the German demographer Johann Peter Süssmilch (1707–1767) in 1761, but its modern form was largely developed by the American demographer and biometrician Alfred Lotka (1880–1949) between 1907 and 1913. Renewal theory has obvious relevance for any collection of things that are created in the manner of a birth and eliminated in the manner of a death, for example, a collection of machinery parts in a factory. A broader theory of renewal for such processes, not discussed here, has been developed for other applications.

Lotka's work provides the basic framework of mathematical demography and is the primary focus of this article. Many applications and extensions of his work have been made as the subject of demography has blossomed since the 1950s. Some of the more important elements of this newer work as it is used by demographers are summarized below.

Births, Cohorts, and Lotka's Equation

To track births, researchers record the rate at which new individuals are born into a population at each instant of time. They simplify by considering only female births, males being accounted for separately later. At a time denoted by t let the rate at which females are born be denoted by $B(t)$. As time advances these newborns will age, so the cohort of females aged a at time t consists of the survivors among the $B(t - a)$ individuals who were born at the earlier time $(t - a)$. Using the notation $l(a)$ to indicate the fraction of newborn females that survives from birth to age a, one sees that at time t there must be $l(a)$ $B(t - a)$ females aged a. This expression links past births to cohorts and thus to the age composition of the female population.

To obtain current births at time t researchers need the per-capita fertility rate, denoted by $m(a)$ and defined as the rate of female births to a mother at age a. Mothers aged a will together produce female births at a rate $m(a)\ l(a)\ B(t - a)$. The total birth rate $B(t)$ in the population is a sum of births to mothers of all ages. Using an integral to indicate the sum yields the first form of Lotka's equation for population renewal:

$$B(t) = \int_{15}^{45} m(a)l(a)\, B(t-a)da \qquad [1]$$

The limits on the integral here are the limits on the reproductive ages of mothers. For human populations, this would typically range from 15 to 45 years. An unfortunate aspect of equation [1] is that to obtain today's birth rate one must know the past birth rate going back at least as far as the oldest reproductive age. This is information researchers rarely have. Instead, in most situations one can specify only the age composition of the population at some starting time (which one labels as time $t = 0$) and would like to use the renewal argument to obtain birth rates $B(t)$ for all later times. Researchers deal with such cases by noting that at time t (after the starting time), births into the population are a sum of (1) births to individuals who were present before the starting time—call these $f(t)$; and (2) births to individuals who were born at or after the starting time.

The latter births must clearly follow from the argument that produced equation [1], so one can write:

$$B(t) = f(t) + \int_0^t m(a)l(a)\, B(t-a)da \qquad [2]$$

In this equation the limits on the integration indicate a sum of the individuals born after the starting time, which implies that the limits are 0 and t. A mathematical expression for $f(t)$ may be written out by applying to the initial population the logic that was used to derive equation [1].

Between the two forms given, Lotka's equation translates a population's past composition into its future. The equations above are written for female births: What about males? In most countries (with some striking exceptions) human births occur with a sex ratio of about 105 male births to 100 female births, and this ratio can be used to infer male births from female. In addition, if male survival rates are available, male cohorts can be tracked just as was shown above for female cohorts.

The Stable Population

Suppose that a population has for many generations followed the renewal process of births and deaths with some fixed schedule of age-specific birth and survival rates. It is reasonable to expect that the population as a whole, and the birth rate in particular, should then experience a steady rate of growth r per unit time. Such steady growth would imply that the birth rate $B(s)$ at some time s and the birth rate $B(s + t)$ at a later time $(s + t)$ would be in the ratio:

$$B(t + s) = B(s)\, e^{rt}$$

Such an exponential ratio of births at different times satisfies equation [1] only if the growth rate r satisfies what is called Lotka's *characteristic equation:*

$$1 = \int m(a)l(a)\, e^{-ra}\, da$$

This equation shows how age-specific fertility and survival determine the unique steady rate of population growth that these rates can support. Among the many important results that flow from this equation, two will be mentioned here. First, the equation implies that r will be positive (population increase) or negative (population decline) depending on whether the *net reproduction rate* (NRR), defined by NRR = $\int m(a)l(a)da$, is larger or smaller than one. An NRR equal to one characterizes and defines a population in which $r = 0$. This is called a stationary population. The characteristic equation for this case also defines what is commonly called *replacement fertility.* Second, in populations whose NRR is not far from one, an expansion of the exponential term in the equation yields the useful approximate result that:

$$r \approx \ln(\text{NRR}) / T,$$

in which the quantity T is the average age at childbearing of mothers. This result provides ready insight into the impact of changes in the level and timing of fertility, and of changes in survival rate, on the steady population growth rate.

When births over time grow at a steady rate r, if the total birth rate is $B(t)$ at time t, the population at the same time at any age a can be inferred to be $B(t)l(a)e^{-ra}$. Hence a population in a steady state growing at rate r will have an age composition in which the fraction of the population at age a is proportional to $l(a)e^{-ra}$. The age composition of such a population does not change over time and is known as the *stable population.* The stable population is basic to demographic analysis. It underlies the use and interpretation of population pyramids. For example, the well-known difference between the shapes of the pyramids for rapidly growing (broad-base) versus slowly growing (narrow-base) populations is attributable to the differences in growth rates and survival rates. In population analysis, the stable population provides a ready standard of comparison that yields insights into observed population structures that are rarely stable. (A mathematical note: This discussion glosses over the fact that $B(t)$ is a rate, not a number, and the stable structure as it is written above is a density. Correctly, the density should be integrated over an age interval, such as a calendar year, to obtain the number of individuals in that interval; but there is little danger of error, and greater clarity, in the exposition without introducing this refinement.)

Dynamics of Births

As was shown above, a fixed set of age-specific fertility and survival rates define a stable population. Suppose, however, that at a time $t = 0$ a population has an age composition that is not the stable one, but the fertility and survival rates still remain fixed. Lotka proved that over time the population's age composition will converge toward the stable composition—this is the reason for the adjective *stable.* The mathematical demonstration of this convergence starts with equation [2], in which an arbitrary initial age composition can be used to determine the term $f(t)$. Lotka showed that the birth rates $B(t)$ obtained by solving that equation have the form:

$$B(t) = B_0 e^{rt} + B_1 e^{r_1 t} \cos(\omega t) + B_2 e^{r_1 t} \sin(\omega t) + etc.$$

In this series of terms, the first simply represents the stable population, with r being the stable growth rate (as can be seen by omitting all the other terms). The second and later terms (the "etc." in the equation stands for a possibly infinite sequence of similar terms) contain exponents such as r_1 and corresponding sinusoidal terms that are computed as additional solutions—called the *roots*—of the characteristic equation. These additional roots have the property that their exponential parts are smaller than the first exponential r, which implies that stable population dominates the solution as time increases. Each additional term has an oscillatory character indicated by the sine and cosine terms; the second and third terms above have a period of $(2\pi/\omega)$. These decaying cycles are transient aspects of the population that are observed en route to the stable population.

These cycles have real demographic consequence in populations that are far from stability. The many countries (e.g., Japan, China) that experienced rapid fertility declines in the second half of the twentieth century provide striking examples of this phenomenon. After the decline, fertility rates were relatively stable at their new low levels, but the population structure still reflected years of high predecline fertility and rapid growth. Age compositions in these populations in subsequent years clearly show Lotka's damped oscillations—they consist of population booms, busts, and echoes. The Lotka solution in this case is also the basis for Nathan Keyfitz's calculation of momentum—the effect on long-run numbers of a sudden transition to replacement fertility. The tendency of a population with fixed fertility and survival rates to gravitate to the stable population structure is an example of *demographic ergodicity*—the convergence of age composition to a stable structure whereby the history of a population's age structure is gradually obliterated by the process of population renewal.

Reproductive Value

The discussion thus far has largely ignored the population's starting age composition except as the term $f(t)$ in equation [2]. But the starting composition is surely relevant to the future population, which leads to the question: If a single female of age a is added to the population, what contribution does she make to the future population? That contribution can be specified by keeping count of her children, her grandchildren, and so on. The issue here is not the total number of these descendants, which might well be infinite if all future generations are counted; rather, the question is how the future contributions of a female depend on her age. In other words, what is the relative contribution to the future population made by females of different ages? This relative contribution was called *reproductive value* by the great statistician and geneticist R. A. Fisher (1890–1962), who introduced the notion in his work on the evolution of reproductive characteristics.

How is reproductive value, denoted by $V(a)$ at age a, to be determined? To make a sensible comparison between ages, the effect of population growth must be discounted and then the contributions made by the female at her current and future ages until death must be added. Doing so produces the expression:

$$V(a) = \left(1/l(a)\right) \int_a^{45} e^{-rx}\, m(x) l(x) dx,$$

with the limits on the integral running from current age a to the maximum reproductive age (45). The reproductive value plays a key role in population momentum, in evaluating the dynamics of a population subject to disturbance, and in evolutionary theory.

Applications of Lotka's Theory

The logic and mathematics of Lotka's theory underlie several methodological developments. The cohort-component method of projecting a population, first used by P. K. Whelpton and now in regular use by forecasters, is an expression of equation [2]. Although equation [2] applies only to populations that are closed to migration, it is easily modified to incorporate births gained or lost via migration. If the net migration flow is constant over time and exhibits some specified age pattern that is also constant over time, the stability properties of equation [2] apply with suitable modification to the equation that includes migration. Such modified equations are commonly used to project and analyze the dynamics of populations subject to significant migration flows.

The mathematical analysis outlined above treats time and age as continuous, hence the integrals. In practice, demographers must work with events observed over discrete intervals, such as one year or five years. The equations carry over fairly directly to the discrete case. For example, in equation [1], if $m(a)$ and $l(a)$ are the rates for a discrete interval with a length of one year, the equation remains the same except that a sum over discrete age intervals replaces the integral.

The tracking of cohorts in Lotka's analysis extends directly to cases in which the growth rate of births or other population segments changes with time and has made possible methods of demographic estimation for unstable populations as developed by Ansley J. Coale, Samuel H. Preston, and others. The characteristic equation highlights the central demographic importance of the age schedules of mortality and survival, which have therefore been the subject of considerable independent study. Coale, Paul Demeny, and James Trussell developed their model demographic schedules of mortality and fertility in the context of renewal theory. Numerous methods of direct and indirect demographic estimation originate in the logic and mathematics of Lotka's analysis.

Demographic Ergodicity and Time-Varying Rates

Perhaps the most obvious limitation of Lotka's equation is that the fertility and survival rates are taken as fixed and known. But derivation of the equation does not require the rates to be fixed: The equations remain valid with time-dependent birth and death rates. Solving them in such cases is harder because Lotka's analysis does not apply, but progress has been made on several fronts. A key feature of Lotka's theory is demographic ergodicity, and, as Álvaro López (1926–1972) first showed, ergodicity also holds for many situations in which rates vary over time. In other words, given a time-dependent sequence of fertility and survival rates, the process of population renewal causes the population's age composition to converge toward a particular stable (but time-varying) composition. This phenomenon is called *weak demographic ergodicity* and has been shown to hold for many types of temporal change in the rates. Joel Cohen has shown that ergodicity holds for many kinds of random change over time in fertility and survival rates. Aside from this general property, progress has been made in finding some useful explicit solutions to Lotka's equation for time-varying rates, including work by Robert Schoen and Young Kim for cyclically changing rates and by Shripad Tuljapurkar and Nan Li for populations undergoing demographic transitions from old to new rates. The latter work is also the basis for calculations of population momentum when fertility or mortality transitions take place gradually over some years.

Sex and Marriage

Lotka's theory greatly simplifies the real-world situation by using fertility rates for females by age as a proxy for a more realistic accounting of marriage (and, in modern times, cohabitation or simply mating) as a precursor to reproduction. This simplification is serviceable and is surely correct in some aggregate average sense. But demographers have naturally been interested in adding an explicit accounting of marriage to the theory of population renewal. Efforts to do this have not yet been successful in producing what demographers call a *two-sex theory* of population renewal. Some useful work has been done in terms of defining the mathematical structure of a marriage function that translates male and female age compositions into an age composition of married couples. Robert Pollak has established stability properties for some particular forms of two-sex renewal. But a generally useful theory remains elusive. In addition, much of this two-sex theorizing makes little contact with the far more successful theory of the proximate determinants of fertility or of fecundability (the probability of conception). In recent years, this type of theory has attracted new interest among epidemiologists who analyze sexually transmitted diseases and are therefore concerned with tracking the rate of sexual interactions.

Feedback and Nonlinearity

The renewal theory discussed above assumes that fertility and mortality rates are exogenously determined (i.e., by factors such as economics or culture that are not explicitly included in the present analysis), even if they vary over time. Yet there are persuasive arguments that one or both of these rates may be at least partly determined by the state of the population itself. One such line of thought begins with the English economist T. R. Malthus (1766–1834) and continues through more recent and considerably more general arguments for the necessity of homeostasis—a self-regulatory force in human population growth. A different line of thought is exemplified by Richard Easterlin's work on the relationship between cohort size, expectations, and eventual cohort fertility. In either type of argument, a relationship is posited between fertility or mortality and the past time sequence of births; this is called a feedback relationship. If researchers introduce a feedback relationship into equation [2], for example, they make the equation *nonlinear* in the birth rates. A general analysis of the dynamics of such nonlinear equations poses many mathematical challenges. The goal of such an analysis is to produce understanding that parallels the understanding of Lotka's theory—to determine what sustained population trajectories can be maintained by particular types of nonlinearity. Intuitively, negative feedback, in which increasing birth rates act to depress future fertility rates, should lead to population cycles. Various studies show how feedback can maintain population cycles, but they unfortunately also suggest that it is hard to find good specifications of feedback that are consistent with observed population cycles. More complex types of feedback can generate interestingly complex, even chaotic, dynamics in nonlinear models, but the practical usefulness of this work for human demography remains uncertain.

See also: *Actuarial Analysis; Age Structure and Dependency; Coale, Ansley Johnson; Cycles, Population; Euler, Leonhard; Keyfitz, Nathan; Life Tables; Lotka, Alfred; Momentum of Population Growth; Multistate Demography; Projections and Forecasts, Population; Stochastic Population Theory; Süssmilch, Johann.*

BIBLIOGRAPHY

Caswell, Hal. 2001. *Matrix Population Models: Construction, Analysis, and Interpretation.* Sunderland, MA: Sinauer.

Coale, Ansley. 1972. *The Growth and Structure of Human Populations: A Mathematical Investigation.* Princeton, NJ: Princeton University Press.

Keyfitz, Nathan. 1968. *Introduction to the Mathematics of Population.* Reading, MA: Addison-Wesley.

Preston, Samuel H., Patrick Heuveline, and Michel Guillot. 2001. *Demography: Measuring and Modeling Population Processes.* Malden, MA: Blackwell.

Smith, David P., and Nathan Keyfitz. 1977. *Mathematical Demography: Selected Papers.* Berlin: Springer-Verlag.

Shripad Tuljapurkar

REPRODUCTIVE HEALTH

Reproductive health is a concept that came to prominence in international discourse about population issues in the 1990s, especially as a result of the preparatory process leading to the International Conference on Population and Development (ICPD) held in Cairo in 1994. It is defined in Chapter 7, paragraph 2 of the ICPD Programme of Action as follows:

> Reproductive health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, in all matters relating to the reproductive system and to its functions and processes. Reproductive health therefore implies that people are able to have a satisfying and safe sex life and that they have the capability to reproduce and the freedom to decide if, when and how often to do so. Implicit in this last condition are the right of men and women to be informed and to have access to safe, effective, affordable and acceptable methods of family planning of their choice, as well as other methods of their choice for regulation of fertility which are not against the law, and the right of access to appropriate health-care services that will enable women to go safely through pregnancy and childbirth and provide couples with the best chance of having a healthy infant. In line with the above definition of reproductive health, reproductive health care is defined

> as the constellation of methods, techniques and services that contribute to reproductive health and well-being by preventing and solving reproductive health problems. It also includes sexual health, the purpose of which is the enhancement of life and personal relations, and not merely counseling and care related to reproduction and sexually transmitted diseases.

From Birth Control to Reproductive Health

The evolution of language referring to fertility policy since the 1950s, from "birth control" to "family planning" to "reproductive health," represents a paradigm shift in theory, policy, and practice. When concerns about the consequences of delayed fertility decline in the demographic transition in the developing world originally emerged, the major focus was on the economic implications of rapid population growth. Logically, this necessitated a better understanding of the factors influencing fertility and reproduction. For example, priority was placed on mapping and measuring the proximate determinants of fertility, and the socioeconomic characteristics of women that influence the proximate determinants. Interest in reproduction in general, and fertility regulation in particular, has gradually evolved into attention to reproductive health. A variety of actors, ranging from demographers to women's health advocates, worked together in the early l990s to propose this new, broader approach. They intended to promote population and development policies and programs that were centered on individual rights, health, and well-being.

The World Health Organization (WHO) defines health as a "state of complete physical, mental and social well-being." The ICPD applied this concept of health to reproduction. WHO promotes, and sets standards for, scientific analysis of reproductive health. Estimates of the "global burden of reproductive ill-health" clearly signal that that burden affects women more than men. (See Table 1) For women of childbearing age in developing countries, the burden of reproductive ill-health is far greater than the disease burden from such important diseases as tuberculosis and respiratory infections. Among women aged 15 to 44 in developing countries, reproductive ill-health is estimated to account for 36 percent of the total disease burden, compared with 12 percent for men.

As advocates of the concept emphasize, reproductive health services are not limited to family planning services, nor is their clientele limited to women in unions. Programs delivering family planning services could be organized as categorical programs; this is more difficult for reproductive health services, which require a broader array of facilities. Reproductive health is not solely a health issue. The concept includes such factors as gender-based violence, power dynamics in sexual relationships, and individuals' subjective assessment and perception of risks involved in contraceptive practice. As stated in a follow-up report on ICPD (ICPD+5), "There is a continuing need to include social, cultural, economic and behavioural dimensions in the planning and implementation of reproductive health policies and programmes. This requires the involvement of many other sectors in a partnership to remove barriers to access and create a more enabling environment" (United Nations Population Fund 1999, paragraph 65).

Reproductive Health Services

The programmatic implications of the goal of improving reproductive health, over and above the provision of contraceptive services, include prevention and treatment of reproductive tract infections, sexually transmitted diseases, including HIV, and reproductive system cancers; counseling or treatment of infertility; pregnancy and delivery care; access to safe, legal abortion; and information on sexuality and sexual dysfunction.

The concept of reproductive health provides a framework to guide program implementation strategies and performance indicators. It emphasizes quality of care for the individual, often neglected in older, target-oriented family planning programs. For example, a client-provider interaction concerned with choosing an appropriate contraceptive can be used for family planning counseling as traditionally practiced (mostly one-way, didactic communication from an authority figure to a passive acceptor about medical aspects of contraception), or it can involve true two-way dialogue, with the provider seeing the client as a partner in solving health problems. The latter model of reproductive health care includes exploring topics such as sexual practices and risks, as well as the gender and power dynamics that affect those risks.

TABLE 1

Selected Aspects of Reproductive Ill-Health: Estimates of Global Incidence (millions), 1990s

Category	Women	Men	Both Sexes
Maternal deaths (annual – 1995) (a)	0.515	–	0.515
Cases of severe maternal morbidity (annual) (b)	30	–	30
Unsafe abortions (annual) (b)	20	–	20
Adults living with HIV/AIDS (c)	17.6	19.6	37.2
Annual adult incidence of HIV infection (c)	1.8	2.5	4.3
Annual incidence of curable STIs (1999) (d)	174.7	164.8	339.5
Prevalence of female genital mutilation (b)	100-140	–	100-140
Percent infertile couples (e)	–	–	8-12%

SOURCES: (a) Maternal Mortality in 1995: Estimates developed by WHO, UNICEF, UNFPA. Geneva, World Health Organization, 2001.
(b) WHO: *HRP Biennial Report 2000–2001.*
(c) UNAIDS: *AIDS Epidemic Update* December 2001.
(d) Global prevalence and incidence of selected curable STIs, WHO/HIV/AIDS/ 2001–2002.
(e) Sciarra, J. (l994). "Infertility: An International Health Problem." *International Journal of Gynecology and Obstetrics,* 46:155–163.

The Future of Reproductive Health

Future improvements in reproductive health call for more research, drawing on both social science methods and "operations research" on the effectiveness and costs of reproductive health interventions. Special attention needs to be paid to promoting evidence-based reproductive health care in developing countries. The WHO and other international agencies have made a major commitment in this area. The WHO Reproductive Health Library (RHL) offers analyses to help ensure that resource allocations and current health care practices are based on scientifically solid and up-to-date information. The RHL aims "not only to prevent the introduction of unsubstantiated health care practices into programmes but also to replace the practices that have been demonstrated to be ineffective or harmful with those based on best available evidence" (Villar et al. 2001). Stronger assessments of the economic value of reproductive health interventions are also needed, so that investments in reproductive health are given their proper priority in health sector reform.

Beyond research, the ICPD and ICPD+5 documents include numerous recommendations for governments, United Nations agencies, donors, and other actors concerning reproductive health. A roadmap for progress has been laid out, ranging from specific "benchmark indicators" in health to suggested changes in policies and resource allocation. The recommendations cover not only specific health topics such as maternal mortality, but also the reproductive health needs of population groups such as adolescents and men, while acknowledging the priority that should be accorded to women and girls.

Commitment to implementing the reproductive health approach requires a clear understanding of how the thinking underlying it differs from the once prevalent "population control" mentality, and the programmatic and policy changes implied by this paradigm shift. The Fourth World Conference on Women summed up the links among reproductive health, human rights, gender equity, and sexuality in its Platform for Action (United Nations 1995, paragraph 96):

> The human rights of women include their right to have control over and decide freely and responsibly on matters related to their sexuality, including sexual and reproductive health, free of coercion, discrimination and violence. Equal relationships between women and men in matters of sexual relations and reproduction, including full respect for the integrity of the person, require mutual respect, consent and shared responsibility for sexual behaviour and its consequences.

See also: *AIDS; Family Planning Programs; Feminist Perspectives on Population Issues; Health Systems; Induced Abortion: History, Prevalence, Legal Aspects; Maternal Mortality; Sexuality, Human.*

BIBLIOGRAPHY

Bongaarts, John, and Robert G. Potter. 1983. *Fertility, Biology, and Behavior: An Analysis of the*

Proximate Determinants. New York: Academic Press.

Campbell, Oona, John Cleland, Martine Collumbien, and Karen Southwick. 1999. *Social Science Methods for Research on Reproductive Health.* Geneva: World Health Organization.

Davis, Kingsley, and Judith Blake. 1956. "Social Structure and Fertility: An Analytic Framework." *Economic Development and Cultural Change* 4(3): 211–235.

Germain, Adrienne, Sia Nowrojee, and Hnin Hnin Pyne. 1994. "Setting a New Agenda: Sexual and Reproductive Health and Rights." In *Population Policies Reconsidered: Health, Empowerment, and Rights,* ed. Gita Sen, Adrienne Germain, Lincoln C. Chen. Boston: Harvard Center for Population and Development Studies.

Helzner, Judith F. 2002. "Transforming Family Planning Services in the Latin American and Caribbean Region." *Studies in Family Planning* 33(1): 49–60.

Jain, Anrudh, and Judith Bruce. 1994. "A Reproductive Health Approach to the Objectives and Assessment of Family Planning Programs." In *Population Policies Reconsidered: Health, Empowerment, and Rights,* ed. Gita Sen, Adrienne Germain, and Lincoln C. Chen. Boston: Harvard Center for Population and Development Studies.

Villar, José, Metin Gülmezoglu, Jitendra Khanna, Guillermo Carroli, Justus Hofmeyr, Ken Schulz, and Pisake Lumbiganon. 2001. "Evidence-based Reproductive Health in Developing Countries." *WHO Reproductive Health Library* 4.

INTERNET RESOURCES.

Health, Action, Empowerment, Rights & Accountability (HERA). 1998. "Action Sheet: Reproductive Rights and Reproductive Health." <http://www.iwhc.org/uploads/HERAactionsheeteng%2Epdf>.

United Nations. 1995. "Beijing Declaration Platform for Action, Fourth World Conference on Women (FWCW)." <http://gopher://gopher.undp.org/00/undocs/gad/A/CONF.177/95_11/20>.

United Nations Population Fund. 1994. "International Conference on Population and Development (ICPD), Programme of Action." <http://www.unfpa.org/ICPD/reports%26doc/icpdpoae.html>.

———. 1999. "International Conference on Population and Development ICPD+5, Implementation of the Programme of Action." <http://www.unfpa.org/icpd/icpdmain.htm>.

World Development Report. 1993. "Investing in Health." <http://publications.worldbank.org/ecommerce/catalog/product?item_id=194651>.

World Health Organization. 1997. "The global burden of reproductive ill-health." *Progress in Human Reproduction* 42: 2–3. <http://www.who.int/hrp/progress/42/prog42.pdf>.

JUDITH F. HELZNER

REPRODUCTIVE RIGHTS

In the early 1990s, there was mounting international recognition that individuals' rights to reproductive integrity and choice required a coherent, unifying context of reproductive and sexual health. Two United Nations (UN) conferences in the mid-1990s propelled an expansive concept of reproductive health as an element of social justice that includes rights both to have children and to enjoy human sexuality without unwanted reproduction. These conferences placed reproduction in its wider setting, as an important aspect but not the sole purpose of human sexuality, equating rights not to reproduce with rights to plan for parenthood.

The International Conference on Population and Development, held in Cairo, Egypt, in 1994, and the Fourth World Conference on Women, held in Beijing, China, in 1995, advanced a common vision of reproductive health that everyone has the same human right to enjoy. Reproductive health, the conferences declared, "implies that people are able to have a satisfying and safe sex life and that they have the capability to reproduce and the freedom to decide if, when and how often to do so." Reproductive rights are understood to be rights that depend on duties to respect, protect, and fulfill human rights to reproductive health.

Sources of Reproductive Rights

The Cairo and Beijing concept of reproductive health, to which everyone is entitled, was built on a foundation of internationally recognized human rights. When the United Nations was established in 1946, its urgent task was to redeem confidence in respect for human rights after the inhumane excesses of the Nazi period and World War II. The UN initiated the Universal Declaration of Human Rights of 1948 to condemn, among other wrongs, the gross denials of reproductive rights during this period, such as forced sterilizations of vulnerable populations and severe punishment of abortion. (In Nazi-dominated Vichy France, a woman had been sentenced to death and executed for terminating her pregnancy.)

The Universal Declaration of Human Rights was described only as a declaration because it did not create any new rights but only declared those that already existed. To reinforce recognition of rights, however, UN member states created a series of legally enforceable international human rights treaties by which states could confirm their commitment. These include the International Covenant on Civil and Political Rights (the Political Covenant), the International Covenant on Economic, Social, and Cultural Rights (the Economic Covenant) and, more specifically, the Convention on the Elimination of All Forms of Discrimination Against Women (the Women's Convention). These international instruments reflect laws that already exist in the legal systems by which many countries conduct their national life, and elevate them to national commitments that states make not only to their own populations but also to each other in international law. That is, states accept international scrutiny of and accountability for their observance of these designated human rights.

Rights to Have and Not to Have Children

The Political Covenant expresses the most traditional of reproductive rights. Article 23 (echoing Article 16 of the Universal Declaration) recognizes "the right of men and women of marriageable age to marry and to found a family" and that "no marriage shall be entered into without the free and full consent" of the intended spouses. The Political Covenant implies that marriage is a precondition to reproduction, because Article 23 opens with the widespread understanding (also included in the Universal Declaration) that "the family is the natural and fundamental group unit of society." This approach reflects the conservative disapproval of reproduction outside marriage.

The UN Charter observes the purpose "to reaffirm faith in fundamental human rights . . . [and] in the equal rights of men and women." The Universal Declaration of Human Rights and the implementing Political and Economic Covenants echo the entitlement to equality of both sexes. Because of human biology, however, reproduction affects the sexes differently. Women's unmarried parenthood is apparent in pregnancy and childbirth, whereas men have traditionally been able to conceal and deny their paternity. Similarly, women can have pregnancy involuntarily imposed by rape and may be subject to laws that deny abortion even on this ground, whereas men can only very rarely be forced to experience sexual intercourse. The biological difference has been translated into discriminatory social sanctions. Men shown to have fathered children outside marriage usually face, at most, financial sanctions of support payments. Women have been and often still are stigmatized, condemned, and severely punished, by family and society, for unwed motherhood and face communal ostracism and judicial penalties—even reaching stoning to death, a sanction still threatened in some communities. The expectation of virginity at marriage applies discriminatorily to brides but not to grooms. Loss of virginity may reduce women's marriage prospects and options.

The Women's Convention requires, in Article 1, that women be entitled to exercise their rights, which include rights to reproductive health, "irrespective of their marital status." Article 12 of the Economic Covenant requires states to recognize "the right of everyone to the enjoyment of the highest attainable standard of physical and mental health." Article 16 of the Women's Convention requires that states ensure that women enjoy with men "the same rights to decide freely and responsibly on the number and spacing of their children and to have access to the information, education and means to enable them to exercise these rights." This convention's Article 12 more explicitly requires states "to eliminate discrimination against women in the field of health care in order to ensure . . . access to health care services, including those related to family planning." Family planning includes planning when and whether to have children. This is the foundation on which the Cairo and Beijing conferences built the concept of the right to reproductive health.

Duties to Respect Reproductive Choice

Rights depend on duties, in that a right is enforceable only against those individuals and governmental and other agencies duty bound to comply with its exercise. States that have ratified one or more of the Political and Economic Covenants and the Women's Convention accept duties not only of compliance but also of periodic reporting to and monitoring by the different bodies these treaties have created to review parties' compliance. Different rights require different responses for compliance, but a general distinction may be drawn between so-called negative and positive rights. Negative rights require state tolerance and passivity when individuals act to enjoy their rights. Negative rights are sometimes expressed as "the right to be let alone," to act as one wishes and is able, without interference by police or other government officers. Positive rights are rights for which a person may need to be provided with the means to exercise them—at least those unable, for whatever reason, to provide such means for themselves.

Reproductive rights have historically been negative rights. Laws may intervene to set minimum ages for marriage and prohibit incestuous unions, but marriage is otherwise a private arrangement, and natural procreation by fertile couples within marriage is even more intimately a matter for the participants alone. Laws prohibiting artificial contraception have now been almost universally discarded, so that in nearly all countries fertile couples can decide whether and when to conceive children without accountability to government officers or agencies.

Negative rights, however, may in practice be rights for those who can provide themselves with contraceptive means or means to promote their fertility when it is impaired, but not for others. In order for all individuals to be able to avail themselves of reproductive rights, states would have to observe them as positive rights and ensure access to necessary services for citizens whether they are rich or poor; fertile, subfertile, or infertile; privileged or disadvantaged.

Some international treaties express the right to family planning services as a positive right, in recognition of the burden on poor women of repeated pregnancy and their vulnerability, particularly in low-income countries, to maternal ill-health and pregnancy-related death. Even in affluent countries, however, medically assisted reproductive services to overcome infertility may be available only as "luxury medicine" and be unavailable to many without unbearable personal expenditure and sacrifice. Article 15 of the Economic Covenant requires states to recognize the right of everyone to enjoy "the benefits of scientific progress and its applications," but it imposes no positive duty on states to fund access to reproductive technologies. Accordingly, reproductive rights remain an ideal, but they are subject in practice to personal and governmental resources and the sense of priority with which they are allocated.

See also: *Conferences, International Population; Family Planning Programs; Feminist Perspectives on Population Issues; Population Policy; Reproductive Technologies: Ethical Issues.*

BIBLIOGRAPHY

Center for Reproductive Law and Policy. 2000. *Reproductive Rights 2000: Moving Forward.* New York: Center for Reproductive Law and Policy.

Cook, Rebecca, ed. 1994. *Human Rights of Women: National and International Perspectives.* Philadelphia: University of Pennsylvania Press.

Cook, Rebecca, and Bernard Dickens. 2000. *Considerations for Formulating Reproductive Health Laws,* 2nd edition. Geneva, Switzerland: World Health Organization.

Cook, Rebecca, Bernard Dickens, and Mahmoud Fathalla. 2003. *Reproductive Health and Human Rights: Integrating Medicine, Ethics and Law.* Oxford: Oxford University Press.

Eriksson, Maja Kirilova. 2000. *Reproductive Freedom: In the Context of International Human Rights and Humanitarian Law.* The Hague, Netherlands, and Boston: Martinus Nijhoff.

Symposium Number. "Conference on the International Protection of Reproductive Rights." 1995. Symposium *American University Law Review* 44: 963–1,475.

REBECCA J. COOK

REPRODUCTIVE TECHNOLOGIES

MODERN METHODS Luigi Mastroianni, Jr.
ETHICAL ISSUES Bernard M. Dickens

MODERN METHODS

The medical management of infertility has involved increasingly complex treatment methods. Most of these reproductive technologies employ manipulations of the gametes: sperm and eggs. Most of the newer methods are offshoots of in vitro fertilization systems, although older techniques such as artificial insemination still play an important role.

Artificial Insemination

Artificial insemination has been practiced for more than a century. When done using the husband's semen, it is clinically useful in the management of conditions such as penetration failure, premature ejaculation, and retrograde ejaculation into the bladder. Artificial insemination using a specimen other than the husband's (donor insemination) also has evolved as an acceptable treatment for infertility. Donor insemination is utilized mainly in cases in which the spermatozoa are absent or severely compromised in number and quality.

The donor, who usually is anonymous and is identified only by a third party, is thoroughly screened for general health, genetic abnormalities, and sexually transmitted diseases such as HIV infection. Other characteristics are considered as well. Detailed pretreatment counseling is critical and should include an in-depth discussion with both partners of the acceptability of using a donor. The ethical issues to be considered should include whether the offspring will be informed of the method of conception and the safeguards in place to ensure the long-term availability of genetic information if it becomes medically important in the future. Donor insemination has been extended to single women and lesbian couples in many centers.

Techniques have evolved to concentrate and wash the spermatozoa from the ejaculate so that they can be safely inserted directly into the uterus. Intrauterine insemination (IUI) commonly is combined with the induction of ovulation with gonadotropins, which allows precise timing of the insemination and the development of several egg-containing follicles. This increase in the number of ovulations improves the success rate. Gonadotropin superovulation combined with intrauterine insemination has proved useful in the management of male infertility as well as unexplained infertility. It has also contributed significantly to an epidemic of multiple pregnancies that are associated with increased prematurity and newborn morbidity. Although the incidence of high multiple pregnancies can be reduced by careful clinical management, it cannot be eliminated completely. For this reason, the approach is gradually being replaced by in vitro fertilization procedures in which the number of embryos transferred into the uterus is more easily controlled.

In Vitro Fertilization/Embryo Transfer

Normal reproduction requires a properly functioning fallopian tube. The fallopian tube captures the egg from the ovulating ovarian follicle, transports it to a point well within its lumen for fertilization, and retains and nurtures the newly dividing embryo for three days, after which, at the eight- to 16-cell stage, it is delivered into the uterus. After approximately three additional days the embryo attaches to the uterine lining (endometrium) in the process of implantation.

Much of the early information on fertilization was derived from observations in marine forms, mainly the sea urchin. The first mammalian in vitro fertilization was carried out in the rabbit in 1952 by M. C. Chang, but it was not until 1980 that Robert Edwards and Patrick Steptoe reported the first successful pregnancy after the in vitro fertilization (IVF) of human eggs. Until their experiment there was reluctance to transfer in vitro fertilized human embryos back into the uterus out of concern that they were abnormal. There is now firm evidence that there is no increased risk of congenital or genetic abnormalities in children born after IVF and embryo transfer.

Multiple ovulations are induced with gonadotropins, follicle-stimulating hormone (FSH) to produce larger number of follicles, and human chorionic gonadotropin (hCG) or luteinizing hormone (LH) to finalize the development of the follicle and egg. The eggs are easily recovered by means of a transvaginal ultrasound probe to facilitate direct aspiration from the mature follicles. Spermatozoa that have been appropriately conditioned are then added to the culture system containing the eggs, initiating the fertilization process.

Within 24 hours, a spermatozoon has penetrated the egg and its nucleus has formed a pronucleus. The nucleus of the egg also forms a pronucleus. The two pronuclei then join, completing the initial phases of fertilization. Within hours there is a first cell division, followed by other cell divisions. Usually on the third day after fertilization embryos are selected for transfer into the uterus. The transfer is carried out with a fine, flexible catheter placed into the uterine cavity transcervically. In the early phases of the development of IVF, it was common to transfer multiple embryos in the hope that at least one would implant. As the quality of the cultured embryos has improved, multiple embryo transfer with its attendant complication of multiple pregnancies has become unnecessary. In some countries the number of embryos transferred is regulated to no more than two, and this is now standard practice in many U.S. centers.

Initially IVF was used solely in patients with damaged, nonfunctioning fallopian tubes. As it became clear that fertilization could be enhanced by using in vitro techniques, IVF became clinically applicable for couples with impaired sperm number or motility. As laboratory and clinical methods have evolved, additional techniques for managing fertilization have been developed that enhance male fertilization potential.

IVF and Male Fertility Potential

In 1992 Gianpierro Palermo, A. Van Steirteghem, and colleagues reported pregnancies after the mechanical injection of sperm directly into the cytoplasm of the egg. This procedure—intracytoplasmic sperm injection (ICSI)—has been applied to clinical situations in which there are a limited number of spermatozoa or in which the spermatozoa are functionally impaired. The egg is held firmly in place under the microscope. A single spermatozoon is aspirated into a fine catheter, and the catheter is inserted directly through the zona pellucida, the protein egg coat, past the egg membrane and into the cytoplasm, where it is released. Thus, the necessity for the spermatozoon to traverse these barriers by normal mechanisms is eliminated. Groups with the most experience with ICSI have reported a slightly increased incidence of genetic abnormalities.

Men with congenital absence of the vas deferens, which transports spermatozoa from the testes, fail to release sperm in the ejaculate. In these cases the epididymis, the storage reservoir of spermatozoa proximal to the vas, contains spermatozoa. These spermatozoa can be aspirated for in vitro fertilization through the use of ICSI. Spermatozoa have also been recovered directly from the testes and used successfully for ICSI. Men with congenital absence of the vas have been shown to be carriers of the cystic fibrosis gene. Pregnancies that might not have been possible otherwise can be produced with ICSI, and although the incidence of abnormalities is increased over that of the general population, the increase is small. Fortunately, when the embryo that is transferred is abnormal, it is destined not to proceed through pregnancy. Generally, grossly abnormal embryos fail to implant or do not develop normally, aborting early in the pregnancy. To address these issues further, techniques for genetic evaluation of the embryo have been developed.

Preimplantation Genetic Diagnosis

As laboratory techniques for in vitro culture of embryos have been refined, systems have been developed to analyze the genetic characteristics of a single cell for preimplantation genetic diagnosis (PGD). PGD involves the removal of a cell from a dividing embryo by micromanipulation for genetic analysis, using probes to identify and assess the normality of individual chromosomes. Only embryos that are deemed genetically normal are transferred into the uterus, and the remainder are discarded. These techniques are particularly useful in couples who are carriers for certain genetic diseases, such as Tay-Sachs disease. This approach is also useful clinically in women over age 35, who are at a greater risk for having a baby with Down's syndrome. Transferring only normal embryos could result in an increased pregnancy rate after in vitro fertilization. The downside is that because the technique involves the removal of a cell from the embryo, there is the possibility that the embryo will be injured, impairing further development. PGD allows the determination of the sex of the embryo, and some have suggested that it be used for prenatal sex selection. This would be clinically applicable in cases in which there is a sex-linked genetic defect that would be present only in an embryo of a given sex (e.g., hemophilia).

Embryo Freezing

The techniques of IVF result in the recovery of numerous oocytes that are then available for fertilization. In contrast to semen, which is readily frozen and stored, techniques for freezing eggs have encountered difficulties. The freezing and storage of embryos, however, is technically feasible and practical. Embryo freezing is most successful when it is carried out at the pronuclear stage shortly after the development of the male and female pronuclei. Freezing of embryos that are not transferred in the treatment cycle allows the opportunity for additional pregnancies without another cycle of stimulation and ovum recovery.

Although offering a significant advantage in terms of the pregnancy rate per couple, the eventual use or disposal of freeze-stored embryos is a matter for careful consideration. In its guidelines, the Ethics Committee of the American Society for Reproductive Medicine strongly recommends that the decision on freezing and eventual disposition of unused embryos be made in advance, after a thorough consultation with both partners. The couple may elect to allow their stored embryos to be used for research. A preliminary decision is also made in advance about the disposition of the frozen embryos in the event of a divorce or the death of one partner. From time to time legal issues arise in this regard that must be resolved in court.

Research utilizing human embryos is controversial. Policies vary from one country to the next. In the United Kingdom research is deemed permissible up to the fourteenth day of development but not beyond that time. This matter is receiving increasing attention as methods are developed to identify and culture embryonal stem cells to provide future treatment options for a number of diseases.

Donor Eggs

The use of an egg donated by another woman is the female counterpart to the use of donor semen for male infertility. The differences, however, are significant. Although small, there are risks associated with the procedures employed to recover the ova. The ovaries can overrespond to the gonadotropin hormones, causing hyperstimulation, a serious medical condition. Rare deaths have been reported from hyperstimulation because of coagulation problems and pulmonary emboli. Infection after ovum recovery, although rare, has been reported.

Ovum donors usually are recruited from among young women, often college or graduate students. Some programs allow a differential in the payment scale when a woman undergoing IVF is willing to release some of her recovered oocytes for the use of an infertile woman who is unable to produce eggs. Obviously, the ethical and social issues surrounding ovum donation are far more complicated than is the case for semen donation. The Ethics Committee of the American Society for Reproductive Medicine has established guidelines for the compensation of ovum donors and has suggested that a woman be paid reasonably for her time and effort.

Recipients of donated eggs are usually women who are unable to produce their own eggs. Ovum donation has been used in postmenopausal women who wish to extend their reproductive life span. Extreme examples include pregnancies in women over age 60, which have been reported in at least three countries. The risk to the mother in those circumstances is not insignificant, and the social and ethical issues surrounding such treatment require careful consideration. Donated embryos genetically unrelated to the couple have also been used.

Conclusion

The development of reproductive technologies has occurred at a breathtaking rate. The net result has been increased opportunity for reproductive choice. These techniques have provided an increased likelihood of pregnancy among women in their late reproductive years. They have allowed men with subfertility or even complete absence of spermatozoa in their ejaculate to establish a pregnancy by using their own genetic material. Concomitant with these dramatic developments has been an increasing concern over ethical issues, and societal norms have been strained. As basic mechanisms of reproductive functions are analyzed and demystified, there will be continued clinical and laboratory innovation not only in the management of infertility but in the development of systems to prevent pregnancy as well.

See also: *Contraception, Modern Methods of; Genetic Testing; Multiple Births; Reproductive Rights.*

BIBLIOGRAPHY

Dohle, G. R., D. J. Halley, J. O. Van Hemel, A. M. van Den Ouwel, M. H. Pieters, R. F. Weber, and L. C. Govaerts. 2002. "Genetic Risk Factors in Infertile Men with Severe Oligozoospermia and Azoospermia." *Human Reproduction* 17: 13–26.

Ethics Committee of the American Society for Reproductive Medicine. 2000. "Financial Incentives in Recruitment of Oocyte Donors." *Fertility and Sterility* 74: 216–220.

Guzick, D. S., S. A. Carson, C. Coutifaris, J. W. Overstreet, P. Factor-Litvak, M. P. Steinkampf, J. A. Hill, L. Mastroianni, J. E. Buster, S. T. Nakajima, D. L. Vogel, and R. E. Canfield. 1999. "Efficacy of Superovulation and Intrauterine Insemination in the Treatment of Infertility." *New England Journal of Medicine* 340: 177–183.

Patrizio P., and L. G. Leonard. 2000. "Mutations of the Cystic Fibrosis Gene and Congenital Absence of the Vas Deferens." In *The Genetics of Male Infertility: Results and Problems in Cell Differentiation,* ed. K. McElreavy. Berlin and Heidelberg: Springer-Verlag.

LUIGI MASTROIANNI, JR.

ETHICAL ISSUES

Reproductive technologies—the manipulation and exchange of gametes (i.e., sperm and ova) and human embryos—were developed to overcome the natural infertility that frustrates individuals' intentions to parent children. The development and application of these technologies raised heated ethical debates at the turn of the twenty-first century. Some condemn these technologies as "unnatural," although many other applications of medical science intended to overcome natural failures in health, such as organ failure or susceptibility to infection, are not ethically condemned.

Ethicists do not agree on the moral status that human embryos deserve. Those who consider them to have high intrinsic worth, as actual or potential human beings, oppose the deliberate wastage of embryos that accompanies the development and application of reproductive technologies. Those who accord embryos respect, but at a lower level than born people or fetuses, assert that embryos may be employed, and their wastage may be responsibly planned, in efforts to assist reproduction. The ethical expectation of tolerance of plurality—that is, the acceptance of different ethical approaches—requires that individuals not be compelled to act against their conscience, and that they not be barred from acting as their conscientious convictions allow, unless there is demonstrable evidence that their actions cause pain to others. Scientists widely accept, for instance, that embryos may ethically be used and be let perish in reproductive research up to fourteen days from their creation, when the "primitive streak," the origin of the brain, appears.

Ethical Acceptance

Reproductive technologies include drug treatments to assist fertility and natural conception. Hormonal stimulation of women's ovulation raises ethical concerns because it may result in hyperstimulation and the natural conception of a high number of embryos in the same reproductive cycle. Pregnancies of four or more fetuses usually jeopardize the health of the mother, and endanger the survival of their fetuses or born children, due, for instance, to low birth weight. Triplet and even twin pregnancies can also present risks. One medical response to high multiple pregnancies is to use techniques that reduce the number of embryos or fetuses growing *in utero*; these techniques raise ethical concerns related to abortion.

People who adhere to religious convictions approach reproductive technologies differently. Some raise few ethical objections, seeing the procedures as expressions of divinely inspired human resourcefulness and proper human collaboration in creation. However, there is considerable religious condemnation of the prospect of human reproduction by cloning. Cloning is the production, by non-sexual means, of a genetically identical cellular structure (a "twin") such as an embryo, from a pre-existing structure. The religious objection to it is that induced human cloning is unnatural, and a human assumption of divine authority to create human life. The Roman Catholic tradition is very conservative regarding almost all reproductive technologies and rejects any procedure perceived as unnatural. Roman Catholic ethics may allow transfer of ova into a woman's reproductive system for natural fertilization there by her husband. The Islamic tradition rejects all gamete and embryo transfer, because of the strong emphasis on the integrity of genetic lineage, but accepts many technologies that equip women to bear their husbands' children. As a secular, pluralistic approach to human behavior, the observance of ethics requires tolerance of diverse opinions about the many forms of consensual reproduction.

Gamete and Embryo Donation and Use

Ethical respect for individuals' self-determination or autonomy requires that gamete and embryo donors give their informed consent. Donors may be required to remain anonymous to recipients, since personal contact may raise concerns about payments, unethical commerce, and treating reproductive materials as marketable commodities. Similar concerns arise when clinics purchase gametes and embryos and pass costs on to recipients the donors do not know. When couples have surplus embryos or gametes from their own *in vitro* fertilization (IVF) treatment, they may donate an embryo or gamete to another couple. If IVF clinics refuse to accept applicants if they will not agree to donate surplus gametes or embryos, they raise issues around the patient-donors' freedom of choice, and clinic operators' conflict of interest. If treatment is unsuccessful, childless donors may face the knowledge that strangers may bear and rear their children when they cannot. If a couple ends IVF treatment because they have separated, one may veto the other's consent to embryo donation. Patients are always ethically entitled to withdraw consent that has been elicited by excessive pressure.

Use of gametes and embryos, by couples themselves or by the recipients of donation, depends on these materials satisfying genetic and other criteria. Ethicists disagree over precisely which characteristics make gametes and embryos unsuitable for use. Gross genetic abnormality, determined by preimplantation genetic diagnosis (PGD), will clearly negate use, as will racial incompatibility with possible recipients. Mild genetic abnormalities, such as to genetically-inherited but manageable disabilities, may not be an ethical basis of rejection, and some legal systems and ethics codes prohibit decision making on the sole basis of an embryo's sex. Ethical advantages of PGD are that it reduces the incidence of elective abortion due to negatively perceived embryonic or fetal characteristics, and may provide support for initiating pregnancies women would otherwise decline.

Eligibility for Assisted-Reproduction Services

The characteristics that make couples and individuals ineligible to receive technological assistance to become parents are often ethically contentious, since they may reflect negative stereotypes of poor parents that lack evidence, and may violate principles of nondiscrimination. Social justice is denied when low family income excludes couples from access to high-cost assisted reproduction. Couples may also be ineligible for reproductive assistance when one parent has a disability. Denial of assistance to applicants with physical disabilities may be unethical even when disabling conditions may be genetically transmitted, and raises issues of negative eugenics concerning whether conditions such as congenital deafness and short stature truly are disabilities. Negative eugenics is the practice of restricting people considered unfit to transmit their genetic characteristics from having children, which became discredited by association with coercive Nazi practices. Mental impairment may more easily justify ethical denial of assistance, on the grounds that prospective children's interests would be violated, but this claim also requires demonstrated evidence. Ethicists assert that applicants' unmarried status and partnership in same-sex relationships are decreasingly defensible ethical grounds to deny technologically assisted reproductive services, since evidence shows that children brought up in homes of such parents are not significantly different from children reared in more conventional homes.

Since advanced paternal age is not a natural barrier to parenthood, ethicists sometimes question whether age should be a bar to assisted reproduction. Post-menopausal pregnancy is often opposed on grounds that aging mothers are a disadvantage to children, although many children are successfully raised by grandparents. Assisted reproduction in cases of premature menopause raises fewer ethical objections. There is also an ethical debate around assisting widows to conceive children by their deceased husbands, since some consider recovery of sperm while the men are unconscious, dying, or deceased without their clearly given prior consent ethically objectionable.

A surrogate mother is a woman who agrees in advance to gestate a child or children for surrender upon birth to others who requested this service. Such women provide authentic prenatal mothering, whether they are also genetic mothers or receive embryos created by IVF from other women's ova. Ethical concerns around surrogate motherhood include how women are engaged for this role, and whether their consent is adequately informed, freely given, and not unduly induced. Both commercial recruitment and pressuring family members or friends to render unpaid services raise ethical concerns.

Children's Interests

If the experience of human life is considered inherently beneficial, it may be ethically unobjectionable to create a new human life. Some may claim, however, that inappropriate reproductive assistance causes births that violate the interests of particular families, communities, or societies. Human reproductive cloning may ethically be opposed, for instance, with the argument that its safety has not yet been established in animal studies. Objection relies on political or macro-ethical claims, however, which address community-wide interests, rather than micro-ethics, meaning the ethics of individual physician–patient relationships, since within those relationships patients may ethically be assisted to bear children at known risk of adverse health consequences.

Communities are increasingly recognizing the ethical entitlement of children born of gamete and embryo donation to know about their genetic origins. The anticipated growth of genetically based diagnosis, prognosis, and treatment is likely to reinforce claims to this knowledge, particularly as therapeutic drugs begin to be designed to fit the particular features of patients' genetic inheritance. Ethicists differ on how much children should be entitled to learn. At one end of the spectrum are those who argue that information of children's biological parents' genetic deficits and predispositions to illness should be available, so that children may benefit from accessible treatments and be able to avoid diets, lifestyles and, for instance, environments that trigger inherited predispositions to illness. At the other extreme are those who claim that, notwithstanding confidentiality, children have a right to know the personal identities, circumstances and family background of those whose genes they have inherited, and the right to meet them if the children wish and practically can. The ethical basis of this claim is that individuals should not become parents unless they are willing to be responsible to their children. However, social parenthood, meaning accepting continuing responsibility for the welfare and rearing of children, is now distinguishable from medically assisted biological parenthood. Children conceived in casual, perhaps single-instance sexual encounters may not have enforceable claims to know who their fathers are, and it is not ethically established that children of artificial, planned conception have superior rights to those born of natural, unplanned conception.

See also: *Eugenics; Genetic Testing; Quality of Population; Religions, Population Doctrines of; Reproductive Rights.*

BIBLIOGRAPHY

Department of Health and Social Security (U.K.). 1984. *Report of the Warnock Committee of Inquiry into Human Fertilisation and Embryology.* London: Her Majesty's Stationery Office, Cmnd. 9314.

Golombok, Susan, R. Cook, A. Bish, and C. Murray. 1995. "Families Created by the New Reproductive Technologies: Quality of Parenting and Social and Emotional Development of the Children." *Child Development* 66: 285–298.

Harris, John, and Soren Holm, eds. 1998. *The Future of Human Reproduction.* Oxford: Clarendon Press.

New York State Task Force on Life and the Law. 1998. *Assisted Reproductive Technologies: Analysis and Recommendations for Public Policy.* Albany, NY: New York State Task Force on Life and the Law.

Royal Commission on New Reproductive Technologies. 1993. *Final Report: Proceed With Care.* Ottawa: Minister of Government Services, Canada.

Serour, Gamal, and Bernard Dickens. "Assisted Reproduction Developments in the Islamic World." *International Journal of Gynecology and Obstetrics* 74: 187–193.

Bernard M. Dickens

RESETTLEMENT

Resettlement of people from one part of a country to another is a specific form of internal migration and is of particular significance in less developed countries. It is usually associated with programs of agricultural settlement carried out under government auspices. There are two main forms of resettlement. The first is a largely voluntary movement, seen as a solution to "overpopulation" in the areas of origin and as a means to increase production in "underused" land in the destination areas. The second form, more forced than voluntary in nature, is settlement of people who have been displaced by environmental events, development projects, or conflict.

The extension of agricultural settlement as older-settled areas fill up has occurred throughout human history, albeit usually on a more-or-less spontaneous basis. In the twentieth century governments often took a hand in the process, opening new areas for closer agricultural settlement and selecting settlers—mainly persons with agricultural backgrounds. While there have been examples of such schemes in developed countries—for example, Donald Rowland (1979) has discussed the returned soldier settlement schemes in Australia following World Wars I and II—the largest resettlement schemes have been initiated by colonial and independent governments in developing countries. Indonesia, Brazil, and China are notable cases in point. Large variations in population density between different parts of the nation are often a reflection of ecological realities (in Indonesia, for example, some 60 percent of the population is in Java, which accounts for only about 6 percent of the country's land area). Nevertheless, comparatively "empty" areas, such as in Indonesia's other major islands, often have some potential for closer settlement.

Land settlement schemes were prominent in the first four decades following World War II in many developing countries. By the mid-1980s, such projects were no longer favored. In a representative comment, Andrei Oberai concluded:

> Despite the substantial amounts that have been invested in planned settlement schemes . . . their performance has not been very encouraging. . . . If not complete failures, they have, in almost all parts of the world, given settlement officials and policy makers serious cause for concern. They are costly in relation to the number of persons settled, and frequently suffer from low productivity and high rates of desertion. In some cases they also appear to have created social tensions in the areas concerned (Oberai 1986, pp. 141–142).

As a result of such assessments as well as the decreasing availability of suitable land, the number and scale of settlement programs declined and by the beginning of the twenty-first century few countries had them.

Although they vary by country, land settlement schemes have typically involved governments in selecting potential settlers, assisting and organizing their move to the settlement area, clearing and preparing the land for agriculture, and providing the settlers with housing and other services and economic assistance until their agricultural holdings become established.

The goals of government-sponsored settlement schemes have differed. In Indonesia, the Philippines, and Peru "evening out" the national population distribution has been an important aim. In Brazil, Malaysia, and Sri Lanka the main objective has been regional development. Some schemes have explicit (or implicit) political motives. The "colonization" of Tibet by Han Chinese is one example. Some have suggested that Indonesia's transmigration scheme has sought to establish the dominance of Javanese in the outer islands of Indonesia.

In 1985 Thayer Scudder put forward a four-stage model of the land settlement process: (1) planning and design of the scheme, initial infrastructure development, and the recruitment of settlers; (2) the actual transfer of settlers and their initial establishment in the new environment; (3) economic growth and social progress in the settlement area; and (4) incorporation of the settlement scheme into the existing local and regional structure. There is an additional, fifth stage, however: what may be referred to as the "second generation problem." Once the initial settlers have become established and their children begin to enter the working ages, this second generation puts great pressure on local labor markets, which often cannot absorb the increasing numbers of workers. In some schemes, there is evidence of settlers having higher fertility than their counterparts in origin areas, which exacerbates the problem.

Indonesia's Transmigration Program

Probably the largest single government-organized land settlement scheme has been the transmigration program in Indonesia, which resettled families from Java and Bali in Sumatra, Kalimantan, Sulawesi, and West New Guinea (Papua). As shown in Table 1, the numbers over the twentieth century amounted to about 1.5 million families—or around 8 million people. The Dutch colonial government began the program in 1905, and after independence successive regimes continued carrying it out until it was officially terminated in 2000. As with other settlement

TABLE 1

Indonesian Transmigration in 1905–1998

Period	Number of Families (thousands)
1905–1968	243
1969–1974	39
1974–1979	55
1979–1984	366
1984–1989	228
1989–1994	247
1994–1998	315
Total	1,494

SOURCE: Mubyarto (2000).

schemes, it also created a parallel flow of spontaneous migrants into the settlement areas or to nearby land, both from Java and Bali and from other parts of Indonesia.

Problems of Resettlement Schemes

Land settlement programs have encountered a range of problems. These have included belated discovery that the settlement land could not support intensive agriculture; insufficient preparation of settlers for farming in a different environment; insufficient early support for settlers and consequent "desertion" of settlers from schemes; social tensions between settlers and the original inhabitants of the settlement areas, often arising from inadequate recognition of the latter's title for the land or from inadequate compensation; and ecological problems created by poor or unsustainable agricultural practices.

The costs of resettlement per family are high in relation to alternative strategies to fight poverty, increase agricultural production, or influence population numbers and distribution. The World Bank, which became involved in supporting some land settlement programs as a development strategy in the 1970s and 1980s, subsequently withdrew most of its support, partly on these grounds.

Forced Internal Resettlement

Forced migrations across national borders have attracted a great deal of research attention, but analogous movements within countries have been substantially greater in size and have been much less studied. The main causes of such forced resettlement are large-scale infrastructure projects, environmental disasters, and political, ethnic, or religious conflict. The bulk of these resettlements occur within less developed countries. In a 2000 report, Michael Cernea and Christopher McDowell maintained that "the most widespread effect of involuntary displacement is the impoverishment of a considerable number of people" (Cernea and McDowell, p. 12).

Dam construction is a major reason for population displacement. It is estimated that around 12 million Chinese were displaced by reservoir and dam construction in the half century following establishment of the People's Republic of China in 1949. The Three Gorges Project, damming the Yangtze River in central China, involves the inundation of almost 30,000 hectares (74,000 acres) of farmland and the resettlement of at least 1.2 million people; it is due to be completed in 2009.

Environmental disasters such as volcanic eruptions, floods, cyclones, tsunami, and droughts can cause massive displacement on both a temporary and permanent basis. South Asia and Africa are the regions most affected. Those displaced are often described as environmental refugees. A 1980s estimate found that in India alone four million persons on average were needing to migrate elsewhere to seek food and shelter each year. The Sahelian drought of the late 1980s saw the displacement of several million people in a number of African countries, including Burkina Faso, Chad, Mali, Mauritania, and Niger.

Internally Displaced Persons

Persons fleeing persecution or threat of violence but who remain within their country (and thus cannot formally be recognized as refugees under the mandate of the United Nations High Commission for Refugees [UNHCR]) comprise another large category of displaced persons. Beginning in the late twentieth century, the UNHCR has identified internally displaced persons (IDPs) as a "group of concern." Although they are outside of the 1951 UN Refugee Convention, the UNHCR defined IDPs as:

> persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized state border (U.S. General Accounting Office, p. 5).

Figure 1 shows the UNHCR estimates of trends in numbers of IDPs (and the numbers of refugees for comparison). Figure 1 shows that the numbers of IDPs recognized by the UNHCR expanded greatly in the late 1980s and early 1990s with the number of nations with IDPs increasing from 14 in 1985 to 34 in 1996. The increases in numbers were predominantly in Africa (Burundi, Somalia), Europe and the former USSR (Bosnia and Herzegovina, Azerbaijan, Georgia, Cyprus, Russian Federation, Croatia, Armenia) and Asia (Afghanistan, Sri Lanka, Cambodia). The figure of around eight million IDPs globally at the beginning of 2001 underestimates the actual number. For example, it omits 1.3 million IDPs officially identified in Indonesia. Indeed, in 2001 the U.S. General Accounting Office estimated that there were over 20 million IDPs worldwide.

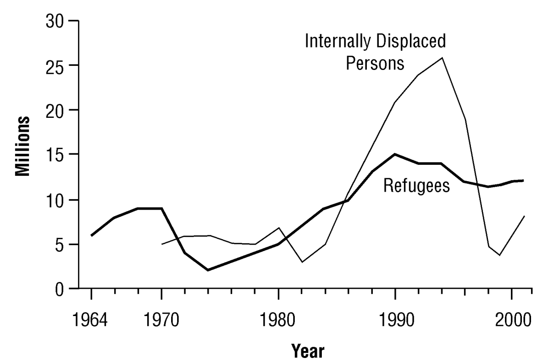
IDPs are often less able to obtain assistance than refugees, because they do not qualify for UNHCR protection and support. They usually are forced to move under conditions of great duress and are often unable to take their possessions with them. The camps they are initially housed in are often overcrowded and suffer from major health and social problems.

Governments seek to return IDPs to their home area if that is possible, but often they are resettled in other parts of the country. In Indonesia, for example, the same government agency that was responsible for transmigration has responsibility for resettling IDPs who are unable to return to their home area. Forced movements within less developed nations appear to be increasing in scale although those officially recognized by the UNHCR show a downturn in the late 1990s.

See also: *Ethnic Cleansing; Forced Migration; Internal Migration; Refugees, Demography of.*

FIGURE 1

Worldwide Total Refugees and Internally Displaced Persons 1964–2001



SOURCE: Population Reference Bureau (1999); UNHCR Statistics.

BIBLIOGRAPHY

Cernea, Michael M., and Christopher McDowell. 2000. *Risks and Reconstruction: Experiences of Resettlers and Refugees.* Washington, D.C.: World Bank.

Heming, Li, and Phillip Rees. 2000. "Population Displacement in the Three Gorges Reservoir Area of the Yangtze River, Central China: Relocation Policies and Migrant Views." *International Journal of Population Geography* 6: 439–462.

Hessler, Peter. 1999. "Tibet through Chinese Eyes." *Atlantic Monthly* 283(2): 56–66.

Hugo, Graeme. 1996. "Environmental Concerns and International Migration." *International Migration Review* 30(1): 105–131.

Jacobson, Jodi L. 1988. *Environmental Refugees: A Yardstick of Habitability.* Washington, D.C.: Worldwatch Institute.

Oberai, Andrei S. 1986. "Land Settlement Policies and Population Redistribution in Developing Countries: Performance, Problems, and Prospects." *International Labour Review* 125 (2): 141–161.

United Nations. 1981. *Population Distribution Policies in Development Planning.* New York: United Nations.

GRAEME HUGO

RESIDENTIAL SEGREGATION

Residential segregation refers to the geographic differentiation of two or more population groups within a city or metropolitan area. When segregation is extreme (such as when an ethnic minority is confined to a ghetto), members of each group may live almost completely apart. Normally, however, segregation is a matter of degree. Even casual observation confirms that most urban neighborhoods exhibit some amount of internal diversity in socioeconomic status, ethnicity, life cycle stage, and other attributes of their inhabitants.

Measures of Segregation

To capture the variable nature of segregation, researchers have relied heavily on the index of dissimilarity (symbolized by D). This index measures the *evenness* dimension of segregation by comparing the proportional distributions of two groups, X and Y, across spatial units such as census tracts or blocks in a given region, typically a city or metropolitan area. The popularity of D lies in its intuitive appeal: It can be interpreted as the percentage of members of group X who would have to move to a different tract or block in order for the regional distribution of X to be the same as Y. Another segregation dimension of interest is *exposure*, which indicates the likelihood that a member of X shares the same neighborhood either with someone from Y (reflecting the potential for intergroup interaction) or with other members of X (reflecting intragroup isolation). Because exposure measures take group size into account, Stanley Lieberson concluded in 1980 that they are better than D for representing how segregation is experienced by average members of X and Y.

Segregation and Inequality

This concern with experience underscores the importance of residential segregation as a sociological as well as a spatial phenomenon. During the first half of the twentieth century, human ecologists tended to view the locational circumstances of a group as a natural expression of its position or standing in society. In the United States, these ecologists noted the benefits of segregation, especially to European immigrants for whom living side by side with compatriots offered familiarity, comfort, and support. Later scholars have adopted a less benign perspective, emphasizing the profound connection between segregation and inequality. While some see segregation as an outcome of economic disparities, others argue that segregation plays a causal role, shaping the life chances of group members. In 1993, Douglas S. Massey and Nancy A. Denton contended that the development of the urban underclass could be traced to the manner in which segregation concentrates disadvantage in particular neighborhoods. Such neighborhoods are marked by physical deterioration, inadequate services, health hazards, and high rates of poverty and crime. They also limit a resident's access to the kinds of educational and employment opportunities that promote social and geographic mobility.

Segregation in U.S. Cities

The fateful nature of residential segregation in the United States has been documented most thoroughly for African Americans. In the early 1900s, members of this group were less segregated from native-born whites than were newcomers from Southern and Eastern Europe. Segregation then increased dramatically through mid-century as black migrants from the Southern states flooded into the northern industrial cities and encountered constraints on housing choices. By the latter part of the century, the most intense phase of segregation had passed. Nevertheless, data from the 2000 census revealed an average black-white dissimilarity (D) score for metropolitan areas that still exceeded 60—a level greater than that for segregation between whites and other minorities. In terms of exposure, the typical black urbanite today lives in a neighborhood containing a majority of black occupants.

The fact that even affluent African Americans are underrepresented in desirable residential settings demonstrates the inability of socioeconomic differences to explain fully black-white segregation. An alternative explanation stresses the institutional barriers that blacks continue to face in the housing market despite legislative efforts to curb discrimination (e.g., the Fair Housing Act of 1968 [amended in 1988], the Equal Credit Opportunity Act of 1974, the Community Reinvestment Act of 1977). Several audit studies, in which purported minority and white homeseekers (actually research confederates) approach real estate agents about advertised properties, document the unfavorable treatment received not only by African Americans but also by Latinos. In 1995 John Yinger reported that, compared to whites, these groups receive less information about homes for sale or rent, are shown fewer units, and are more often steered toward lower-income areas. Audit studies of mortgage lenders and insurers provide similar evidence of discrimination.

The residential preferences of individuals help to sustain segregation. There is ongoing debate in the United States over whether African Americans prefer to live in integrated neighborhoods or whether—perhaps in response to the anticipated negative reactions of whites—they would rather live in settings where they are numerically dominant. The influence of white preferences is less ambiguous. Some white residents of an area may move out when its racial mix exceeds their tolerance for integration. More importantly, other white homeseekers elect not to move in, prompting further compositional shifts and, ultimately, avoidance of the area by a greater number of whites. Whatever the motivation, the mobility decisions of whites and blacks drive the process of neighborhood racial transition. Such decisions are thus a key micro-level mechanism through which the aggregate pattern of segregation is perpetuated.

Though that pattern remains largely intact in U.S. cities, the period since 1970 has witnessed several noteworthy changes, including at least small declines in black-white segregation across most metropolitan areas, increasing black suburbanization, and a rising number of racially integrated neighborhoods. These changes may result from the strengthening of fair housing legislation or the expansion of the black middle class, but the evidence is not definitive. Decreases in black-white segregation coincide with increases in the racial and ethnic diversity of the United States as a whole. African Americans in cities with large Asian and Latino populations tend to be less segregated, suggesting that other minority groups serve as a buffer between whites and blacks. Intergroup contact in diverse communities may also reduce ethnic antagonisms.

Asian and Latino residential experiences in the United States differ from those of blacks in several ways. Although substantial variation exists within the two broad categories (Laotian vs. Japanese, Cuban vs. Salvadoran, etc.), Asians and Latinos are generally less segregated from whites than blacks are. Moreover, their segregation appears less permanent, with clustering in enclaves—a voluntary response of immigrants to language and cultural obstacles—diminishing as higher-status households move to suburban neighborhoods or settle in them directly. Spatial assimilation of households, however, does not always reduce the level of segregation. In fact, 1990–2000 census results show approximate stability for both Asians and Latinos on the evenness dimension of segregation and increases on the isolation dimension. In the cities that serve as major immigrant gateways, such as Los Angeles, new arrivals sometimes pile up at a faster pace than their predecessors are able to disperse. The resulting concentration of immigrants and minorities in relatively few destinations could produce a balkanized landscape in which segregation is apparent farther up the geographic scale, with groups sorted by municipality or metropolitan area instead of by neighborhood.

The Future

Should racial and ethnic discrimination weaken significantly, the major constraint on locational choice would be the ability to pay, potentially leading to heightened segregation by income. Such a trend may already have begun in the United States, although Paul Jargowsky's 1996 research found that levels of income segregation remain modest when compared to black-white levels. Life cycle segregation might also intensify as young singles, families with children, and the elderly of all ethnic groups are freer to pursue housing and neighborhood packages suited to their needs. One principle governing the future is clear: As long as societies are stratified, cities will be residentially segregated on some dimension, given the different resources and preferences represented among their populations.

See also: *Poverty and Income Distribution; Racial and Ethnic Composition; Suburbanization.*

BIBLIOGRAPHY

Alba, Richard D., John R. Logan, Brian J. Stults, Gilbert Marzan, and Wenquan Zhang. 1999. "Immigrant Groups in the Suburbs: A Reexamination of Suburbanization and Spatial Assimilation." *American Sociological Review* 64: 446–460.

Ellen, Ingrid Gould. 2000. *Sharing America's Neighborhoods: The Prospects for Stable Integration.* Cambridge, MA: Harvard University Press.

Farley, Reynolds, and William H. Frey. 1994. "Changes in the Segregation of Whites from Blacks during the 1980s: Small Steps toward a More Integrated Society." *American Sociological Review* 59: 23–45.

Farley, Reynolds, Charlotte Steeh, Maria Krysan, Tara Jackson, and Keith Reeves. 1994. "Stereotypes and Segregation: Neighborhoods in the Detroit Area." *American Journal of Sociology* 100: 750–780.

Frey, William H. 1996. "Immigration, Domestic Migration, and Demographic Balkanization in

America: New Evidence for the 1990s." *Population and DevelopmentReview* 22: 741–763.

Iceland, John, Daniel H. Weinberg, and Erika Steinmetz. 2002. *Racial and Ethnic Segregation in the United States: 1980–2000.* Washington, D.C.: U.S. Government Printing Office.

Jargowsky, Paul A. 1996. "Take the Money and Run: Economic Segregation in U.S. Metropolitan Areas." *American Sociological Review* 61:984–998.

Lieberson, Stanley. 1980. *A Piece of the Pie: Blacks and White Immigrants since 1880.* Berkeley: University of California Press.

Massey, Douglas S., and Nancy A. Denton. 1988. "The Dimensions of Residential Segregation." *Social Forces* 67: 281–315.

———. 1993. *American Apartheid: Segregation and the Making of the Underclass.* Cambridge, MA: Harvard University Press.

Yinger, John. 1995. *Closed Doors, Opportunities Lost: The Continuing Costs of Housing Discrimination.* New York: Russell Sage Foundation.

INTERNET RESOURCE.

Lewis Mumford Center for Comparative Urban and Regional Research, State University of New York at Albany. 2001. "The New Ethnic Enclaves in America's Suburbs." <http://www.albany.edu/mumford/census>.

BARRETT A. LEE

RESOURCES AND POPULATION

See *Energy and Population; Natural Resources and Population*

RISK

For demographers, the *risk* of a demographically significant event—such as birth, death, the onset of illness, marriage, migration, or labor force entry or exit—is the probability that the event will occur. Demographically significant events define entry or exit from demographically significant conditions, such as life, death, residence in a politically defined region, various marital statuses, employment, and school enrollment.

The demographic definition of risk ignores the desirability and impact of risked events. For example, sexually-active women of childbearing age are "at risk" of pregnancy, but the demographer's calculation of that risk does not consider if women regard pregnancy with delight or dread. Nor does the demographer's risk evaluation consider differences between pregnancy that is unwanted due to minor timing inconveniences and pregnancy that is unwanted because it would precipitate the mother's death. In common language, negative consequences of events are losses and positive consequences are benefits. The demographic approach is technical. The technical analysis is sometimes simplified by calling the consequence of a risked event a loss; a benefit then is a negative loss.

Demographic Rates

Individuals are *at risk* of an event if and only if their risk exceeds zero. A demographic rate is a time-related measure of exposure to risk. The rate is measured by the number of occurrences of an event per at-risk person per unit time. If events are non-recurring (e.g., death), and the time interval for the measurement is one unit (e.g., a year), then the rate is the proportion of at-risk persons who experience the event per time period. In demography, rates at which an event occurs are distinguished from proportions of population segments who experience the event. The denominator of the proportion, but not the denominator of the rate, may include persons who are not at risk (e.g., men are not at risk of giving birth).

Rates are used to calculate or estimate important time-related measures, including the extent to which members of a population who enter a demographically significant state remain in it over time, the probabilities that an individual who enters that state will remain in it for various numbers of consecutive time periods, and the expected or mean future time remaining in a state for persons who already have been in the state a particular length of time. These measures include the so-called life-table quantities: age-specific death rates, age-specific expected length of remaining life, and proportion of the population surviving at each specific age.

Age-specific rates for a population are often applied to hypothetical or *standard* age distributions to compute standardized or adjusted rates, life expectancies, and other quantities for the entire population. Alternatively, hypothetical or standard rates are applied to the observed age distribution of a population to produce adjusted rates and expectancies for population aggregates.

Methods of Analysis

Risks can be simple or competing. For example, employed persons are at risk of job loss from mortality, retirement, layoff, mandatory military service, incarceration, and voluntary job termination; employed persons who leave their jobs by dying cannot also leave by retirement, layoff, or any other means. Competing risks are used to produce multiple decrement life tables in which members of a population can exit a demographic condition via several specified, mutually exclusive routes (e.g., one can exit the civilian non-institutionalized population by mortality, emigration, or institutionalization). Demographic risk analysis often focuses on socioeconomic differentials in exposure to risk of death and other demographically significant events, implicitly examining the effects on mortality of socioeconomic factors such as schooling, occupation, and race.

Because of practical limitations on the size of available datasets, empirical analysis of many socioeconomic differentials in risk requires multivariate statistical methods. Methods such as logit and probit analysis can be applied in some situations involving a risked event that can occur only once. Poisson regression methods are useful in those situations when the event can occur more than once. Multinomial logit and multinomial probit methods are useful in those situations when there are competing risks, only one of which can occur, and only once. For data that gives the duration of *spells* (uninterrupted periods spent in a demographic state of interest) various types of survival analysis methods are useful, including those based on exponential, Weibull, lognormal, and loglogistic distributions. Cox's proportional hazard method is frequently useful. Appropriate methods also appear in the literature on event history analysis.

Risk and Loss

Effective design of government policy and business strategy often requires prognostications of (a) future demographic risks, rates and proportions, and (b) the exposure to losses (i.e., costs and benefits) that would be associated with these risks, rates, and proportions, if they occurred as projected. The future or past size and age distribution of a population in a demographically significant condition can be projected or estimated by application of a set of age-specific survival rates to the current age-distribution of that population. In practice, all estimates and projections necessarily are based on a combination of information and conjecture about past, current, and sometimes future risks and other factors. Data limitations and methodological disputes add uncertainty. A common but incomplete response to this uncertainty is to make demographic projections in sets, each element of which is based on different assumptions about unknown information. But demography offers no standard procedures for choosing among the members of a set of projections, and the choice is inescapably subject to dispute. Production of a set of projections saves the demographer from the need to defend intrinsically-subjective speculation about the unknown, and it pushes disputes about demographic projections outside of demography.

The loss distribution. If it is possible to evaluate the losses associated with demographic events, then it is possible and often useful to evaluate the general level of exposure to loss from a set of risks, or from different subsets of those risks. Common descriptive statistics in addition to the mean and variance are informative but not routinely used. The expected loss is the first moment of the loss distribution, otherwise known as its mean or expectation. If outcomes x are continuously differentiable and occur with probability $Pr(x)$ and loss $L(x)$, then the expected loss, $E(L)$, is given by $E(L) = \int L(x)\mathrm{Pr}(x)dx$. If outcomes are discrete, then $E(L) = \Sigma_i L(x_i)\mathrm{Pr}(x_i)$. The variance of $L(x)$ describes the accuracy with which loss can be anticipated without additional predictive information. The higher the variance, the less informative is the mean about the loss that one is likely to experience. The worst case loss is the maximum of the loss distribution.

In the absence of concrete knowledge about the future, insurance provides a defense against disruptively large losses and, more generally, a hedge against variance in the distribution of losses. Insurance permits individuals to experience some present loss with certainty (in the form of payment of premiums) in exchange for protection against uncertain future losses that exceed a threshold (the insurance deductible). Insurance commonly is available for only some risked events; for those that cannot be insured, the analysis of risk and loss exposure, and planning on the basis of that analysis, is particularly useful.

Valuing losses. Demography itself is seldom, if ever, informative about how to compare different types of losses. Comparison of dissimilar losses requires a theory of value, or at least some principles about how to compare dissimilar demographic states and the events, such as birth, death, employment, and migration that cause them to change. For example, how is one to compare the losses associated with 100 deaths from workplace injuries to job loss by 60,000 employed persons? Numerous and conflicting economic, legal, aesthetic, emotional, political, religious, and other analyses of value exist. Thus, disputes are endemic to considerations of the losses associated with demographic projections. Policies are often evaluated on their actual or projected effects on mortality and other demographically significant events. These disputes are especially severe when they concern social policies that involve tradeoffs between risks of different types, such as increased unemployment risk and increased mortality risk.

Conflicts also often focus on risk (probability) estimation and worst case analysis. The *worst imaginable* event in any situation is likely to be the demographic tragedy of massive loss of human life. Imaginable events are not necessarily possible. Because the demographic framework examines risk only for those who are at risk, the first question is whether or not the risk of the worst imaginable event is zero or so close to zero that it should be treated as such. If this risk is distinguishable from zero, then this loss is the worst case loss. But if this risk is not distinguishable from zero, then this loss passes out of consideration. Heated debate over the risk of the worst imaginable event has been a prominent feature of public policy discussion concerning nuclear power, genetically modified plants and animals, environmental pollution, workplace safety, and other matters.

Expert Versus Popular Views of Risk

Much of the disagreement between experts and the lay public appears to stem from, or to be exacerbated by, the following:

Differences in probability estimation. Lacking technical training and often distrustful of expert pronouncements, substantial proportions of the lay public seem to prefer their own subjective estimates of risk probabilities to the data-based estimates of technical experts. A substantial segment of the population appears to lack intuitive understanding of very small decimal fractions, with consequent difficulty understanding the frequency of occurrence of low-probability events.

Differences in valuation of risked events. Experts tend to focus on quantitative loss measures and tend to use generally accepted estimation methods. In contrast, large segments of the general public rely on subjective evaluations that are quite dissimilar to expert evaluations.

Differences in attention. There are differences in attention given to the worst imaginable loss versus the average, expected, or most-likely loss. Attentive to the accuracy of their predictions over the long run, technical experts tend to give the greatest weight to scenarios that are most likely, and no weight to scenarios that have no probability of occurrence. Substantial segments of the general public focus on the worst imaginable case, perhaps because it inspires the greatest emotional response.

Differences in the conceptualization of losses. At their best, risk experts apply methods that let them make finely-graded comparisons of the losses associated with the occurrence of a risked event to the losses associated with its nonoccurrence. For example, technologies periodically fail disastrously, and disasters take lives (e.g., airplanes crash, bridges collapse, and physician errors kill patients). A simple and popular measure of the impact of technology failure is the number of lives lost from it. But technologies that fail periodically also can prolong and improve the quality of lives. At a minimum, one should compare the number of lives lost from a technology failure to the number of lives that would have been lost if the technology had not been deployed at all. And since everyone dies eventually, regardless of what technology is or is not deployed, the relevant measure is even better approximated by the number of person-years of life lost by the failure of a technology, compared to the number of person-years of life that would be lost by not deploying that same technology. Technical experts can apply life tables or analogous methods to calculate the loss of person-years of remaining life. Analysis and comparison of age-specific death rates (rather than numbers of deaths) is yet more complicated and directs attention to the societal rather than the individual consequences of deadly events. Quality-of-life issues are important too.

Differences in considerations of "spillover" effects. Experts tend to confine their analyses to variables that they can measure; substantial segments of the general public appear to consider the consequences of a risked event on their entire way of life. Losing a job can be seen as a simple loss of income, or it can be seen as the unraveling of everything supported by that income in the family of the employed person.

Differences in treatment of losses associated with unfamiliar risks. Substantial portions of the general public appear to respond to danger from an unfamiliar event (e.g., anthrax infection by contaminated mail, real or imagined illness from radiation-sterilized food) by increasing their estimate of the risk (probability) of experiencing the event, increasing their estimate of the loss that would result from the experience, or both, sometimes with anxiety, hostility, and the growth of social movements and collective action added.

Differences between technical and lay approaches to risk and loss exposure lead to questions about when it is useful to apply the technical analysis to public policy debates, and how to present it to those who combine high emotional interest in the subject with low exposure to the technical issues. Answers to these questions are external to demography, and they rest on judgments and strategic decisions about what is worth studying in detail, and what social choice inferences should be emphasized, stated, or left implicit. Widely-felt emotions and subjective impressions are social facts that cannot be ignored, but they are poor tools for analysis of risk and loss exposure. Those who claim that risk and loss exposure are equivalent to the general public's perception of them risk seriously flawed results.

Equally unstable analyses may result from the so-called *rival rationalities* view that conceives of experts as focused narrowly on statistical analysis of that which can be quantified, and an equally rational general public focused on a wide range of qualitative aspects of risk, including voluntariness and fairness of risk and loss exposure, and the dread with which a possible loss is perceived. The rival rationality view of risk assessment is not subject to any requirement for empirical evidence on risk magnitudes. This method is likely to be particularly troublesome when the risks of advanced technologies are considered. When science is misunderstood, as it often is, then popular misconceptions can and do lead to perceptions of imagined risks involving horrible but imaginary future losses. Finally, there appears to be confusion regarding the perceptions that are the basis for lay assessments of risk and loss exposure: It has been argued that anxiety about a risked event makes exposure to that event seem less voluntary, thereby raising the perceived risk of the event and exposure to loss from it, regardless of any actual difference in risk or exposure.

Conclusion

In summary, demography offers a particular conceptual and methodological framework for the measurement and analysis of risk; for predicting, forecasting, and comparing risks in different times and places; and for understanding how a given risk structure affects a population. The demographic approach to risk emphasizes the explicit connection between the structure of risk experienced by a population and the structure of age—the time spent in a demographically significant condition—that the population develops over time.

Demographic techniques emphasize the proper technical calculation of demographic risk measures. Demographic methods permit and even encourage analysis based on hypothetical values of demographic risks. These calculations are an important step in the analysis of exposure to loss. But demography offers no guidance about how to value the losses (and benefits) associated with the occurrence of risked events. Thus, demographic analysis of loss exposure requires combining demographic risk calculation with loss evaluations provided by other disciplines, engendering all the difficulties described above.

See also: *Accidents; Disasters; Life Tables; Event History Analysis; Value of Life, Economic.*

BIBLIOGRAPHY

Margolis, Howard. 1996. *Dealing with Risk.* Chicago: University of Chicago Press.

Preston, Samuel, Patrick Heuveline, and Michel Guillot. 2001. *Demography: Measuring and Modeling Population Processes.* Oxford, Eng. and Malden, MA: Blackwell Publishers.

Slovic, Paul. 2000. *The Perception of Risk.* Earthscan Publications.

Timmreck, Thomas. 1994. *An Introduction to Epidemiology.* Boston, MA, and London: Jones and Bartlett.

Ross M. Stolzenberg
Howard Margolis

RURAL-URBAN BALANCE

Large-scale shifts of population from the countryside to the city have been a feature of the demographic and geographic landscape for more than a century. Urbanization has accompanied the demographic transition in virtually all middle- and high-income countries. Urbanization, by definition, results in declining share of the population in rural areas. For instance, the Japanese rural population share dropped from 50 percent to 21 percent between 1950 and 2000, while in Canada the corresponding drop was from 39 percent to 21 percent. When urbanization is well advanced, it is accompanied by a decline also in the absolute size of the rural population, as is illustrated for the period from 1950 through 2000 by data for several major European nations: France (−21%), Germany (−47%), Italy (−12%), and the United Kingdom (−22%). (In the United States, the rural population was slowly increasing over that period—a rise of 14%—but is projected to gradually decline over the first half of the twenty-first century.) These shifts in population distribution are due to the combined effects of rural outmigration, the changing relative size of the rural and urban populations, rural-urban differences in natural increase, and the reclassification of territory from rural to urban.

Phases of Rural-Urban Population Balance

In the contemporary industrialized countries, shifts in the internal distribution of the population have moved well beyond simple urbanization. One can identify four broad phases of rural-urban population balance that characterize the trajectory of these societies.

A first phase could be termed classic urbanization. In Europe and North America this phase commenced with the Industrial Revolution and continued into the twentieth century. The growth of cities and urban territory outpaced that of the countryside, fed by net rural-urban internal migration. The second phase, commencing in the beginning of the twentieth century but accelerating by mid-century, might be characterized as suburbanization, or perhaps more accurately, as metropolitan expansion. Throughout this second phase the share of the population in the countryside continued to decline, and did so eventually also in terms of absolute size. With declining fertility, the rate of natural increase could no longer counterbalance the effect of net migration loss, initiating a process of outright rural depopulation. Rural depopulation was most notable in agricultural areas. In the United States the rural population of the heavily agricultural West North Central (northern Midwest) census division declined steadily in each decade from 1920 to 1970.

The third phase we might label "counterurbanization." The phenomenon was first noticed for the United States in the 1970s, but counterurbanization trends were soon also noticed in Europe, Japan, and Australia. This demographic surprise was alternately described as the "nonmetropolitan turnaround" or a "rural renaissance," and it generated a considerable amount of debate about its determinants and likely persistence. Observers variously attributed it to changes in industrial structure, technical issues in geographic classification, growth of retirement communities, and cultural shifts affecting locational preferences.

The fourth phase, about which there is less consensus, may be called "population diffusion." It describes a pattern of population redistribution discernible in most industrialized, high-income countries at the start of the twenty-first century. It can be characterized by (a) the location of a very large majority of the population in urban regions; (b) population deconcentration within urban regions; and (c) the absence of consistent, geographically pervasive, large-scale, unidirectional flows of population. For instance, the 5.2 percent U.S. nonmetropolitan gain in the 1970s was followed by only 2.7 percent in the 1980s, and then 10.3 percent in the 1990s. In Australia, selected outlying local government areas (LGAs) recorded losses between 1996 and 2001, while capital regions and some smaller coastal settlement areas grew. France, in particular, has shown appreciable variation in growth and decline across rural territory in recent decades. Contributing to these trends in population geography are shifts in underlying demographic dynamics. As fertility declines and natural increase diminishes to near-zero, much of the urban-rural population change is determined by net migration. The relative size of the urban and rural populations and their age structures also likely to come into play in determining population change over time. For example, labor migration may redistribute rural-origin persons away from the rural hinterland toward other metropolitan (and selected nonmetropolitan) employment sites, while retirement migration may relocate individuals away from these sites to lower density communities.

The declining share of the rural population, and also its decline in absolute terms, was accompanied by a significant shift in the character of rural economic activity and social life during the latter half of the twentieth century. Rurality has been associated with occupations such as farming, animal husbandry, fishing, and mining. At one time "rural" was also synonymous with limited education, high fertility, "traditional" values, and disengagement from urban-industrial life. This is no longer necessarily the case. At the dawn of the twenty-first century, urban and rural occupy locations along a geographic settlement spectrum. Residents of territory classified as rural or nonmetropolitan in high-income societies have access to many of the same products and services of contemporary society that city-dwellers enjoy. Their geographic distance from some employment and cultural opportunities tends to be offset by better access to modern transportation and communication technology. It remains true, however, that within this broad scale most urbanized societies retain pockets of rural areas for which social exclusion is an enduring reality.

As to middle-income countries, many of them have already experienced much of the demographic transition and are in the midst of the rural-urban transition. Major Latin American countries (Mexico, Colombia, Brazil) have experienced a substantial decline in the share of the rural population, generally from about one-half around 1950 to about one-quarter by the end of the twentieth century. Malaysia and the Philippines record less than half of their population in rural areas. With declining fertility and continued urbanization, those rural areas out of reach of metropolitan spillover and having little destination attractiveness for internal migrants, are likely to experience absolute declines in population before long.

Changing Concepts and Definitions

Concepts and definitions are intrinsically bound up with the description and analysis of trends in population concentration. In the first phase of population shift, the period of significant declines in the rural share, notions of "urban" and "rural" may have been relatively obvious and readily captured by a dichotomy. As urban populations became dominant in many countries—and with the prospect of a world half-urban early in the twenty-first century—definitions have shifted along with population. Most national population statistics still recognize "urban" and "rural." Conventionally, settlements exceeding a certain threshold—often from about 2,000 to 5,000 persons—are classified as urban. This definition worked well enough in a predominantly dispersed agrarian society. But as the share of the rural population declined, the classification of "urban" territory in industrialized societies needed elaboration, adding terms such as "metropolis," "megalopolis," and the like. The reclassification of territory and of persons by place of residence has implications for the "rural" population. Some metropolitan areas, as defined, extended far into their hinterland, even to include agrarian and very low-density settlements. (China and the United States both offer examples of this.) The resulting reclassification of persons from rural to urban would further reduce the rural population. These issues of classification and their evolution over the historical span of demographic data collection are at once an illustration of the difficulty of capturing the event, and more importantly, a recognition that re-definition often follows changes in behavior of people at the individual and societal level.

See also: *Suburbanization; Urbanization.*

BIBLIOGRAPHY

Bogue, Donald J. 1985. *The Population of the United States.* New York: Free Press.

Champion, Anthony G. 1992. "Urban and Regional Demographic Trends in the Developed World." *Urban Studies* 29: 461–482.

Lichter, Daniel, and Glenn V. Fuguitt. 1982. "The Transition to Nonmetropolitan Population Deconcentration." *Demography* 19: 211–221.

Long, Larry, and Diana DeAre. 1988. "US Population Distribution: A Perspective on the Nonmetropolitan Turnaround." *Population and Development Review* 14: 433–450.

White, Michael J., and Peter R. Mueser. 1989. "Explaining the Association Between Rates of Inmigration and Outmigration." *Papers of the Regional Science Association* 67: 121–134.

INTERNET RESOURCES.

Australia Bureau of Statistics. 2002. <http://www.abs.gov.au/ausstats>.

Bessy-Pietri, Pascale, et al. 2000. "Evolutions contrastées du rural." (Recensement de la population 1999, report #726.) Institut National de la Statistique et des Etudes Economiques (INSEE, France). <http://www.insee.fr.>.

Johnson, Kenneth M., and Calvin Beale. 2002. "The Rural Rebound." <http://www.luc.edu/dept/sociology/johnson/p99webn.html>.

United Nations, Population Division. 2002. *World Urbanization Prospects: The 2001 Revision.* New York. <http://esa.un.org/unpp>.

MICHAEL J. WHITE

RURAL-URBAN MIGRATION

See *Internal Migration; Urbanization*

RYDER, NORMAN B.

(1923–)

Canadian-American demographer and sociologist, Norman B. Ryder studied political economy at the University of Toronto and obtained his Ph.D. in sociology from Princeton University in 1951. In the first years of his career, he worked at the University of Toronto and the Dominion Bureau of Statistics—now Statistics Canada—in Ottawa. He joined the Department of Sociology at the University of Wisconsin in 1956, where he founded the Center for Demography and Ecology and was appointed Thorstein Veblen Professor of Sociology. He moved to Princeton University in 1971 as professor of sociology but was based primarily at Princeton's Office of Population Research. He was president of the Population Association of America (1972–1973) and of the Sociological Research Association (1974–1975).

Three articles published in 1964 and 1965 stemming from his doctoral thesis—on the concept of a population, on "demographic translation" (between period and cohort measures), and on the cohort as a concept in the study of social change—were early major contributions to theory and methodology in demography. (The thesis itself, *The Cohort Approach,* was published in 1980.) Independently of French demographer Louis Henry (1911–1991), he devised parity-progression measures of fertility change and he brought birth history and parity analysis to the center of fertility forecasting.

Ryder was co-director, with American demographer Charles F. Westoff (b. 1927), of the U.S. National Fertility Study, the three rounds of which (1965, 1970, and 1975) produced evidence of the widespread diffusion of modern contraception and recorded the distinctive patterns of reproductive behavior of American families in the middle decades of the twentieth century.

Ryder was an important interpreter of the post-World War II baby boom, emphasizing its elements of continuity with the past—for example, noting that the birth-rate increase did not entail a reversal of the long-run decline in higher-parity births. He took the Princeton side in asserting a determinative role of the pill in the renewed American fertility decline, as against the view from Berkeley, espoused principally by Judith Blake, of demand-driven change. In the 1970s he was a key player in the design of the World Fertility Survey, although later (in a 1986 review of a volume summarizing its findings) quite critical of WFS achievements. He also made significant contributions to family demography.

See also: *Cohort Analysis; Demography, History of; Henry, Louis.*

BIBLIOGRAPHY

SELECTED WORKS BY NORMAN B. RYDER.

Ryder, Norman B. 1964. "Notes on the Concept of a Population." *American Journal of Sociology* 69(5): 447–463

———. 1964. "The Process of Demographic Translation." *Demography* 1: 74–82.

———. 1965. "The Cohort as a Concept in the Study of Social Change." *American Sociological Review* 30(6) 843–861.

———. 1975. "Reproductive Behavior and the Family Life Cycle." In *The Population Debate: Dimensions and Perspectives. Papers of the World Population Conference, Bucharest, 1974.* New York: United Nations. Volume 2, pp. 278–288.

———. 1980. *The Cohort Approach: Essays in the Measurement of Temporal Variations in Demographic Behavior.* New York: Arno Press.

———. 1982. *Progressive Fertility Analysis.* (World Fertility Survey, Technical Bulletin no. 8) The Hague, Netherlands: International Statistical Institute.

———. 1983. "Fertility and Family Structure." *Population Bulletin of the United Nations* 15: 15–34.

———. 1986. "Observations on the History of Cohort Fertility in the United States." *Population and Development Review* 12: 617–643.

———. 1990. "What is Going to Happen to American Fertility?" *Population and Development Review* 16: 433–454.

Ryder, Norman B., and Charles F. Westoff. 1971. *Reproduction in the United States 1965.* Princeton: Princeton University Press.

Westoff, Charles F., and Norman B. Ryder. 1977. *The Contraceptive Revolution.* Princeton: Princeton University Press.

Jacques Légaré

S

SANGER, MARGARET

(1879–1966)

Pioneer of the birth control movement in America, and internationally, Margaret Sanger arguably achieved more for reproductive choice than any other person in the twentieth century. The sixth of eleven children, Sanger was strongly influenced by her Freethinker, Irish father, Michael Higgins. Working as a nurse in New York, she saw what she called "the turbid ebb and flow of misery," and became convinced of women's need for birth control information. The 1873 Comstock Law prohibited distribution of such information through the U.S. mail. In 1914, Sanger was prosecuted under this law for the content of her magazine *The Woman Rebel,* although the case was eventually dropped. In 1916, she founded the American Birth Control League and was imprisoned briefly for opening a birth control clinic, the first in America, in Brooklyn. By curtailing her socialist views, she garnered substantial middle-class support for her cause. Partial victory was achieved in the Crane decision of 1918, in which the law was amended to permit contraceptive advice as a medical therapy.

Sanger had fled to England in 1914 to avoid prosecution and during that time she associated with members of the Malthusian League and with English psychologist and writer Havelock Ellis (1859–1939). In the 1920s, her interest in world population issues grew. Like many in her generation, she espoused eugenics. She was instrumental in setting up the first World Population Conference, in Geneva in 1927, which brought together the leading demographers of the time. Birth control, however, was deemed too sensitive to be discussed, and her own role in the meeting was kept at a low profile, although she did edit the published proceedings. An outgrowth of this conference was the establishment of the International Union for the Scientific Study of Population Problems.

Sanger was a timid but effective speaker and a master of publicity. Her 1938 autobiography, a number of laudatory biographies, and a tract from a Catholic publisher (entitled *Killer Angel*), focus on her early turbulent years. However, two of Sanger's greatest achievements came when she was over 70. In 1951, she challenged Gregory Pincus, the reproductive physiologist, to develop the "perfect contraceptive." With financial help from Sanger's friend, the philanthropist Katherine McCormick, Pincus and his colleagues went on to develop the first birth control pill in 1960. In 1952, in Bombay, Sanger played a key role in founding the International Planned Parenthood Federation, and became its first president.

Powered by an unshakeable belief in her cause, Sanger's protest against an unjust law grew into a crusade that changed the way women in America—and in a growing number of other countries—live.

See also: *Birth Control, History of; Eugenics; Family Planning Programs.*

BIBLIOGRAPHY

SELECTED WORKS BY MARGARET SANGER.

Sanger, Margaret. 1970 [1938]. *An Autobiography.* New York: Maxwell.

SELECTED WORKS ABOUT MARGARET SANGER.

Asbell, Bernard. 1995. *The Pill: A Biography of the Drug that Changed the World.* New York: Random House.

Gray, Madeline. 1979. *Margaret Sanger: A Biography of the Champion of Birth Control.* New York: Richard Marek Publishers.

Moore, Gloria, and Ronald Moore. 1986. *Margaret Sanger and the Birth Control Movement: A Bibliography, 1911–1984.* Metuchen, NJ: Scarecrow Press.

David Malcolm Potts

SAUVY, ALFRED

(1898–1990)

Alfred Sauvy, French demographer, statistician, economist, and man of letters, was founding director of Institut national d'études démographiques and founding editor of the journal *Population.* After graduating from the Ecole polytechnique, Sauvy joined Statistique Générale de France, the country's central statistical office, predecessor of today's INSEE (Institut National de la Statistique et des Etudes Economiques). His work there involved him in demographic studies, such as an examination of the effect of immigration on France's population, and the preparation, in 1928, of the first modern-type population projections in France, distinguishing age and sex. These projections, repeated in the 1930s, shed light on the longer-term consequences of maintaining below-replacement levels of fertility. (His projections for France, published in 1932, predicted a 1975 population between 31 and 39 million. The actual population, reflecting a sharp turnaround in French fertility, falling mortality, and substantial immigration, turned out to be 53 million.) Sauvy, and his intellectual mentor, Adolphe Landry (1874–1956, Minister of Social Affairs and author of *La révolution démographique,* [1934]) were concerned about the effects of demographic trends on France's national strength and specifically with the fiscal problems inherent in the observed and anticipated shifting ratio between the old and the young. Both saw the solution to this in the rejuvenation of the population through higher birth rates. Sauvy, with Landry, was active in the late 1930s in the preparation of policy reforms aimed at stimulating fertility. He was also pro-immigration, favoring a selective policy, followed by assimilation. His first book, *Richesse et Population,* which appeared during World War II, was a recapitulation of his analysis of economic-demographic interactions in France.

After the war, Sauvy became an influential and highly visible figure in France—a demographer who was also an intellectual with a strong and distinctive voice in contemporary debates on issues of social and economic policy. More than any other demographer in France, or elsewhere, Sauvy reached a broad readership through his many books (more than 40 in all, over four decades) on population and economics, written in an appealing style and accessible to the intelligent reader. That influence was extended by his numerous articles in newspapers and periodicals, such as *Le Monde* and *L'Observateur.* He wrote on many themes but his principal and recurrent interests were the need for strengthening pro-family policies aimed at sustaining the postwar resurgence of birth rates, encouraging immigration in ways that serve well-conceived domestic interests, and fighting the spirit of Malthusianism (the great disease, manifest in psychological dispositions as much as demographic behavior, that he saw as the mortal enemy of France's greatness) by pursuing a pro-growth economic and social agenda. Sauvy's positions on these matters did not fit well, if at all, into the conventional political categories of the French left and right. Although a socialist at heart, his economic prescriptions, even though permeated with a spirit of dirigisme, were typically pro-market and pro-competition, and his demographic policies were easily classified as conservative or, on matters of birth control, even reactionary.

Sauvy's platform for his role as an advocate for specific policies was his directorship of the Institut national d'études démographiques (INED), founded in 1945, a post he held for 17 years; INED's scientific journal *Population,* which he launched in 1946 and which he edited until 1974; and Sauvy's own professional work, recognized in 1959 with his appointment as professor at the Collège de France. INED and *Population* were his lasting creations, with few, if any, peers among population research organizations and scientific population journals. Among his books two stand out as his most important contributions: the two-volume *Théorie générale de la popula-*

tion (1952–1954 and, in a revised edition, 1963–1966) and the four volume *Histoire économique de la France entre les deux guerres* (1965–1975). *Théorie générale de la population* was a bold synthesis of contemporary knowledge on population and its relationships with socioeconomic phenomena, discussing such issues as population optimums, technological progress and employment, social classes and social structure, ideas on overpopulation, and international migration. In addressing these and many other issues, Sauvy largely avoided use of the tool kit of modern social science. He did not hold those research instruments in very high esteem; his primary interests were in lucidity, directness, and social relevance. An English translation of *Théorie Générale de la population* appeared in 1969. *Histoire économique de la France entre les deux guerres* was a magisterial treatment of the subject, with strong emphasis on the role of demographic factors, that drew on Sauvy's personal observations about and active involvement in the events of the interwar period.

Sauvy's professional interests were firmly focused on France and its population problems—exclusively so in the first two decades of his professional career and largely so during the remainder of it. He played an international role, however, as France's representative on the United Nations Population Commission (from its inception in 1947 to 1974) and by serving as president of the International Union for the Scientific Study of Population (IUSSP) (1961–1963). The great acceleration of world population growth in the postwar decades and the consequent efforts toward development of international population policies did, from time to time, draw his attention, and some of his writings addressed global issues. As a case in point, he is the father of the term, now obsolete but once popular, "third world," that first appeared in his 1952 article in *L'Observateur* entitled "Three Worlds, One Planet." The term he actually used, *tiers monde,* reminiscent of associations with French revolutionary history, is, however, richer in meaning than the English equivalent. However, Sauvy was not a globalist. In a 1949 article, "The 'False Problem' of World Population" (an English translation appeared in 1990), he argued that the concept of "world population" was artificial, hence largely meaningless, and that using it could only lead to confused thinking and erroneous policy conclusions. He saw the international system as one built on the jealously guarded principle of national sovereignty. "Terrestrial compartmentalizations," he observed, "are sufficiently well established to render any global calculus that ignores them quite pointless" (Sauvy 1990, p. 760). Problems of population, he contended, differed from country to country and required different, and preferably home-made, medicines.

Sauvy was utterly devoid of pretense—perhaps a reflection of his Catalan origin. He often rode his bicycle to his Paris office, wearing his inevitable beret. He was a devotee of rugby, and he played until he was well into his 50s. He assembled a unique collection of rare books, mostly from eighteenth-century French economic and demographic literature, and was the force behind INED's annotated re-editions of some of those works. He died on the eve of his 92nd birthday.

See also: *Demography, History of; Landry, Adolphe; Optimum Population; Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY ALFRED SAUVY.

Sauvy, Alfred. 1943. *Richesse et population.* Paris: Payot.

———. 1945. *Bien-être et population.* Paris: Editions sociales françaises.

———. 1949. "Le 'faux problème' de la population mondiale." *Population* 4(3): 447–462. Transl. "The 'False Problem' of World Population." *Population and Development Review* 16(4), 1990: 759–774.

———. 1952–1954. *Théorie générale de la population,* Vol. I: *Economie et croissance,* Vol. II: *La vie des populations.* Paris: Presses universitaires de France. Transl.: General Theory of Population, trans. by Christophe Campos. New York: Basic Books, 1969.

———. 1953. *L'Europe et sa population.* Paris: Les éditions internationales.

———. 1958. *De Malthus à Mao Tse-Toung: le problème de la population dans le monde.* Paris: Denoël. Transl.: *Fertility and Survival: Population Problems from Malthus to Mao Tse-Tung.* New York: Criterion Books, 1961.

———. 1959. *La montée des jeunes.* Paris: Calmann-Lévy.

———. 1963. *Malthus et les deux Marx: le problème de la faim et de la guerre dans le monde.* Paris: Denoël.

———. 1965–1975. *Histoire économique de la France entre les deux guerres,* 4 Vols. Paris: Arthème Fayard.

———. 1973. *Croissance zéro?* Paris: Calmann-Lévy. Transl. *Zero Growth?* New York: Praeger, 1975.

———. 1973. *La Population: sa mesure, ses mouvements, ses lois.* Paris: Presses universitaires de France.

———. 1976. *Eléments de démographie.* Paris: Presses universitaires de France.

———. 1980. *La Machine et le chômage: le progrès technique et l'emploi.* Paris: Dunod.

———. 1987. *L' Europe submergée. Sud-Nord dans trente ans.* Paris: Dunod.

———. 2001. *La vieillesse des nations.* Anthology: selected and annotated texts by Jean-Claude Chesnais. Paris, Gallimard.

SELECTED WORKS ABOUT ALFRED SAUVY.

Institut National d'Etudes Démographiques. 1992. "Hommage à Alfred Sauvy." *Population* Special Issue (November–December) 47(6).

Keyfitz, Nathan. 1990. "Alfred Sauvy." *Population and Development Review* 16(4): 727–733.

Lévy, Michel. 1990. *Alfred Sauvy compagnon du siècle.* Paris: La manufacture.

Tabah, Léon. 1991. "Alfred Sauvy: Statistician, Economist, Demographer and Iconoclast (1898–1990)." *Population Studies* 45(2): 353–357.

JEAN-CLAUDE CHESNAIS

SECOND DEMOGRAPHIC TRANSITION

The French characterization of the onset of the decline in marital fertility late in the eighteenth century as a *révolution démographique,* found no international favor. Instead, the process became known as the "demographic transition." The implication was that populations were passing through a period of change from one demographic regime to another. More particularly, a regime marked by a combination of high mortality and compensatory high fertility would be replaced by a regime in which the combination of low levels of both mortality and fertility would ensure a new and stable equilibrium. Rapid population growth would be a transitional phenomenon. Thus, if fertility had indeed declined to replacement level, there would then have been little interest in post-transitional fertility trends. These trends would have been in line with the underlying concept.

Negative Population Growth

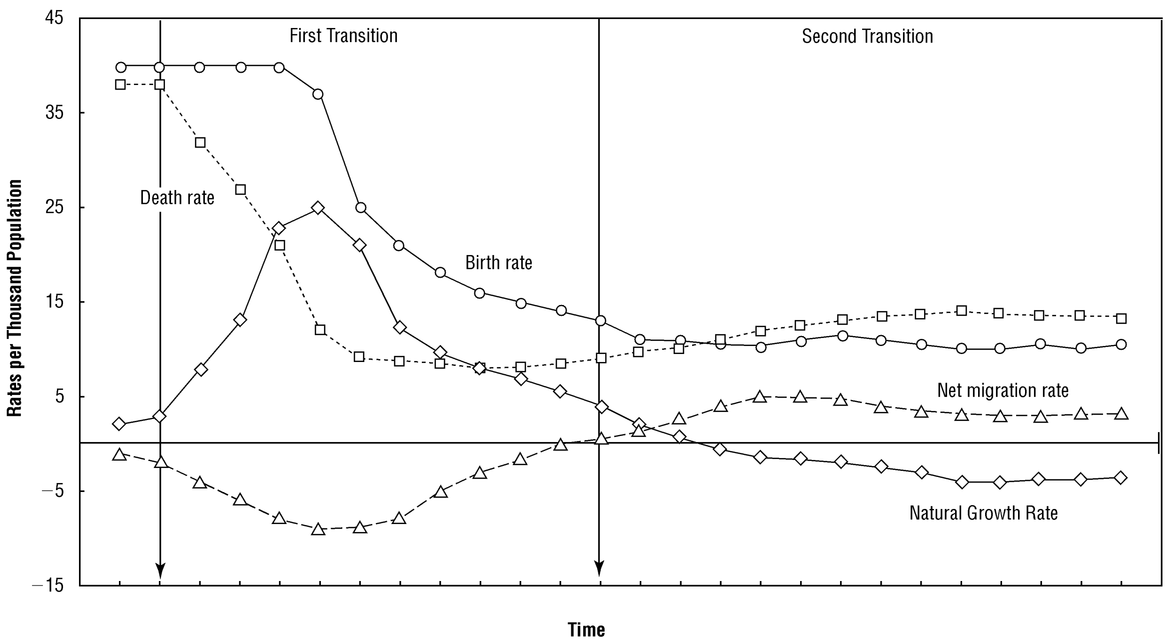
But things did not turn out that way. Advanced industrial societies face a new imbalance between the components of natural population growth. Fertility has declined well below replacement level. Life expectancies at advanced ages have risen substantially. The combination of the two leads to a rapidly aging population. Negative rates of natural population growth are already observed in numerous countries. National projections show that this phenomenon will spread. There are no indications this state of affairs is temporary; hence the conclusion that a second demographic transition is in progress.

The justification for that term lies in the crucial difference between the situation in the early twenty-first century and that of the late-eighteenth century. Then, the decline in mortality upset the balance and led to an adjustment in fertility behavior. Now it is the second natural population growth factor—fertility—that apparently makes reaching and maintaining a long-term population balance an unattainable objective. The fundamental changes in fertility and family formation in industrialized societies after the mid-1960s were revolutionary—completely unexpected and occurring with astonishing simultaneity. Continuation of unprecedented low levels of fertility is bound to generate a further adjustment in demographic regime.

The third determinant of population growth, international migration, is the obvious variable to provide compensation. Indeed, the term "replacement migration" has been coined to draw attention to that role. More importantly, positive rates of net migration already characterize advanced industrial societies.

FIGURE 1

Model of First and Second Demographic Transitions



Note: Net migration pattern reflecting European experience.

SOURCE: Van de Kaa (1999).

Demographic Transition and Migration

Figure 1 illustrates graphically how the first transition may have evolved to become the second. The graph has some novel features. While most demographers are aware that in many industrializing countries emigration helped to reduce the pressure on resources during the period of rapid population growth, the classical picture of the demographic transition usually only displays the changes in the birth rate, death rate, and rate of natural population growth. The model of the first transition presented here rectifies that omission; net migration is included. The model of the second transition is, of course, largely prospective. The underlying assumptions are, however, straightforward and well founded in empirical data.

Aging will cause the death rate to rise; it will exceed the birth rate due both to the comparatively small number of women in the reproductive age groups and a completed family size that, owing to competing aspirations, typically will not reach replacement level. Immigrants, first attracted as guest workers well before population growth rates turned negative, are bound to find their way to more developed regions for many years to come. The assumption is that the inflow remains under some sort of control. Nevertheless, the influx of migrants, whether arriving as refugees, tourists overstaying their visas, asylum seekers, undocumented migrants brought in through trafficking, seasonal laborers, or economic migrants allowed entry under an official scheme, will be a crucial factor in the future growth and population structure of advanced industrial societies.

Changes in Values and the Second Demographic Transition

The suggestion that after the mid-1960s the industrialized countries of Western Europe had entered a new stage in their demographic history was first made by Ron Lesthaeghe and Dirk J. van de Kaa in a Dutch sociological journal in 1986. In selecting the term *second demographic transition* for it, they were clearly influenced by Philippe Ariès's 1980 conference paper entitled "Two Successive Motivations for the Declining of the Birth Rate in the West." In that paper Ariès argued that the decline in the birth rate that began at the end of the eighteenth century "was unleashed by an enormous sentimental and financial investment in the child." The current decrease was "on the contrary, provoked by exactly the opposite attitude. The days of the child-king are over. The under-forty generation is leading us into a new epoch, one in which *the child, to say the least, occupies a smaller place*" [emphasis added]. In their paper Lesthaeghe and van de Kaa extended the change to one from a "bourgeois family model" to an "individualistic family model" affecting not only childbirth but the whole process of family formation and dissolution. There the discussion rested for a while. van de Kaa attemped to broaden the concept to include mortality and migration in papers published in 1988 and 1999.

There can be no doubt that just as occurred during the first transition, the new shifts in demographic patterns result from the interplay of structural, cultural, and technological factors during a complex process of social change. The welfare state ensures citizens an income and protects them from the vagaries of life. New, highly efficient contraception has been introduced; frequently restrictions on abortion and sterilization have been lifted. Significant changes in value systems have been documented. These ideational transformations accentuate individual autonomy, involve the rejection of all forms of institutional controls and authority, and show a rise of expressive values connected with self-fulfillment, according to Lesthaeghe and Johan Surkyn. Thus, they strongly emphasize so-called "postmaterialist" values.

For a while it appeared as if the new transition process would remain limited to Northern and Western Europe. Data for the 1990s show, however, that Southern and Eastern Europe are increasingly affected. Lesthaeghe and Surkyn feel that even "economic recovery in Eastern Europe is not likely to alter the demographic trend in a fundamental way."

Understanding the Second Demographic Transition

Proving the existence of sequences and generalizations in the first transition has not been very easy. John Cleland concluded after surveying half a century of research: "Too many mediating factors obscure any mechanical dose-response relationship between the probabilities of survival and fertility trends." Researching the second transition will be equally difficult. The increase in life expectancy at advanced ages may, perhaps, be interpreted as the lagged response to greater individual efforts to prevent disease, presumably fueled by the same value changes that generated the shifts in fertility behavior and family formation. The relationship with international migration is, no doubt, much more indirect. A number of theoretical postulates and considerations may apply. However, changes in population growth rates, in age structure, and in the composition of the labor force of advanced industrial societies, are of crucial importance in explaining the onset and continuation of inflows.

See also: *Aging of Population; Ariès, Philippe; Demographic Transition; Fertility, Below-Replacement.*

BIBLIOGRAPHY

Ariès, Philippe. 1980. "Two Successive Motivations for the Declining Birth Rate in the West." *Population and Development Review* 6(4): 645–650.

Cleland, John. 2001. "The Effects of Improved Survival on Fertility: A Reassessment." In *Global Fertility Transition,* Suppl. to Vol. 27: *Population and Development Review,* ed. Rodolfo A. Bulatao and John. B. Casterline. New York: The Population Council.

Lesthaeghe, Ron, and Dominique Meekers. 1986. "Value Changes and the Dimensions of Familism in the European Community." *European Journal of Population* 2: 225–268.

Lesthaeghe, Ron, and Johan Surkyn. 2002. "New Forms of Household Formation in Central and Eastern Europe: Are They Related to Newly Emerging Value Orientations?" IPD-WP 2002-2, Brussels.

Lesthaeghe, Ron, and Dirk J. van de Kaa. 1986. "Twee demografische transities?" In *Bevolking: Groei en Krimp,* eds. Dirk J. van de Kaa and Ron Lesthaeghe. Deventer, Netherlands: Van Loghum Slaterus.

———. 1994. "The Second Demographic Transition Revisited: Theories and Expectations." In *Population and Family in the Low Countries 1993* Amsterdam: Lisse, Zwets and Zeitlinger.

———. 1999. "Europe and Its Population: The Long View." In *European Populations: Unity in Diversity,* ed. Dirk J. van de Kaa, Henri Leridon, Guiseppe Gesano and Marek Okòlski. Dordrecht, Netherlands: Kluwer Academic Publishers.

van de Kaa, Dirk J. 1987. "Europe's Second Demographic Transition." *Population Bulletin* (42) 1.

DIRK J. VAN DE KAA

SEGREGATION

See *Residential Segregation*

SEX RATIO

In most human populations, male and female sub-populations are territorially integrated, but the sex ratio—the ratio of males to females—varies from place to place, especially among small localized populations. When reference is made to the short-lived ratios of men and women in workplaces, institutions, and organizations, the term *gender balance* is more appropriate and is increasingly preferred.

Measures, Accuracy, and Sub-Population Ratios

The sex ratio is usually expressed as a *masculinity ratio*—the number of males per 100 females. It may also be given as a *masculinity proportion* (i.e., percentage of males) or as a percentage excess or deficit of males. Sometimes the ratio is given in transposed form, as the number of females per 100 males (e.g., in India), and sometimes per 1,000 rather than per 100. The United Nations has unsuccessfully attempted to standardize the usage.

Published international data on sex ratios are neither very common nor very accurate, as census enumerations of the two sexes can vary in their reliability. One sex is often less completely enumerated than the other, particularly males in the West (especially among illegal immigrants and those opposed to authority) and females in numerous less developed countries (e.g., Afghanistan, Bangladesh, India, and Pakistan, where son and male preference predominates and females are habitually disadvantaged in numerous ways).

Sex ratios are calculated for many sub-populations (e.g., age, ethnic, and educational groups) as well as for different events, such as conceptions (known as primary sex ratios), births (secondary sex ratios) and deaths, and migration. Population sex ratios, sometimes termed tertiary sex ratios, are determined by sex-differentials in fertility, manifested in the preponderance of male births; sex-differentials in mortality, especially the normally greater longevity of females; and sex-differentials in mobility. The numerical significance of these three factors upon sex ratios of populations varies over time and space.

Sex Ratios at Birth

Sex ratios at birth have been, historically, the least important numerical influence on sex ratios of large populations in the past, being remarkably consistent within the range of 104–108 male births per 100 females. This biological disparity seems to be related particularly to hormonal levels at conception. The male surplus at conception is believed to be high but it is reduced by excess male mortality before birth, especially when health conditions are poor; sex ratios at birth rise somewhat when health conditions improve. First-order births tend to have slightly higher sex ratios than later-order ones, as seen in the sex balance of births in post-war baby booms. However, in many Asian cultures, the persistence of son preference in combination with access to techniques of fetal sex determination has resulted in a surge of female abortions in the late-twentieth century, substantially raising sex ratios at birth (recorded sex-ratios are also raised by under-enumeration). In a number of Asian countries, these ratios have risen to levels that are highly anomalous: 110 in South Korea, 111 in India, and 117 in China. In these countries, levels for later-order births are much higher. Beyond the practice of sex-selective abortion, the possible spread into large Asian and Muslim populations of the latest techniques of pre-implantation sex selection, sometimes known as gender choice, may further distort sex ratios at birth with major social and psychological implications. A growing excess of males is already affecting the marriage market in parts of China in the early twenty-first century.

Sex Ratios at Death

As all humans are mortal, the preponderance of male births implies higher numbers of deaths among males than among females. In age-specific terms, the differences between the sexes are, however, also pronounced: typically, male death rates are higher at every age. Thus the male numerical advantage at birth is eroded as a cohort ages, as can be observed in age-specific population sex ratios. When mortality is high, this effect is strong; hence females achieve a numerical equality with males at a relatively low age, such as around age 20. With low mortality, despite the female advantage in death rates, most males and females survive to middle age. Thus it takes longer in a cohort before the number of females equals the number of males, and, in a population, numerical equality of females with males occurs at a relatively high age. For example, in the United Kingdom in 2000, the number of males exceeded the number of females at every age up to roughly age 50. In the age group from 45 to 49, the sex ratio was 100.2; in the age group 50 to 54, it was 99.1. Since the sex ratio at birth is about 105—not greatly different from equality—the figures just cited indicate that in low mortality populations male and female numbers are broadly balanced in a large lower segment of the age pyramid. With mortality further lowered, the upper limit of that age segment is expected to rise further. Projections suggest, for example, that in the United Kingdom by the middle of the twenty-first century, the population sex ratio even at the age range from 60 to 64 will still exceed 100, reflecting the enduring influence of the sex ratio at birth on the sex ratio of the population up to the threshold of old age. But sex-differential mortality has a major effect on population sex ratios once survival rates start falling rapidly, as they do beyond age 60. Survival rates fall for both sexes but do so more steeply for males. In the United Kingdom, for example, expectation of life at birth in 2000 was approximately 80 years for females and 75 years for males. But the population sex ratios among the elderly (reflecting in part past differences in survivorship) show large male deficits: the sex ratio is 70.1 at ages 75 to 79 and 45.2 among those 80 years and older.

Several exceptions to this broad depiction of the pattern of population sex ratios and the mortality factors influencing them should be noted. One was signaled above, with reference to the anomalous sex ratios at birth owing to higher mortality among female fetuses found in some countries in Asia. Should such elevated sex ratios at birth persist, they would have a major effect on the balance of the sexes over time in a broadening segment of the age pyramid, spreading from lower to higher ages.

A second qualification has to do with anomalous female mortality relative to male mortality. Cultural factors operating to the disadvantage of females in a number of countries, notably in Pakistan, India, and Bangladesh, have tended to counteract the biological female advantage in survivorship, causing either excess female over male mortality or greatly reducing the natural female mortality advantage over broad age groups, especially among children and in younger adult ages. In such circumstances, population sex ratios can exceed the sex ratio at birth well up to the upper ranges of the age pyramid. But even in such populations, among the oldest of the old the number of females typically exceeds the number of males. As in recent decades, female mortality improvement has been faster than male mortality improvement even in these countries. This anomalous pattern of population sex ratios is expected to be gradually attenuating in future years.

Thirdly, in some populations, especially in Eastern Europe, while overall mortality is relatively moderate, the female mortality advantage over males is found to be exceptionally high. For example, in the Russian Federation in 2000, the expectation of life at birth for the entire population was 66 years but the gap between female and male life expectancy was 12 years: 60 years for males and 72 years for females. Such wide disparity in mortality strongly affects population sex ratios. In most East European countries, the sex ratios for those aged 60 and over were below 60, and overall population sex ratios were below 90. In Russia, for example, in 2000, the corresponding ratios were 53 and 88. However, exceptional war-time mortality, even after 55 years of peace, has contributed to this sharp imbalance.

Sex Ratios of Migrants

Sex ratios of migrants tend to vary much more than ratios at either birth or death. Some migrations have been male-dominated, as for example in the early colonization streams from Europe to the New World and in the major gold rushes; some have been female-dominated, including the widespread migrations of domestic servants to Latin American cities and much rural-urban migration in the West; and other migrations have been more or less balanced, especially when they have been forced by political or environmental conditions. Transient and temporary circulatory movements tend to be even more gender-selective. Gender selectivity tends to vary with the evolution of migration streams, men being more preponderant at earlier stages, with the proportion of women increasing over time. In the last quarter of the twentieth century, sex ratios of migrants changed rapidly in many countries, as women's greater autonomy and opportunities were reflected in their increased mobility. However, migration has less consistent effects on the overall sex ratios of populations than either births or deaths, as it tends to be spasmodic, linear, and localized in impact. In addition, its effects on the sex ratios of populations tend to decrease with increasing size of a real unit—at its limits, the sex ratio of the total world population is unaffected by migration.

Patterns of Sex Ratios

Toward the end of the twentieth century, the estimated sex ratio of the total world population was 102, having risen from 100 in 1950, reflecting improvements in mortality. The overall sex ratio in more developed countries was 94, well below that of the less developed countries, which was 103—the difference being mainly a result of the older age distribution in the former region. Sub-continental variations in sex ratio are greater than global variations over time, and range from 90 in Eastern Europe to 106 in South Central Asia, largely for the cultural and health reasons already cited.

Variations are much greater at the country level, mostly because migration plays a larger role in the population change of smaller countries. While the majority of countries have sex ratios of 96 to 103, a number of East European countries, including Russia, have ratios below 90 and several very populous Asian countries (e.g., Bangladesh, China, India, and Pakistan) have ratios of 105 or more. The main causes of low sex ratios of countries are recent conflicts and wars and high levels of male mortality (e.g., Belarus, Russia, Ukraine), as well as the emigration of men (e.g., Barbados, Lesotho, and Portugal). The main causes of high sex ratios are the immigration of men (e.g., oil-rich states of the Gulf, Libya, Brunei), the emigration of women (e.g., Ireland in the past, the Philippines, and many Pacific islands), and unusually high female mortality (e.g., Bangladesh, India, Nepal, and Pakistan).

Large countries like India, China, and the United States exhibit marked regional variations in sex ratios reflecting cultural and social differences. Owing largely to the influence of migration, there are also considerable rural-urban and local variations in sex ratios whose range generally increases inversely with population size. Thus, small mining towns have high sex ratios while retirement towns have low ones. Since populations are constantly changing and redistributing themselves, the patterns of sex ratios within countries are never stable.

See also: *Gender Preference for Children; Induced Abortion; One-Child Policy; Partner Choice; Sex Selection; Spontaneous Abortion; Women's Status and Demographic Behavior.*

BIBLIOGRAPHY

Boyle, Paul, and Keith Halfacree, eds. 1999. *Migration and Gender in the Developed World.* London and New York: Routledge.

Chahnazarian, Anouch. 1988. "Determinants of the Sex Ratio at Birth: Review of Recent Literature." *Social Biology* 35: 214–235.

Chant, Susan, ed. 1992. *Gender and Migration in Developing Countries.* London: Belhaven.

Clarke, John I. 2000. *The Human Dichotomy: The Changing Numbers of Males and Females.* Amsterdam: Pergamon.

Coale, Ansley J. 1991. "Excess Female Mortality and the Balance of the Sexes." *Population and Development Review* 17: 517–523.

Croll, Elisabeth J. 2000. *Endangered Daughters.* London: Routledge.

James, William H. 1987. "The Human Sex Ratio. Part 1: A Review of the Literature." *Human Biology* 59: 721–752; 873–900.

———. 1987. "The Human Sex Ratio. Part II: A Hypothesis and a Program of Research." *Human Biology* 59: 873–900.

Lopez, Alan D., and Lado T. Ruzicka, eds. 1983. *Sex Differentials in Mortality.* Canberra, Australia: Australian National University.

Mayer, Peter. 1999. "India's Falling Sex Ratios." *Population and Development Review* 25: 323–343.

Pollard, Tessa M., and Susan B. Hyatt. 1999. *Sex, Gender and Health.* Cambridge, Eng.: CUP.

Teitelbaum, Michael S. 1972. "Factors Associated with the Sex Ratio in Human Populations." In

The Structure of Human Populations, ed. G. A. Harrison and A. J. Boyce. Oxford: Clarendon Press.

John I. Clarke

SEX SELECTION

In many cultures, and especially in certain social classes and subpopulations distinguished by religion, there have long existed strong preferences concerning the sex composition of offspring. Sometimes the preference may have been for achieving gender balance; more often the preference was for offspring of a particular sex. While parental preferences regarding the sex of children are not particularly evident in many industrialized and developing countries currently, a strong preference for sons exists in much of South Asia, East Asia, the Middle East, and North Africa.

The ability of parents to act on such preferences by deliberately influencing the sex composition of their children has increased markedly over recent decades, and further changes are likely. In the countries where son preference is most pronounced, this influence has created situations in which there are millions of "missing females." As the methods of sex selection evolve, so do the ethical questions involved.

Fertility Methods of Sex Selection

Without recourse to manipulating the biology of reproduction, parents can influence the sex composition of their offspring through fertility strategies, infanticide, adoption, and differential neglect. In a fertility strategy, parents may stop having children after the desired number of a certain sex has been reached. In China in the 1980s, partly under pressure from the government's one-child policy, parents often stopped having children after the first boy had been born. However, this strategy does not affect the societal sex ratio at birth (or, by extension, the population sex ratio). Under a male-biased stopping rule, the male-dominated families with one son are offset by female-dominated families where parents first had several daughters before the desired son was born.

Post-Birth Methods of Sex Selection

After birth, parents can influence the sex composition of their children by adoption, infanticide, or differential neglect. They can adopt out children of the undesired sex and adopt in children of the desired sex. This strategy has a long history, particularly in aristocratic families where succession depended on having a child of a particular sex (usually male). According to a study by Sten Johannsson and Ola Nygren in 1991, in modern China it is another way for parents to get a son while complying with the one-child policy. This practice too would not affect the overall sex composition of births.

As discussed by Glenn Hausfater and Sarah Bluffer Hrdy in 1994, sex-specific infanticide has been practiced in many societies past and present. In modern times, outright infanticide is a relatively rare phenomenon and is not responsible for generating the fairly sizable imbalances in population sex ratios found in many parts of the developing world.

Sex-specific neglect, resulting in higher than expected mortality of young females as compared to males, is another practice affecting the sex composition of offspring. It occurs particularly in the form of differential access to health care in countries with strong son preference. Preferential access to health care for male children, coupled in some instances with a somewhat smaller sex differential in access to nutrition and health care among adults, is responsible for much of the large imbalance in population sex ratios observed in the 1980s in South Asia, China, the Middle East, and North Africa. The girls and women who have died as a result of this differential access have been called "missing women" by Amartya Sen (1990). Their number, around 1990, was estimated in a study by Stephan Klasen and Claudia Wink to be nearly 88 million, or 7.7 percent of all females in the countries affected. Ten years later the corresponding estimated figures were 94 million and 6.8 percent (see Table 1). Sex-specific neglect appears to have declined slightly during the intervening decade in most regions. On the other hand, other forms of sex selection particularly relating to manipulations of the sex ratio at birth have gained ground, most notably in China.

Manipulating the Sex Ratio at Birth

Ordinarily, for biological reasons, there are between 3 and 7 percent more male births than female births, the variation being dependent on the population

TABLE 1

Population Sex Ratios (Males per Female) and Estimates of "Missing Women," for Selected Countries, 1980s and Early 1990s and around 2000

	1980s and early 1990s				Around 2000			
			Missing Women				Missing Women	
	Year	Sex ratio	Number (millions)	Percent	Year	Sex ratio	Number (millions)	Percent
China	1990	1.060	34.6	6.3	2000	1.067	40.9	6.7
Taiwan	1990	1.071	0.7	7.3	1999	1.049	0.5	4.7
India	1991	1.079	38.4	9.4	2001	1.072	39.1	7.9
Pakistan	1981	1.105	4.3	10.8	1998	1.081	4.9	7.8
Bangladesh	1981	1.064	4.6	8.9	2001	1.038	3.7	6.9
Nepal	1981	1.050	0.6	7.7	2001	0.997	0.1	0.5
West Asia	1985	1.073	3.9	7.1	2000	1.043	3.8	4.2
Afghanistan	1979	1.059	0.6	9.7	2000	1.054	1.0	9.3
Egypt	1986	1.049	1.2	5.1	1996	1.048	1.3	4.5
Total			88.9	7.7			95.2	6.9

SOURCE: Klasen and Wink (2002).

group in question and on the prevailing fertility and health patterns. The sex ratio at birth can be manipulated, however, through sex-selective abortion following detection of the sex of the fetus. The latter can be achieved using amniocentesis, chorionic villi sampling (CVS), or ultrasound screening. The first two of these methods have a 100 percent reliability, but are invasive and thus risky (with around 1% risk of pregnancy loss). They can only be conducted between 12 and 20 weeks of gestation, and are fairly costly. Ultrasound screening is less expensive and virtually without risk; it is routinely performed during prenatal check-ups. Sex detection is simply based on visual inspection of the fetus on the screen. This method of detection is never fully reliable and is particularly error-prone in the first 20 weeks of pregnancy. When the tests are performed with the intent of subsequent sex-selective abortions, all three methods allow only late-term abortions (15-25th week) with significant health risks to the mother and serious ethical questions, as discussed below.

Ultrasound screening spread rapidly in China in the 1980s as ultrasound machines became available even in remote areas of the country. As shown by Judith Banister and Ansley J. Coale in 1994, sex-specific abortion based on ultrasound results has since become the method of choice in China for parents complying with the government's one-child policy to ensure that their child is of the desired sex, usually a boy. The practice is believed to be the major factor in China's very high recorded sex ratio at birth, which exceeded 1.16 in the 2000 Census, and in the large and growing "missing" female population (see Table 1). In India, recent data on the sex ratio at birth and among children very likely also reflect an increasing prevalence of sex-selective abortions as parents shift from post-birth to pre-birth sex selection strategies, particularly based on ultrasound detection. The governments of both China and India have prohibited prenatal sex determination in order to prevent sex-selective abortion, although the measures are readily circumvented as shown by Ashish Bose in 2001.

New Developments and Technologies

Technological advances allow even earlier selection of the sex of offspring than through ultrasound screening and sex-selective abortion. In one method in use in some industrialized countries, sex selection takes place in the context of in-vitro fertilization (IVF). Multiple fetuses are created in vitro, their sex is determined, and those of the desired sex are implanted. This method is complex and expensive and might reduce the success rate of the IVF procedure, but it is highly reliable. Thus far it is chiefly used by parents who are at high risk of transmitting a sex-linked genetic disease to their children. A second method, less costly and invasive, involves separation of sperm into those carrying X and Y chromosomes and intrauterine injection of the selected sperm to produce offspring (X for female, Y for male). Clinical trials reported by E. F. Fugger and his colleagues in 1998 suggest a 70 to 90 percent success rate. While sex-specific implantation in the context of IVF is unlikely to spread to poor countries, sperm-sorting methods such as the ones currently being used might, if the costs can be lowered and success enhanced, eventually replace or at least accompany sex-selective abortions as the method of choice for parents, particularly those with high son preference.

Ethical Issues

Sex selection raises a number of ethical issues concerned with motivation, methods, and outcomes. The competing rights of parents and children (or fetuses) are central in an evaluation of various sex selection techniques.

While the goal of "balancing" the gender composition of a family might not be objectionable, deciding to only have children of a particular sex (often male) implies that parents value human beings differently depending on their sex. This motivation violates the precept of equal rights to life for all, which is common to most conceptions of human rights. This in itself might justify corrective action on the part of the state, even if there were not a societal interest in maintaining a rough gender balance in the population at large. In addition, the various methods of sex selection also have different ethical implications, depending on the likely outcome for the disfavored sex. In the case of adopting away daughters, considerable harm is likely to occur for those girls, but the harm done to the disfavored sex is less clear in the case of fertility strategies, although it is probable that families that first had several girls before the desired boy was born will treat their daughters worse than the favored boy. Post-birth methods of infanticide and differential neglect are ethically most objectionable as they ultimately lead to the death of a child purely because of its sex. Thus there are strong grounds for state action to combat the problem of "missing women" as it ultimately kills girls and women, whose rights surely trump the rights of parents for sex selection of their off-spring.

The ethical status of the various methods of prebirth sex selection is more complicated. It overlaps with the broader ethical debate surrounding abortion in general. Some would argue that the reproductive rights of parents (in particular, of women) are as important or even more important than the right to life of the fetus so that any abortion, even one done for sex selection, should be permissible. As discussed by John A. Robertson in 2001, others argue that the motivation of sex selection is objectionable and thus find sex-selective abortions unethical, even if they would find abortions for other reasons acceptable. Whatever ethical stance is taken on early-term abortion, many would see the recourse to late-term abortion for sex-selection purposes, which is the current practice, as deeply objectionable. However, the rights of a fetus would generally be deemed to exceed those of a fertilized egg before implantation, and sperm sorting would, according to Robertson, be therefore considered the least ethically problematic method of pre-birth sex selection.

Where strong gender preferences exist, there may be a case for tolerating use of a pre-birth sex selection method such as sperm sorting while at same time seeking to change the underlying social influences that result in different valuation of offspring by sex.

See also: *Feminist Perspectives on Population Issues; Gender Preferences for Children; Reproductive Rights; Reproductive Technologies: Modern Methods, Ethical Issues; Women's Status and Demographic Behavior.*

BIBLIOGRAPHY

Banister, Judith, and Ansley J. Coale. 1994. "Five Decades of Missing Females in China." *Demography* 31: 459–479.

Bose, Ashish. 2001. "Fighting Female Foeticide." *Economic and Political Weekly* 36: 3,427–3,429.

Fugger, E. F., S. H. Black, K. Keyvanfar, and J. D. Schulman. 1998. "Births of Normal Daughters after MicroSort Sperm Separation and Intrauterine Insemination, In-vitro Fertilization, or Intracytoplasmic Sperm Injection." *Human Reproduction* 13: 2,367–2,370.

Hausfater, Glenn, and Sarah Bluffer Hrdy, eds. 1984. *Infanticide: Comparative and Evolutionary Perspectives.* New York: Aladine.

Johansson, Sten, and Ola Nygren. 1991. "The Missing Girls of China: A New Demographic Account." *Population and Development Review* 17: 35–51.

Klasen, Stephan, and Claudia Wink. 2002. "A Turning Point in Gender Bias in Mortality? An Update on the Number of Missing Women." *Population and Development Review* 28: 285–312.

———. 2003. "Missing Women: Revisiting the Debate." *Feminist Economics* (March).

Registrar General. 2001. "Provisionary Population Totals." *Census of India Series 1*, Paper 1 of 2001. New Delhi: Ministry of Home Affairs.

Robertson, John A. 2001. "Preconception Gender Selection." *American Journal of Bioethics* 1(1): 2–19.

Sen, Amartya. 1990. "More than 100 Million Women Are Missing." *New York Review of Books,* 20 December.

Stephan Klasen

SEXUALITY, HUMAN

Population-based studies of human sexuality investigate the sexual expression of women and men at different stages of the life course and across groups and societies. Sexual expression is composed of sexual functions, or capacities, of males and females; sexual behaviors, both partnered and alone; and sexual attitudes—interests, preferences, and beliefs about sexuality. Identifying and investigating biological, psychocognitive, demographic, and sociocultural determinants of sexual expression as well as the interrelationships among sexual attitudes, behavior, and function are a central concern. This research also assesses the consequences of sexual expression, which include but are not limited to effects on wellbeing, health, relationship quality, sexual satisfaction, fertility, the stability of sexual partnerships, and the transmission of sexually transmitted infections (STIs), especially HIV and AIDS.

In the 1990s the increasing availability of large-scale probability samples on sexual behavior, a result of international concern about HIV/AIDS, facilitated advances in the study of human sexuality. Studies employing nationally representative data on adult sexual behavior were published for several developed countries, including Great Britain, Finland, France, and the United States, along with cross-national comparisons of European, African, and Asian countries. The United States in particular has conducted additional large-scale, representative-sample surveys featuring modules on sexual behavior—the National AIDS Behavioral Survey, the National Survey of Adolescent Males, the National Survey of Men, the National Survey of Women, the General Social Survey, and the National Longitudinal Study of Adolescent Health—which represent vast improvements over research derived from convenience, local community, or self-selected samples.

These studies also marked the emergence of human sexuality as a distinct topic in population studies. Previously, many researchers had focused only on the limited set of sexual behaviors that are consequential for fertility outcomes (e.g., frequency of coitus, out-of-wedlock fertility, contraceptive practices). Lacking basic information about sexual attitudes and behavior, researchers were spurred by the threat of HIV/AIDS in the 1990s to develop a comprehensive approach focused on sexual expression. Many of these studies collected information on partnered sex, an approach that captured variation in status (e.g., married versus nonmarried), gender, and patterns of multiple partners or sexual networks.

Basic Concepts

Sexual expression has sociocultural, psychocognitive, emotional, physiological, and behavioral dimensions. It encompasses the content of sexual action: how people think about sex, what they do sexually, and the concomitant psychophysiological states. Sexual attitudes are the beliefs, preferences, and interests individuals express about sexual issues, conduct, and partners. Sexual behaviors specify the sexual practices individuals engage in alone, with another person, or with multiple others. Sexual functioning refers to how individuals experience sexual desire, pleasure, and other psychophysiological states associated with the sexual response cycle.

Although researchers recognize the significance of biological factors, particularly physiology, maturation, and aging, on sexuality, those working from a population perspective tend to emphasize the social control, or social organization, of sexuality. Of particular importance are institutional controls—religion, kinship, law, and medicine—and traditional demographic attributes, such as ethnicity, which imbue cultural meanings into sexual behavior, thus defining the proximate costs and benefits of sexual choices. Population-based research increasingly focuses on sexual partnerships as well as partnership networks as a key feature of sexual expression.

TABLE 1A

Prevalence of Same-Gender and Opposite Gender Partners (percentages)

	Partners in Last Year		Partners since Age 18		Partners since Puberty	
	Men	Women	Men	Women	Men	Women
No partners	10.5	13.3	3.8	3.4	3.3	2.2
Opposite gender only	86.8	85.4	91.3	92.5	90.3	94.3
Both men and women	0.7	0.3	4.0	3.7	5.8	3.3
Same gender only	2.0	1.0	0.9	0.4	0.6	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
Any same-gender sex (%):						
Both men and women	25.3	25.0	81.6	89.9	90.7	94.9
Same gender only	74.7	75.0	18.4	10.1	9.3	5.1
Total	100.0	100.0	100.0	100.0	100.0	100.0
Total *N*	*3,494*	*4,376*	*3,073*	*3,853*	*1,334*	*1,678*

Note: Partner variables (last year, since eighteen and since puberty). "Partners since puberty" is based on age of first vaginal intercourse and age of first same-gender partner from NHSLS.

SOURCE: Laumann et al. 1994:311.

Sexual Expression

Reflecting the social and institutional bases of sexuality, a central research area in human sexuality is the comparative analysis of sexual expression. Key sources of variation include cross-national, intrasocietal, historical, and life-course stage differences. Because the United States currently has the most comprehensive data on sexual expression, including national probability samples of adolescents, adults, and high-risk groups, the following sections rely heavily on illustrative U.S. results. Reflecting the dominant research strategies in the literature, this section reviews each facet of sexual expression separately, although it should be kept in mind that sexual functioning, behavior, and attitudes are interrelated phenomena.

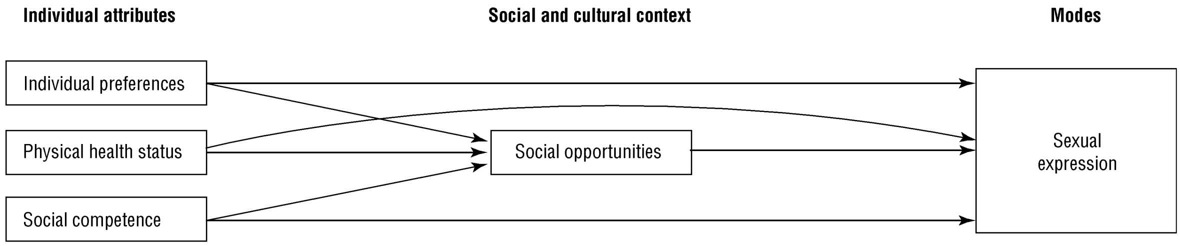
For example, homosexuality, which has attracted heated debate about its meaning, prevalence, and etiology, can be decomposed into three dimensions: desire, behavior, and identity. Tables 1a and 1b provide an overview of the prevalences of these dimensions. However, it should be stressed that asking people about homosexuality is fraught with difficulties because its stigmatization in popular opinion is likely to produce systematic biases towards underreporting in responses to survey questions.

Sexual attitudes. Sexual attitudes refer to the beliefs, preferences, and interests individuals hold about sexual conduct. Although sexual attitudes are culturally contingent, scholars have focused primarily on a limited set of attitudes: premarital sex, teenage sex, extramarital sex, and homosexuality. Research concentrates on two topics: (1) sexual permissiveness and (2) normative orientations. The first approach, pioneered by Ira Reiss, assesses levels of permissiveness for various sexual issues, including premarital sex and extramarital sex. In contrast, the normative orientations approach does not assume a one-dimensional scale of permissiveness; instead, it focuses on identifying different types of sexual regimes. Edward O. Laumann and colleagues (1994), for example, found three major classes in the United States: traditional, relational, and recreational orientations. Cross-national variation is even more dramatic. Eric D. Widmer et al. (1998) grouped countries into one of three major sexual regimes with reference to attitudes toward nonmarital sex—teen permissives (Germany, Austria, Sweden, Slovenia), sexual conservatives (United States, Ireland, Poland), and homosexual permissives (Netherlands, Norway, Czech Republic, Canada, Spain)—along with a heterogeneous residual category composed of countries with moderate sexual attitudes (Australia, Great Britain, Hungary, Italy, Bulgaria, Russia, New Zealand, Israel) and two isolates (Japan, Philippines).

Sexual behaviors. Sexual behavior covers autoeroticism, partnered sex, and the relationship between these two dimensions of sexual life. The central finding on autoerotic activity is the much greater incidence of such activity in men than in women.

FIGURE 1

A Model of the Determinants of Sexual Expression



SOURCE: Laumann and Youm (2001).

Major aspects of partnered sex include the number of sexual partners, the frequency of sex, sexual practices, the relational dimensions of sexual behavior, homosexuality, formative sexual experiences, and risk-related behaviors. Table 2 shows that partnered sex among Americans is remarkably conventional. The vast majority of Americans have only one sex partner over a one-year period, have few sexual partners in adulthood, have sex only occasionally, and engage in a limited set of sexual practices. Despite what appears to be a modest amount of sex, Americans are generally happy with their sex lives and their partners. Laumann et al. (1994) also focus on the prevalence of sexual practices relevant for the transmission of disease, such as vaginal, oral, and anal sex, as well as how certain sexual behaviors are correlated with types of sexual partnerships (e.g., marriages and monogamy). Findings about the prevalence of homosexuality and the impact of formative sexual experiences, such as sexual debut, forced sex, and adult and adolescent sexual contacts with children, have been published as well. Finally, a central topic in the demography of sexual behavior is the study of other risk-related behaviors of HIV/AIDS transmission, such as condom use, having paid sex, multiple partnering, and prior experience with STIs.

Sexual functioning. Sexual functioning covers individuals' experiences with sexual desire, sexual pleasure, and psychophysiological changes associated with the sexual response cycle. Demographic research focuses on three topics: sexual maturation, sexual problems, and the use of contraceptives, drugs, and sterilization procedures. Because the transition to sexual maturity has extensive implications for sexual behavior and fertility, researchers are interested in trends, variation, and determinants of the pubertal development of males and females. Also associated with aging, but in a surprisingly more limited way than was expected, an emerging area of research focuses on sexual dysfunctions—disturbances in sexual desire and in the psychophysiological changes associated with the sexual response cycle. Laumann, Anthony Paik, and Raymond C. Rosen (1999) concluded that sexual problems are quite common among the U.S. adult population 18 to 59: More than 40 percent of adult women and 30 percent of adult men reported sexual problems of several months' duration during a 12-month period. Research on the cross-national and historical patterning of sexual problems is scanty, but new studies under way in 2003 will begin to remedy this situation.

A central development regarding sexual functioning is the availability of new technologies—contraceptives, drugs, and sterilization procedures—that directly affect the sexual response or reproductive cycles. Contraceptive and sterilization practices are traditionally covered in the study of fertility control, yet these technologies are significant for human sexuality, since their adoption severs the link between sex and fertility in many countries and directly affects sexual function. Another technological development is the introduction of drugs designed to enhance sexual performance, but little is known about this trend.

Determinants of Sexual Expression

When investigating determinants, most researchers have focused on one aspect or a few aspects of sexual expression. Alternatively, sexual expression can be approached as an integrated entity in which sexual attitudes and functioning act as proximate determinants for partnered and autoerotic sexual behaviors. Laumann and Yoosik Youm (2001) identify four broad classes of determinants, displayed in Figure 1: (1) individual preferences for particular sexual experiences, (2) state of physical health and capacity to engage in particular sexual activities, (3) competence to initiate and maintain social relationships of various sorts, and (4) social opportunities to secure appropriate sex partners. Subjective preferences refer to interests and beliefs about sexual conduct and derive from normative orientations. People with impaired physical or mental health (e.g., erectile or other sexual dysfunctions) may not be able to engage in certain patterns of sexual expression regardless of their preferences. Social competence refers to individuals' skills at and resources for initiating and maintaining ongoing sexual partnerships. These skills include communication and people-handling skills, time, money and goods, and reputation. Finally, these individual-level attributes are theorized to jointly affect the social contexts, or opportunities, in which sexual behavior is embedded. These contexts include the type of partnerships individuals are able to form, mode of meeting, participation in certain social scenes, and social membership factors.

Outcomes of Sexual Expression

There are substantial literatures linking specific aspects of sexual expression to health-related outcomes, such as the transmission of STIs, behavioral responses to HIV/AIDs, well-being, and family-related outcomes, including marital and nonmarital fertility, fertility control (e.g., abortion), and the dissolution of sexual partnerships. This section focuses on two of these outcomes: STIs/HIV and abortion.

STIs/HIV. An emerging paradigm in the study of the transmission of STIs and HIV is the integration of network approaches with survey data on partnered sex. Utilizing Martina Morris's (1993) epidemiological models, Laumann and Youm (1999) not only analyzed individual-level risk factors related to sexual expression, such as the number of partners, but also accounted for the potential infection status of partners as well as transmission dynamics related to the spread of STIs across socially distinct populations. A second area in the demography of human sexuality is the study of responses to the HIV/AIDs epidemic.

TABLE 1B

Prevalence of Sexual Identity and Sexual Attraction, by Gender (percentages)

	Men	Women
Sexual Identity		
Heterosexual	96.9	98.6
Bisexual	0.8	0.5
Homosexual	2.0	0.0
Other	0.3	0.1
Total	100.0	100.0
Total *N*	*1,401*	*1,732*
Sexual Attraction		
Only Opposite gender	93.8	95.6
Mostly opposite gender	2.6	2.7
Both genders	0.6	0.8
Mostly same gender	0.7	0.6
Only same gender	2.4	0.3
Total	100.0	100.0

SOURCE: Laumann et al. 1994, p. 311.

Abortion. The demography of human sexuality has led to better information linking sexual expression to fertility control. Before the emergence of national data sets on sexual behavior, little was known about this link, since few data sets collected comprehensive data on sexual attitudes and behavior. In one of the few national studies of abortion in the United States, Robert T. Michael (2001) found that economic and social incentives for having children, as well as having sexual attitudes against the legalization of abortion, had strong negative effects on the likelihood of this practice. Comparing several high-quality surveys with data reported by abortion providers and compiled by the Alan Guttmacher Institute (AGI), Elise F. Jones and Jacqueline Darroch Forrest (1992) found that survey-reported abortions were systematically and substantially underestimated. Indeed, underreporting of socially stigmatized, sex-related behaviors is a general methodological problem for research on the demography of human sexuality.

Future Issues for the Demography of Human Sexuality

Professional and public interest in human sexuality was sparked most recently by the threat of HIV/AIDS. In addition to the growing prevalence of HIV/AIDS, several trends highlight the continuing need for population-based data on sexual behavior. As an example, the United States underwent dramatic changes in sexual attitudes, sexual practices, and

TABLE 2A

Summary Finding that the Sexual Behavior of Most Adults in the United States is Remarkably Conventional

A. THE VAST MAJORITY OF THE US POPULATION AGED 18 TO 59 HAS ONLY ONE SEX PARTNER WITHIN A YEAR

	Number of Sex Partners in the Past 12 Months (Percent)			
	0	1	2-4	5+
All	11.9	71.1	13.7	3.2
Men	9.9	66.7	18.3	5.1
Women	13.6	74.7	10.0	1.7

B. THE MEDIAN NUMBER OF SEX PARTNERS SINCE AGE 18 IS 2 FOR WOMEN AND 6 FOR MEN

	Number of Sex Partners since Age 18 (Percent)						
	0	1	2-4	5-10	11-20	21+	Median
All	2.9	26.1	29.5	21.7	10.6	9.2	3
Men	3.4	19.5	20.9	23.3	16.3	16.6	6
Women	2.5	31.5	36.4	20.4	6.0	3.2	2

C. AMERICANS HAVE SEX NOT ALL THAT FREQUENTLY - FEWER THAN 2 TIMES A WEEK, ON AVERAGE

	Frequency of Sex in the Past Year (Percent)				
	Not at All	A Few Times a Year	A Few Times a Month	2-3 Times a Week	4+ Times a Week
Men	9.8	17.6	35.5	29.5	7.7
Women	13.6	16.1	37.2	26.3	6.7

D. A LARGE MAJORITY OF AMERICANS DO NOT FIND MANY SEX PRACTICES VERY APPEALING, SO THEY ENGAGE IN A RATHER LIMITED REPERTOIRE OF SEXUAL ACTIVITIES

	Percentage Saying Practice is Very Appealing		Percentage Engaged in Practice: Last Event		Percentage Engaged in Practice: Ever in Lifetime	
	Men	Women	Men	Women	Men	Women
Vaginal intercourse	83.8	76.8	94.6	95.6	95.0	97.0
Watching partner undress	47.8	26.8				
Receiving oral sex	45.0	28.8	27.5	19.9	78.7	73.1
Giving oral sex	33.5	16.5	26.8	18.8	76.6	67.7
Group sex	13.3	1.1				
Using a dildo or vibrator	4.4	2.9				
Watching others have sex	5.3	1.5				
Same-gender sex	3.2	2.9	2.7*	1.3*	4.9*	4.1*
Having sex with a stranger	4.1	0.9				
Anal intercourse	2.8	1.0	2.3	1.2	25.6	20.4
Forcing someone to have sex	0.3	0.2			2.8	1.5
Being forced to have sex	0.1	0.1			3.9	22.8

*For same-gender sex the columns reflect "last 12 months" not last event, and lifetime since age 18.

[continued in Table 2B]

marital behavior in the last decades of the twentieth century. U.S. sexual attitudes continue to be liberalized, the median number of lifetime partners continues to increase, and individuals spend as much as one-quarter of their pre-age-60 adult lives as sexually active singles. Taken together, these trends suggest that sexual expression in the United States is still changing, perhaps making sexual markets more important than marriage markets. Indeed, HIV/AIDS and the changing nature of sexual expression will continue to make the demography of human sexuality an important research concern.

See also: *AIDS; Birth Control, History of; Contraceptive Prevalence; Culture and Population.*

TABLE 2B

Summary Finding that the Sexual Behavior of Most Adults in the United States is Remarkably Conventional

E. YET DESPITE THE MODEST AMOUNT OF SEX, THESE SAME MEN AND WOMEN REPORT THEMSELVES TO BE QUITE HAPPY WITH THEIR SEX LIVES AND WITH THEIR PARTNERS

	Satisfaction with Sex Life (%)		
	Extremely or Very Happy	Generally Satisfied	Unhappy
All	57.7	29.2	13.1
No. of Sexual Partners in Past 12 Months			
Zero	40.7	35.4	23.9
One	63.4	27.2	9.4
Two-Four	44.9	32.7	22.4
Five +	47.2	37.1	15.7
Frequency of Sex in Past 12 Months			
None	39.5	36.7	23.8
1-12 time/year	45.6	32.8	21.6
2 -3 times/month or once/wk	59.2	29.3	11.5
2-3 times/week	69.0	25.1	5.9
4+ times/week	64.5	22.0	13.6

	Satisfaction with Partner (%)						
			Partner Made Respondent Feel				
	Physically Pleased*	Emotionally Pleased*	Satisfied	Loved	Thrilled	Wanted	Taken Care of
Had Only One Partner							
Spouse	87.4	84.8	97.1	97.5	90.9	92.2	89.9
Cohabitant	84.4	75.6	95.5	95.2	89.6	88.2	84.0
Neither	78.2	71.0	92.9	87.6	90.8	87.1	76.0
Had More than One Partner							
Primary Spouse	61.2	56.7	88.1	86.4	77.6	77.6	68.7
Cohabitant	74.5	57.9	90.5	86.2	91.6	85.1	78.7
Neither	77.9	61.7	92.8	83.9	86.6	84.8	72.8
Secondary Partner	54.3	33.0	81.6	48.4	75.6	66.7	53.1

*Percentage "extremely" or "very" pleased or satisfied

SOURCE: Laumann and Michael (2001), pp.16–18.

BIBLIOGRAPHY

Bancroft, John. 1994. "Sexual Motivation and Behavior." In *Companion Encyclopedia of Psychology,* ed. Andrew M. Colman. London: Routledge.

———. 1995. "Sexuality and Family Planning." In *Handbook of Family Planning and Reproductive Health Care,* eds. N. B. Loudon, A. F. Glasier and A. Gebbie. Edinburgh: Churchill Livingston.

Bearman, Peter S., and Hannah Bruckner. 2001. "Promising the Future: Virginity Pledges and First Intercourse." *American Journal of Sociology* 106: 859–912.

Billy, John O. G., Koray Tanfer, William R. Grady, and Daniel H. Klepinger. 1993. "The Sexual Behavior of Men in the United States." *Family Planning Perspectives* 25: 52–60.

Browning, Christopher, and Edward O. Laumann. 1997. "Sexual Contact between Children and Adults: A Lifecourse Perspective." *American Sociological Review* 62: 540–560.

Catania, Joseph A., Thomas J. Coates, Ron Stall, Heather A. Turner, and J. Peterson. 1992. "Prevalence of AIDS-Related Risk Factors and Condom Use in the United States." *Science* 248: 1,101–1,106.

Catania, Joseph A., David R. Gibson, Dale D. Chitwood, and Thomas J. Coates. 1990. "Methodological Problems in AIDS Behavioral Research: Influences on Measurement Error and Participation Bias in Studies of Sexual Behavior." *Psychological Bulletin* 108: 339–362.

Cleland, John, and Benoît Ferry, eds. 1995. *Sexual Behaviour and AIDS in the Developing World.* London: Taylor and Francis.

DeLamater, John. 1981. "The Social Control of Sexuality." *Annual Review of Sociology* 7: 263–290.

Feinleib, Joel A., and Robert T. Michael. 1998. "Reported Changes in Sexual Behavior in Response to AIDS in the United States." *Preventive Medicine* 24: 400–411.

Halpern, Carolyn T., Kara Joyner, J. Richard Udry, and Chirayath Suchindran. 2000. "Smart Teens Don't Have Sex (or Kiss Much Either)." *Journal of Adolescent Health* 26: 213–225.

Hubert, Michel, Nathalie Bajos, and Theo Sandfort. 1998. *Sexual Behaviour and HIV/AIDS in Europe: Comparison of National Surveys.* London: UCL Press.

Johnson, Anne M., Jane Wadsworth, Kaye Wellings, and Julia Field. 1994. *Sexual Attitudes and Lifestyles.* Oxford: Blackwell Scientific Publications.

Jones, Elise F., and Jacqueline Darroch Forrest. 1992. "Underreporting of Abortion in Surveys of U.S. Women: 1976 to 1988." *Demography* 29: 113–126.

Kontula, Toimittaneet Osmo, and Elina Haavio-Mannila. 1993. *Suomalainen Seksi.* Helsinki: Werner Soderstrom Osakeyhtio.

Laumann, Edward O. 2001. "Sexual Expression in America." In *Sex, Love, and Health: Private Choices and Public Policy,* ed. E. O. Laumann and R. T. Michael. Chicago: University of Chicago Press.

Laumann, Edward O., John H. Gagnon, Robert T. Michaels, and Stuart Michael. 1994. *The Social Organization of Sexuality: Sexual Practices in the United States.* Chicago: University of Chicago Press.

Laumann, Edward O., and Robert T. Michael. 2001. *Sex, Love, and Health: Private Choices and Public Policy.* Chicago: University of Chicago Press.

Laumann, Edward O., Anthony Paik, and Raymond C. Rosen. 1999. "Sexual Dysfunction in the United States: Prevalence and Predictors." *Journal of the American Medical Association* 281: 537–544.

Laumann, Edward O., and Yoosik Youm. 1999. "Race/Ethnic Group Differences in the Prevalence of Sexually Transmitted Diseases in the United States." *Sexually Transmitted Diseases* 26: 250–261.

Michael, Robert T. 2001. "Abortion Decisions in the United States." In *Sex, Love, and Health: Private Choices and Public Policy,* ed. E. O. Laumann and R. T. Michael. Chicago: University of Chicago Press.

Michael, Robert T., Jane Wadsworth, Joel A. Feinleib, Anne M. Johnson, Edward O. Laumann, and Kaye Wellings. 1998. "Private Sexual Behavior, Public Opinion, and Public Health Policy Related to Sexually Transmitted Diseases." *American Journal of Public Health* 88: 749–754.

Michaels, Stuart, and Alain Giami. 1999. "Sexual Acts and Sexual Relationships: Asking about Sex in Surveys." *Public Opinion Quarterly* 63: 401–420.

Morris, Martina. 1993. "Epidemiology and Social Networks: Modeling Structured Diffusion." *Sociological Methods and Research* 22: 99–126.

Reiss, Ira L. 1967. *The Social Context of Premarital Sexual Permissiveness.* New York: Holt, Rinehart, and Winston.

Reiss, Ira L., Ronald E. Anderson, and G. C. Sponaugle. 1980. "A Multivariate Model of Determinants of Extramarital Permissiveness." *Journal of Marriage and the Family* 42: 395–411.

Resnick, Michael D., Peter S. Bearman, Robert W. Blum, Karl E. Bauman, et al. 1997. "Protecting Adolescents from Harm: Findings from the National Longitudinal Study on Adolescent Health." *Journal of the American Medical Association* 278: 823–832.

Smith, Tom W. 1991. "Adult Sexual Behavior in 1989: Number of Partners, Frequency of Intercourse and Risk of AIDS." *Family Planning Perspectives* 23: 102–107.

Sonenstein, Freya L., Joseph H. Pleck, and Leighton C. Ku. 1989. "Sexual Activity, Condom Use and AIDs Awareness among Adolescent Males." *Family Planning Perspectives* 21: 152–158.

———. 1991. "Levels of Sexual Activity among Adolescent Males in the United States." *Family Planning Perspectives* 23: 162–167.

Spira, Alfred, Nathalie Bajos, and the ASCF Group. 1994. *Sexual Behavior and AIDS.* Aldershot, Eng.: Avebury.

Tanfer, Koray, and Jeannette J. Schoorl. 1992. "Premarital Sexual Careers and Partner Change." *Archives of Sexual Behavior* 21: 45–68.

Udry, J. Richard, and R. L. Cliquet. 1982. "A Cross-Cultural Examination of the Relationship between Ages at Menarche, Marriage, and First Birth." *Demography* 19: 53–63.

Westoff, Charles F., and Norman B. Ryder. 1977. *The Contraceptive Revolution.* Princeton, NJ: Princeton University Press.

Widmer, Eric D., Judith Treas, and Robert Newcomb. 1998. "Attitudes toward Nonmarital Sex in 24 Countries." *Journal of Sex Research* 35: 349–358.

Edward O. Laumann
Anthony Paik

SIMON, JULIAN L.

(1932–1998)

During most of the last quarter of the twentieth century Julian Simon was the best-known population economist in the world. Simon graduated from Harvard in 1953 with a degree in experimental psychology. His career began in the U.S. Navy, where, as he would later recount, he learned to distrust authority and the conventional wisdom it represented. Switching to business, he completed a master's of business administration degree at the University of Chicago in 1959 and a doctorate in business economics at the same institution in 1961. For the last 15 years of his life he was a professor of business administration at the University of Maryland.

Simon's intellectual output was enormous and diverse. His early work was in the economics of advertising and included a best-selling trade paperback, *How to Start and Operate a Mail Order Business* (1965). In a single year (1993) he proposed both a radical new approach to the teaching of statistics and a method for overcoming psychological depression. His research regularly appeared in major economics journals. (Some 80 articles published from 1965 to 1995 are collected in *Economics against the Grain* [1999].)

Simon's early work in population dealt mostly with the economics of fertility and was not controversial. He was a co-editor of the first four volumes (1978–1982) of the series *Research in Population Economics.* However, Simon primarily is known not for his output of original scientific research but for his polemical attacks on Malthusians and environmentalists, those who argue that population growth stifles economic development and harm the environment.

Simon's critique, best captured in *The Ultimate Resource* (1981, 1996), had several thrusts. First, he was a committed utilitarian who argued that individuals might rationally prefer having many children to having a high level of material wealth or a clean environment. "It All Depends on Your Values" was the title of one section of *The Ultimate Resource.* In the controversial introduction to that book Simon recounted how his conversion from a pessimistic to an optimistic view of population arose from a highly subjective emotional midlife experience.

Second, Simon argued that Malthusians systematically underplayed the importance of economies of scale and of agglomeration and the positive contribution of population pressure to technological innovation. Third, Simon had a passion for extremely long-term time-series data (for a range of welfare measures such as life expectancy and the real prices of natural resources), which in his view delivered the clear message that things were getting better, not worse. Fourth, he was an advocate of looking at all the data at the same time. Although some data series might show adverse trends, taken as a whole, the data delivered an optimistic message. This was the main theme of his second best-selling book, an edited volume (with Herman Kahn) entitled *The Resourceful Earth* (1984), a rejoinder to the pessimistic report of President Carter's *Global 2000* commission.

Simon became the favorite professional authority as well as fiery ideologue of the *laisssez-faire* Reagan right as in dozens of articles in the popular press, television appearances, and lectures across the country he castigated what he called "the population establishment." In the later 1980s Simon added the economics of immigration to his interests. He became an advocate of the free movement of labor and argued in *The Economic Consequences of Immigration to the U.S.* (1989) that anti-immigration advocates systematically overestimated the costs and underestimated the benefits of immigration to the United States.

Like most polemicists, Simon thrived on exaggeration. He endorsed often wildly speculative arguments (for example, that a larger population meant more geniuses and thus more technological innovation). He engaged in publicity stunts such as a $1,000 bet with the environmentalist Paul Ehrlich about whether the price of copper and some other raw materials would be higher or lower in five years (Simon won). When in 1986 the U.S. National Academy of Sciences published a report refuting the conventional pessimism about the impact of rapid population growth on economic development, Simon accused the authors of having pulled their punches.

Will Simon's work stand the test of time? He was an excellent economist, and in his emphasis on scale effects and other nonlinearities, he anticipated much subsequent work in economic growth theory. However, nonlinearities can be used to argue against population growth as well as in favor of it. Perhaps Simon will be remembered primarily as an antidote to the gloom-and-doom excesses of the "Population Bomb" school of thought that flourished in the 1970s.

See also: *Economic-Demographic Models; Immigration, Benefits and Costs of; Natural Resources and Population; Population Thought, Contemporary; Technological Change and Population Growth.*

BIBLIOGRAPHY

SELECTED WORKS BY JULIAN L. SIMON.

Simon, Julian L. 1975. "The Population Establishment." In *Comparative Policy Analysis,* ed. R. Kenneth Godwin. Lexington, MA: Lexington Books.

———. 1977. *The Economics of Population Growth.* Princeton, NJ: Princeton University Press.

———. 1981. *The Ultimate Resource.* Princeton, NJ: Princeton University Press.

———. 1986. *Theory of Population and Economic Growth.* New York: Blackwell.

———. 1989. *The Economic Consequences of Immigration to the U.S.* New York: Blackwell.

———. 1990. *Population Matters: People, Resources, Environment, and Immigration.* New Brunswick, NJ: Transaction.

———. 1999. *Economics against the Grain,* 2 vols. Cheltenham, Eng.: Edward Elgar.

———. 1996. *The Ultimate Resource 2.* Princeton, NJ: Princeton University Press.

———. 2002. *A Life against the Grain: The Autobiography of an Unconventional Economist,* ed. Rita J. Simon. New Brunswick, NJ: Transaction.

Simon, Julian L., ed. 1995. *The State of Humanity.* Oxford: Blackwell.

Simon, Julian L., and Herman Kahn, eds. 1984. *The Resourceful Earth: A Response to Global 2000.* New York: Blackwell.

F. Landis MacKellar

SIMULATION MODELS

The term "simulation" is used to refer to a wide range of quantitative analytic strategies in the population sciences. Defining the term is thus a necessary task, but it also turns out to be a conceptually useful exercise. In a broad sense, demographers are nearly always engaged in simulating something. From aggregate population projections and forecasts to behavioral models for family and household formation, demographers use mathematical models to represent (i.e., *simulate*) the population processes and outcomes found in the real world. Using this general definition, simulation rapidly becomes indistinguishable from quantitative analysis, and ultimately applied mathematics. At the other end of the scale, the definition could be restricted to an explicit representation of the population dynamics of a stochastic process (e.g., a birth, or a job loss) that operates at the level of the individual, is not analytically tractable, and thus requires numerical methods for cumulating up to population-level outcomes over time. This definition would limit the term to the kinds of models that have become known as "stochastic microsimulation" and "agent-based modeling," and it would exclude all but a handful of current demographic methods and applications.

In the middle lies a definition that borrows slightly from each: the basic concept of projection from the most general version, and the absence of analytical tractability from the more restricted version. Under this definition, simulation is distinguished by a focus on dynamic modeling, and the need to explicitly calculate each step in the entire path of events to get from a starting to an ending state of the population. It is a projection of the path, rather than a solution for an end state. This definition excludes the standard life table methods for stationary and stable population projection that form the core of most formal demography, as these can be solved analytically for their equilibrium outcomes. It also excludes the statistical analysis of survey data that forms the core of most social demography, as this is focused on estimating the underlying rates and parameters of these processes rather than projecting their population-level outcomes over time. In effect, this definition of simulation excludes both the traditional macro methods of demographic analysis as well as the traditional micro methods.

That does not sound very promising at first glance, but what is left over is actually quite important: the middle ground that links the micro to the macro. Simulation techniques enable the analyst to specify interesting models of individual behavior and to investigate how these patterns interact and aggregate into population-level outcomes over time. Simulation is the social scientist's equivalent of a laboratory. It borrows from the micro level both the attention to individual level processes and the parameters estimated for these processes, without losing sight of the aggregate dynamic outcomes. And it borrows from the macro level the focus on population dynamics, without the constraint that the underlying model be analytically solvable. As a result, simulation allows a much more nuanced, theory-driven approach to investigating some of the most intriguing questions in the population sciences.

States and Rates

All forms of simulation have two basic components in the model: states—a set of classes that define the individuals in the population, and rates—a set of rules that define the dynamics of moving from one state to the next. The states can be indexed by attributes that divide the population into homogeneous classes, like race, years of experience with an employer, or vaccination status. But they can also be indexed at the level of the individual if maximal heterogeneity is desired. In that case, each individual has a unique index. The states can be based on attributes that do not change (sex), that change deterministically (age), or that change probabilistically (first birth) and allow return (marital status).

The rates are dynamic rules that describe the conditions under which events occur, and the states at risk of these events. In the simplest form, these rules can be specified as homogeneous fixed rates, such as a single aggregate fertility, mortality, or unemployment rate. But because most fixed rate systems are analytically tractable, they are typically not analyzed using simulation. Simulation is used instead to analyze settings in which the rates vary in more or less complex ways. They can vary over time, using any parametric or non-parametric specification. They can vary by the state indices described above, much like component projection life tables. And they can vary endogenously as a function of the state of the system, as in models for population growth that build in the carrying capacity of the environment. Rates can be specified in either deterministic or stochastic form.

Macro- and Micro-simulation

The range of models that emerge from these possible variations in states and rates can be grouped into two broad categories: macro-simulation models and micro-simulation models. (Evert van Imhoff and Wendy Post (1998) provide a good discussion of the similarities and differences.) Macro-simulation models divide the population into a limited number of states, with deterministic transition rates between states. Such models typically translate into a set of ordinary differential equations (often nonlinear) that can be solved numerically through iterative updating. Micro-simulation models operate with the states indexed at the individual level, and events specified as a stochastic process. These translate into an algorithm that can be implemented as a computer-generated Monte Carlo simulation.

A macrosimulation model. To get a feel for the difference, consider a model for the spread of an infectious sexually transmitted disease. A macro-simulation model might look something like Figure 1.

In Figure 1, three population states are *S*, the number of susceptible individuals; *I*, the number of infected individuals; and *D*, the cumulative number of deaths from infection. The two rates that govern transition from the states are R_i, the rate of infection (morbidity), and R_d, the death rate due to infection (mortality). The infection rate is a function of the number of susceptible and infected individuals, and the "force of infection" denoted by β. A simple specification for the force of infection is given by the following:

$$\beta = \frac{c\tau}{(S + I)}$$

which represents the average contact rate c, and the probability of transmission given contact τ, per person $(S + I)$. The death rate is a function of the number of persons infected and the death rate μ. The system of differential equations that describes this process is:

$$\frac{\partial S}{\partial t} = -R_i S = -\beta SI$$

$$\frac{\partial I}{\partial t} = R_i S - R_d I = \beta SI - \mu I$$

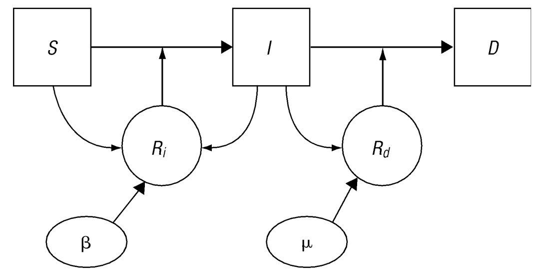
$$\frac{\partial D}{\partial t} = R_d I = \mu I$$

If the force of infection, β, is fixed, this system is analytically tractable, and one can solve for the usual quantities such as the reproduction rate, doubling time, and equilibrium prevalence. Norman Bailey's classic text (1957) and Roy Anderson's more recent volume (1982) are good references for these methods. But a slightly more realistic model would also include vital dynamics, at which point obtaining solutions for *S(t), I(t),* and *D(t)* will require numerical methods.

To implement this model, one needs to specify a set of input parameters for the rates, and initial conditions, such as the starting number in each state. The equations can then be iteratively solved. For each iteration, the value of the state variables will be updated sequentially by the amounts defined by the system of equations above. Because the rates are deterministically specified, the values predicted for *S(t), I(t),* and *D(t)* have no stochastic variability. If the simulation is run repeatedly with the same set of inputs, the results will be identical. Variation is only obtained by varying the inputs (e.g., the components of the rates), and typically a researcher will vary some of the input parameters in order to conduct sensitivity analyses. With complex models that have many inputs, the dependence of the outcomes on the direct and interactive effects of the inputs is often of interest, and becomes an analytic task in its own right. One approach is to use a systematic scheme such as Latin hypercube sampling to generate data on both inputs and outputs; analyzing these data can in turn use more traditional statistical methods to provide numerical summaries of the sensitivity.

FIGURE 1

Macrosimulation Model for the Spread of an Infectious Sexually Transmitted Disease



SOURCE: Author.

It is a relatively straightforward matter to modify models like this to obtain more realistic representations of the process, as there is no constraint that the system of equations remains analytically tractable. In the example above, one could add to the number of states—either breaking out additional states to represent stages of infection (e.g., the primary, latent, and secondary stages of syphilis; the variably infectious periods of HIV; or the acquired immunity of measles), or to represent population subgroups that may partner preferentially (e.g., age groups). The rates can also be modified, adding policy-relevant components like treatment or prophylaxis. Using sensitivity analyses on these rates, one can estimate the potential impact of alternative intervention strategies.

A microsimulation model. A micro-simulation model of this process, by contrast, consists of a repeated set of computer-generated experiments for the partnership and disease processes in which each person, partnership, and disease transmission is explicitly represented.

The procedure consists of the following steps:

1. Create a sample of (for example) 1,000 susceptible persons.
2. Randomly infect one person.
3. Randomly choose *C* pairs of persons without replacement to be the starting couples (which implies serial monogamy).
4. Randomly choose one pair of persons.
5. If these persons are both single: toss a coin with probability ρ, to form a partnership. If they are a couple: toss a coin with probability δ that the partnership is dissolved; if it is a discordant couple (one *S*, one *I*), toss a coin with probability τ that transmission occurs.
6. For each infected person, toss a coin with probability μ, that that person dies.
7. Return to step 3.

Given the probabilistic nature of the events, repeated runs of this micro-simulation model will result in different outcomes. In this particular case, the micro-simulation will lead, on average, to the same solutions for $S(t)$, $I(t)$, and $D(t)$ as the macro-simulation above, as long as the partnership dynamics are set to be consistent with the dynamics implied by the contact rate c in the macro model.

Differences between Micro- and Macro-simulation

For equivalent models of the underlying process, then, the difference between the micro- and macro-simulation is not in the outcomes they project, but in the flexibility they allow to represent the details of the process, and the different kinds of information they provide.

One of these differences is in the treatment of uncertainty. The variation in outcomes produced by repeated runs of the micro-simulation model provides an estimate of the uncertainty inherent in the dynamic process. In some settings this variation can be substantial, and the ability to quantify it very important. While principled methods for estimating the uncertainty associated with deterministic macro-simulation projections have been developed by Adrian Raftery and his colleagues (1995), they require additional effort to implement. For stochastic micro-simulation, the variability is part of the output, and can be analyzed using standard techniques. Another difference is the size of the population that can be modeled—a difference that is reflected in the labels macro and micro.

Macro models, dealing with aggregate subgroups, can be used to simulate arbitrarily large populations. Their limitations are driven by the number of subgroups rather than the number of persons within each subgroup. Micro models, because they represent each individual, are limited in the size of population that can be simulated. But this limitation is also the source of their flexibility. Micro-simulation models make it possible to investigate more complicated and detailed dynamics. In the disease transmission example used above, it is possible simply to relax the monogamy constraint in the micro-simulation to allow for much more complicated partnership network patterns. This requires a small change in the dynamic rule, removing the restriction against partnership formation for persons already in a partnership. The result will be not just the emergence of "two-stars" (a person with two partners), but larger configurations like three-stars, triangles, 4-cycles, and long paths. All of this will come from the relaxation of the constraint, not from explicit parameterization of each form. By contrast, the macro-simulation model would require that each network configuration (that is, each infection composition category) be explicitly broken out and represented as a state, and all of the transitions between the states would need to be specified. Both the model, and the data requirements, quickly become overwhelming.

Computational and Documentation Issues

Advances in computing power and software development have put the simulation toolkit within the reach of most researchers. For those interested in macro-simulation, there are a number of useful packages, like STELLA and Madonna, that allow the programming for macro-simulations to be done using a flexible, intuitive graphical interface, and require only a standard desktop computer. These packages can easily be self-taught, and, like popular statistical packages, they make it possible (for better or worse) to ignore almost all of the mathematical subtleties needed for the solution of the equation system. They allow the researcher to focus on modeling the states and rate functions, where demographic expertise is most important. This also makes them well suited for teaching basic introductory courses on modeling population dynamics. (An example is the text by Hannon and Ruth, included in the Bibliography.)

For those interested in micro-simulation, it is still typically necessary to be able to program in a language like Fortran, C+, or Java. But there are several packages that are useful for demographers, including the following:

- Socsim <http://www.demog.berkeley.edu/~wachter/socstory.html>;
- Lipro <http://www.nidi.nl/research/prj70101.html>;
- UrbanSim <http://www.urbansim.org/papers/Urbansim_Reference_Guide-09.pdf>;
- Swarm <http://www.swarm.org/index.html>; and
- Sugarscape <http://www.brook.edu/dybdocroot/sugarscape/>.

These programs require considerably more sophistication to use than their macro-simulation counterparts, and often use more computing power, but the payoff is much more control over the process being modeled. With the growing interest in these kinds of models in all of the sciences, it is likely that the software technology for micro-simulation modeling will evolve rapidly in coming years. For now, the choice of which model to use should be guided by the nature of the process being modeled, the level of detail needed, and the technical resources available.

One of the challenges posed by simulation models is how to describe them in published analyses. In contrast to standard statistical methods, the programs built to run both macro- and micro-simulations are purpose built, and every analysis is different—both in terms of the state space, and in the specification of the transition probabilities. There is no generally accepted standard for documenting these programs, and there is typically not enough space in published articles to describe the complete set of assumptions and algorithms. One proposed solution is to set up websites associated with journals to publish the programs behind the articles. This approach has been explored by journals like *Nature,* but in general, the question of how to validate and replicate simulation-based research through the standard publication mechanism remains an unsettled issue.

Role of Simulation in Demography

Simulation has been used in many areas of demography, for nearly as long as the computer has been available as a research tool. Examples include population projection, from the classic text by Mindel Sheps and Jane Menken (1973) to more recent volumes (for example, by Wolfgang Lutz, James Vaupel et al, 1999) and the projection of kinship resources under changing fertility (or mortality) regimes by Jane Menken (1985) and Ken Wachter (1997).

To take one instance, this kind of work is likely to play an increasingly important role in understanding the demographic impact of AIDS in populations experiencing a generalized epidemic. The study of the population dynamics of HIV transmission and the demographic consequences of AIDS has stimulated a substantial simulation-based literature, especially in the analysis of transmission networks. Examples include the work of Roy Anderson and Robert May (1988), John Bongaarts (1989), Alberto Palloni (1996), and Martina Morris (1997).

The concept of evolution is rooted in dynamic models, so simulation methods are also found in all areas of the population sciences that deal with evolution, from the population genetics of Hartl and Clark (1989) and the evolutionary biology of Simon Levin (1994) to the models of cultural evolution developed by Eugene Hammel and his colleagues (1979) and Luigi Cavalli-Sforza and Marcus Feldman (1981), and Herb Gintis's (2000) work on evolutionary game theory.

Simulation models have also played a major role in the study of the population-environment system. Examples include the work by Jay Forrester (1969) and Paul Waddell (2002) in urban ecology, and Elinor Ostrom's (1990) work on "governing the commons." In many of these areas, the models of evolutionary social dynamics, freed from the constraints of mathematical convenience, are providing insights into social systems that challenge the findings of general equilibrium models, and hold great promise for theory development in the social sciences. For the first time, the models enable researchers to represent the full range of dynamics induced by social interaction at the individual, institutional, and environmental levels. The research agenda opened by these methods is both daunting and exhilarating.

It would therefore be a mistake to file simulation methods under "advanced mathematical demography" and assume they are the province of a few select wizards and marginal to the field. Demography has always been fundamentally tied to its methods. Formal demography was for many years what distinguished a demographer from other social scientists. But, constrained by the requirements of mathematically tractable solutions, the development of formal demography became increasingly technical and difficult after the 1970s. As a result, the field grew rapidly where the data and the methods were more accessible, and the theory less constrained by the math—in the micro-level analyses that are the hallmark of contemporary social demography. Micro-level research has deepened the roots of demography in its constituent social science disciplines, and given it a stronger base in theories of human behavior. Without the macro-level connection, however, the population is missing from population science. That connection is what simulation has to offer. If there is going to be a vital demography in the future, the simulation methods described here will likely be at its core, linking the micro to the macro. With these new tools, demographers will again be able to explore the frontiers of research on population dynamics, with a set of tools that facilitates theoretically richer models.

See also: *Artificial Social Life; Family Demography; Projections and Forecasts, Population; Stochastic Population Theory.*

BIBLIOGRAPHY

Anderson, Roy M. 1982. *The Population Dynamics of Infectious Diseases.* London: Chapman Hall.

Anderson, Roy M., Robert M. May, et al. 1988. "Possible Demographic Consequences of AIDS in Developing Countries." *Nature* 332: 228–234.

Bailey, Norman T. J. 1975. *The Mathematical Theory of Infectious Diseases.* New York: Hafner Press.

Bongaarts, John. 1989. "A Model of the Spread of HIV Infection and the Demographic Impact of AIDS." *Statistics in Medicine* 8: 103–120.

Cavalli-Sforza, Luigi L., and Marcus W. Feldman. 1981. *Cultural Transmission and Evolution: A Quantitative Approach.* Princeton, NJ: Princeton University Press.

Forrester, Jay Wright. 1969. *Urban Dynamics.* Cambridge, MA: M.I.T. Press.

Gintis, Herbert. 2000. *Game Theory Evolving: A Problem-Centered Introduction to Modeling Strategic Behavior.* Princeton, NJ: Princeton University Press.

Hammel, Eugene A., Chad K. McDaniel, et al. 1979. "Demographic Consequences of Incest Tabus: A Microsimulation Analysis." *Science* 205: 972–977.

Hannon, Bruce, and Matthias Ruth. 1997. *Modeling Dynamic Biological Systems.* New York: Springer.

Hartl, Daniel L., and Andrew G. Clark. 1989. *Principles of Population Genetics.* Sunderland, MA: Sinauer.

Levin, Simon A., ed. 1994. *Frontiers in Mathematical Biology.* New York: Springer-Verlag.

Lutz, Wolfgang, James W. Vaupel and Dennis A. Ahlburg, eds. 1999. *Frontiers of Population Forecasting,* Supplement to Vol. 24 of *Population and Development Review.* New York: Population Council.

Menken, Jane A. 1985. "Age and Fertility: How Late Can You Wait?" *Demography* 22: 469–483.

Morris, Martina. 1997. "Sexual Networks and HIV." *AIDS* 11: S209–S216.

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge, Eng.: Cambridge University Press.

Palloni, Alberto. 1996. "Demography of HIV/AIDS." *Population Index* 62: 601–652.

Raftery, Adrian E., Geof H. Givens, et al. 1995. "Inference from a Deterministic Population Dynamics Model for Bowhead Whales (with Discussion)." *Journal of the American Statistical Association* 90: 402–430.

Sheps, Mindel C., and Jane A. Menken. 1973. *Mathematical Models of Conception and Birth.* Chicago: University of Chicago Press.

van Imhoff, Evert, and Wendy Post. 1998. "Microsimulation Methods for Population Projection." *Population: An English Selection* 10: 97–138.

Wachter, Kenneth W. 1997. "Kinship Resources for the Elderly." *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences* 352: 1,811–1,817.

Waddell, Paul. 2002. "UrbanSim: Modeling Urban Development for Land Use, Transportation and

Environmental Planning." *Journal of the American Planning Association.* 68(3): 297–314.

MARTINA MORRIS

SLAVERY, DEMOGRAPHY OF

The demography of slavery centers significantly on migration—physical migration of the newly enslaved to their place of captivity, and social migration from the status of free person to that of slave or from slavery to freedom. For a long time slavery did not fit easily into studies of demography, because these migrations and changes in status complicated the basic variables of fertility and mortality. Recent advances in demographic techniques, however, have made slavery a feasible and rewarding topic for analysis. Demographic analysis, linked to new research in social history and global history, has resulted in important advances in the analysis of slavery.

This article discusses the methodological development of demographic and historical studies of slavery, recent findings on the historical patterns in slavery since 1500, and current issues in demographic analysis of slavery. The article concludes with notes on slavery before 1500 and the heritage of slavery for society in the early twenty-first century.

Developments in the Study of Slavery

Studies of slavery conducted in the early and mid-twentieth century focused on analyses of slavery in several well-documented settings: the U.S. South, Brazil, the West Indies, and ancient Greece and Rome. More recent work focused on the slave trade and its volume and direction, especially the Atlantic trade, but also that of the Mediterranean and the Indian Ocean. Studies of the slave trade emphasized links among regions (e.g., between Angola and Brazil) and changes in the trade over time.

In the late-twentieth century, the expansion of social-historical analysis allowed the comparative study of legal definitions and social practices of slavery in Africa, the Americas, the Middle East, the Indian Ocean, and Russia. Advances in migration theory and in quantitative demographic techniques (spreadsheets, databases, and simulations) have enabled the new information to be explored more systematically. Slavery can be seen as a global system of labor with significant regional variants.

The Historical System of Slavery in the Modern World

Slavery expanded with the creation of the Atlantic commercial system, and Atlantic slavery brought expansion of slavery in other regions, especially in Africa and the Indian Ocean region. The global system of slave labor reached its peak in the period from 1700 to 1850 and declined thereafter, although slavery remained significant in some regions for another century. The following are brief descriptions of the major regional variants within the global system of slave labor in the modern era.

The Atlantic. Captives were taken from West and Central Africa mainly to Brazil and the Caribbean. In the course of four hundred years, some ten million enslaved persons were landed, creating a population that totaled, around 1850, some six million slaves and many more free people of African descent. North America received just over five percent of all enslaved immigrants, but its slave population in 1850 exceeded three million.

The Mediterranean and the Red Sea. In a trade that began well before 1500 but expanded around 1800, captives were taken from the fringe of the southern Sahara to the Mediterranean coast, and from the upper Nile Valley to Egypt and Arabia. Many but not all of these slaves lived within the territories of the Ottoman Empire. Some four million migrants over four centuries created a population that, in 1850, included perhaps two million slaves, plus many more descendants of slaves.

The Black Sea. Captives were taken from the Caucasus to the Black Sea territories under Ottoman rule. In addition, Slavic-speaking captives were brought to the Ottoman Empire, and in the sixteenth and seventeenth centuries there was a sizeable population of locally-enslaved Russians. Reliable estimates for the size of this slave trade are not available.

The Indian Ocean. Some 2 million captives were taken from East Africa to insular and mainland shores of the Indian Ocean. The trade was especially heavy in the nineteenth century. By 1850 the resulting slave population numbered about one million; there were smaller numbers of ex-slaves and descendants of slaves.

Sub-Saharan Africa. In around 1500 slavery existed in many parts of Africa, but slave populations were quite small. The growing export of captives to the west, north, and east expanded the population of slaves within Africa. Africans in slavery in 1850 numbered perhaps seven million; this number continued to grow until 1900, and declined steadily thereafter.

Viewed as a global system of labor, slavery exhibited broad and interactive patterns, so that change in one region brought about similar or contrasting change in other regions. Some examples illustrate this interaction. First, since an estimated two-thirds of persons sold to the Americas were male, the sending regions of West and Central Africa developed servile systems relying mainly on female slaves. Second, when abolition movements of the nineteenth century began to reduce the slave trade to the Americas, prices of slaves fell in Africa; in response, purchases of slaves in Africa, the Middle East, and the Indian Ocean region expanded. Third, for regions that abolished slave trade but not slavery, there ensued periods of 30 to 50 years of large-scale slavery without any further influx of captives. During these periods the prices of female and infant slaves increased and all slaves received better treatment, since they could not be replaced as easily as before. These regions included the United States and the British West Indies in the early nineteenth century, Brazil and Cuba in the late nineteenth century, the Ottoman Empire in the late nineteenth and early twentieth century, and several regions of East, Central, and West Africa in the twentieth century. Fourth, regional slave systems ended in two sharply different patterns: either a sudden state-decreed emancipation of slaves or a gradual end of slavery through private agency. For the United States and for British and French colonies of the Caribbean, governments passed acts of slave emancipation. For most other areas of the Old World and New World, slavery came to an end slowly, and more often at the individual and familial level than through governmental action.

Demographic Analysis of Slave Experience

To account for the demographic details of slavery, a three-leveled terminology is required. First, one may distinguish four types of status: free, captive (those taken from their homes but not yet settled as slaves), slave, and ex-slave. The captive status, lasting perhaps a year for each person, was a time of high mortality and low fertility. Second, one may distinguish five progressive stages in the slave experience: recruitment (typically by capture), transportation (by land and sea), "seasoning" (social initiation into slavery plus acclimation to a new disease environment), exploitation (the labor of the slave), and termination (departure from slave status by death, manumission, or escape). Third, in calculating demographic rates, one may distinguish between life-course analysis (mortality and fertility) and the analysis of physical and social migration.

The mortality of slaves was elevated in several ways. Death rates rose to high levels during capture and transportation, and were especially severe for the young and the old. Rates of infant mortality were so high for the Middle Passage—the ocean voyage between West Africa and the Americas on slave ships—as to make survival most unlikely. Mortality for slaves under regular exploitation rose because of heavy work loads, and also because slave plantations were commonly in high-mortality, lowland areas. A life table constructed for slaves in eighteenth-century Grenada yields an expectation of life at birth of 25 years.

The fertility of slaves was reduced in various ways, to a modest degree for women and to a substantial degree for men. For women, live births were low in the course of capture and transportation, and first-generation slave women had apparently small completed families, as they had some of their children before enslavement. For locally-born slave women, fertility was higher in the United States than in the Caribbean or Brazil. For male slaves, fertility was low in the many cases where women were scarce; this factor was reinforced because slave owners fathered children of slave women. Marriage and family among slaves was commonly distorted by law and practice: marriage was allowed and recorded in some areas, but in many areas it was not. Overall, the mortality of slaves usually exceeded their fertility, and manumission of some slaves (especially females) made for declining numbers in the enslaved populations. A self-reproducing or even growing population of slaves, which was the situation in the United States from 1810 to 1860, was most unusual.

Social reproduction of slave populations thus required steady importation of new captives. For the African regions from which slaves were taken, rates of slave export averaging perhaps two per thousand per year were probably sufficient to cause population decline for more than a century. Captures targeted young adults and caused significant mortality, so that population losses exceeded births. In addition to shipment of captives, there were at least two major migrations of those already enslaved: in the early nineteenth century roughly one million slaves were moved from the Old South to the New South in the United States, and about the same number were moved from the sugar fields in northeast Brazil to the coffee fields in southern Brazil.

Physical and social migration of captives and slaves created populations with many significant subgroups: immigrant vs. native-born slaves, and groups defined by language, ethnicity, or occupation. Variations in skin color became important in the Americas, while other markers of social difference distinguished slave populations in Africa. Prices of slaves took account of differences in age, sex, ethnicity, and skills. Children of a slave woman by her owner generally remained slaves in the Americas, but were mostly born free in Africa and the Middle East. In the Americas, slave women had most of their children with slave men, so a distinctive population of African descent grew up. In the Middle East and Africa, slave women had most of their children with free men, so that the enslaved assimilated into the general population. Prices were higher for male than for female slaves in the Americas, but the reverse was commonly true in Africa. On both sides of the Atlantic, female slaves were more likely to be manumitted than males.

Slavery Before the Atlantic World

Slavery has been documented for many regions of the world at many times. For times before 1500 C.E., however, there is a remarkable continuity in the existence of slavery as a labor system in lands adjoining the Eastern Mediterranean, the Black Sea, and the Persian Gulf. From Biblical times to Roman and Byzantine eras through the period of the Islamic Caliphates, this region maintained regimes of slavery, sometimes expanding and sometimes contracting, but always with a system of law enabling slavery. This system later spread to lands bordering the Atlantic and Indian Oceans.

Heritage of Slavery

The heritage of slavery affects each region differently. Patterns set by slavery for marriage and family life, and for racial discrimination or assimilation, may persist into later times. The emancipation of slaves brought creation of new restrictions on the formerly enslaved populations, including the formalization of racial segregation and other limits on access to public services or legal equality. In more recent times, calls have emerged for reparations to be paid to the descendants of slaves. While such reparations would be difficult to assess and administer, the concept does address the unmistakable social and racial discrimination borne by the descendants of slaves. Reparations would also address the unpaid contribution of slave labor to construction, agriculture, and industry in the modern Atlantic world.

See also: *African-American Population History; Ancient World, Demography of; Peopling the Continents; Trans-Atlantic Migration.*

BIBLIOGRAPHY

Eltis, David, Stephen D. Behrendt, David Richardson, and Herbert S. Klein, eds. 1999. *The Trans-Atlantic Slave Trade: A Database on CD-ROM.* New York: Cambridge University Press.

Fogel, Robert W., and Stanley L. Engerman. 1974. *Time on the Cross: The Economics of American Negro Slavery.* Boston: Little, Brown and Co.

Higman, Barry W. 1984. *Slave Populations of the British Caribbean, 1807–1834.* Baltimore: Johns Hopkins University Press.

Lovejoy, Paul E., and Jan S. Hogendorn. 1993. *Slow Death for Slavery: The Course of Abolition in Northern Nigeria, 1897–1936.* Cambridge, Eng.: Cambridge University Press.

Manning, Patrick. 1990. *Slavery and African Life: Occidental, Oriental, and African Slave Trades.* Cambridge, Eng.: Cambridge University Press.

———. 1990. "Slave Trade: The Formal Demography of a Global System." *Social Science History* 14: 255–279.

Mattoso, Katia M. de Queiros. 1986. *To Be a Slave in Brazil, 1550–1888.* trans. Arthur Goldhammer. New Brunswick, NJ: Rutgers University Press.

Meillassoux, Claude. 1991. *The Anthropology of Slavery: The Womb of Iron and Gold.* Trans. Alide Dasnois. Chicago: University of Chicago Press.

Miller, Joseph C., ed. 1993. *Slavery and Slaving in World History: A Bibliography, 1900–1991.* Millwood, NY: Kraus International Publications.

PATRICK MANNING

SMALL-AREA ANALYSIS

Demand for demographic data and analysis referring to localities and similar small areas has grown rapidly in recent decades, spurred by new business applications and government programs. To meet that demand, analysts have drawn on an expanding set of data sources, statistical techniques, and computer applications. The result has been improved data quality across a broad spectrum of variables and geographic areas, enhancing both the usefulness and the importance of small-area analyses. Analysts using small-area data include demographers, sociologists, geographers, economists, marketers, epidemiologists, planners, and others.

Analysts define small areas in several different ways. Under one definition, they are states and other subnational areas for which samples from national surveys are too small to provide meaningful estimates. More typically, small areas refer to counties and subcounty areas like cities, census tracts, postal code areas, and individual blocks. Small areas may range from less than an acre to thousands of square miles, and from no inhabitants to many millions.

This article reviews commonly-used data sources and application techniques and discusses several distinctive features of small-area demographic analysis. Although reference is primarily to the United States, many of the issues discussed transcend national boundaries.

Data Sources

Censuses, administrative records, and sample surveys are the major sources of data for small-area demographic analyses. In most countries, censuses constitute the most comprehensive source of small-area data, typically at five or ten year intervals. They cover a variety of population characteristics (such as age, sex, marital status, and education) and housing information (such as number of dwelling units, occupancy rates, household size, and housing value or monthly rent).

Administrative records kept by national, state, and local governments often provide small-area data for years between censuses. These records contain information on variables such as births, deaths, school enrollments, social insurance, building permits, drivers' licenses, and voter registration—each reflecting a facet of population structure and change that may be useful for constructing estimates and projections or for tracking demographic trends. Most industrialized countries maintain relatively accurate records of this kind; some European countries even produce census-type statistics based solely on administrative records. In many developing countries, however, administrative records are seriously incomplete.

Sample surveys are another potential source of demographic and socioeconomic data, provided that the samples are large enough to yield reliable estimates for small areas. A notable example is the American Community Survey, which is expected to cover some three million U.S. households annually by 2003. This survey will eventually generate estimates down to the block group level for the entire nation.

Estimates and Projections

Small-area estimates of total population generally rely on housing unit, component, or regression methods. The *housing unit* method derives population estimates from calculations of occupied housing units (i.e., households) and average household size, plus the number of persons living in group quarters facilities such as college dormitories, military barracks, and prisons. *Component methods* derive population estimates from birth, death, and migration data (births and deaths from vital statistics records, migration from changes in school enrollments or other indicators of population mobility). *Regression methods* derive population estimates from symptomatic indicators of population change—such as births, school enrollments, electric utility customers, registered voters, drivers licenses, and tax returns—in a multivariate model. All three methods produce useful estimates, but the housing unit method is the most commonly used for small-area estimates because it is relatively easy to apply and the requisite data are widely available.

Estimates of demographic characteristics such as age, sex, and ethnicity are typically based on the cohort-component method. Here, birth, death, and migration rates are applied separately to each age, sex, and ethnic subgroup in the population. Estimates of socioeconomic characteristics such as income, employment, and education are often based on imputation techniques, whereby known proportions of the population exhibiting a characteristic in a larger area (e.g., a state) are applied to population estimates for smaller areas (e.g., cities, counties). Typically, these proportions are calculated separately for different subgroups of the population. Estimates of demographic and socioeconomic characteristics can also be based on administrative records (e.g., Medicare data).

Population projection methods used for small areas are mainly of three kinds. *Trend extrapolation* methods extend observed historical trends. These methods may be simple, such as projecting past growth rates to remain unchanged, or complex, as in ARIMA time series models. These methods are frequently used for small-area projections because the data requirements are small, they are easy to apply, and their forecasts have often proven to be reasonably accurate.

The *cohort-component* method accounts separately for the three components of population change—births, deaths, and migration. Projections of each component can be based on the extrapolation of past trends, projected trends in other areas, structural models, or professional judgment. Simplified versions of the method such as those described by Hamilton and Perry (1962) can also be applied. The cohort-component method is the most frequently-used projection method because it can accommodate a broad range of data sources, assumptions, and application techniques, and can provide projections of demographic characteristics as well as total population.

Structural models are based on an entirely different logic from the other projection methods. They relate the projected population to variables known to drive population change, like comparative wages, employment, and land use. Some structural models involve only a single equation and a few variables; others contain many equations, variables, and parameters. They are often used in combination with the cohort-component method. Although they require highly-detailed data and substantial investments of effort and modeling skill, structural models provide a broader range of projections than the other methods.

Uses of Small-Area Analysis

To increase knowledge. Small-area data shed light on socioeconomic and demographic variations across states, counties, cities, census tracts, and other geographic areas, enlarging the knowledge available to scholars, policy makers, and other analysts. Empirical researchers have applied small-area analysis to many areas of inquiry. For example, Kathleen M. Day (1992) investigated how differences in government tax and expenditure policies affected interprovincial migration in Canada; Rene J. Borroto and Ramon Martinez-Piedra (2000) studied how poverty, urbanization, and geographic location affected the incidence of cholera among regions in Mexico; and Patricia E. Beeson, David N. DeJong, and Werner Troesken (2001) studied how differences in industrial, educational, geographic, and demographic characteristics affected county population growth rates in the United States.

To inform public policy. Small-area analysis supports decision-making by national, state, and local government agencies. Small-area data are indispensable for drawing administrative and electoral boundaries, allocating government funds, siting public facilities, developing program budgets, determining eligibility for public programs, and monitoring program effectiveness. For example, Tayman, Parrott, and Carnevale (1997) used block-level population and household projections to choose sites for fire stations; Gould and colleagues (1998) used birth data by postal code area to identify areas in need of adolescent pregnancy prevention programs; and Hashimoto, Murakami, Taniguchi, and Hagai (2000) developed techniques for monitoring infectious diseases by health district.

To support business decision making. Small-area data figure prominently in many types of business decisions—including site selection, sales forecasting, consumer profiles, litigation support, target marketing, and labor force analysis—analogous to their use in public policy. For example, small-area data were used by Morrison and Abrahamse (1996) to select locations for supermarkets; by Thomas (1997) to project the demand for a hospital's obstetrical services; and by Murdock and Hamm (1997) to produce population estimates and projections to support a company's bank loan application.

Problems of Small-Area Analysis

Several distinctive problems of small-area analysis require attention. First, unlike most larger administrative units, the geographic boundaries of many small areas change over time. Cities annex adjoining areas, census tracts get subdivided, postal code areas are reconfigured, service areas are redefined, and new statistical areas are established. Such changes undermine the consistency of historical data series.

Second, many types of data are not tabulated for some small areas of interest, such as census tracts, school districts, market sales territories, and traffic analysis zones. Consequently, analyses routinely performed for larger areas may be impossible for small areas or feasible only using proxy variables.

Third, even the best censuses and administrative record systems contain errors. The effects of data errors are typically greater for small areas than large areas, where errors are often mutually offsetting. In addition, survey data are generally less reliable for small areas than large areas because sample sizes are smaller and survey responses more variable.

Finally, trends at the small-area level are more likely to be disrupted by idiosyncratic factors—such as the opening or closing of a prison or military base, the construction of a large housing development, the opening of a new road or railway, and the addition or loss of a major employer—than trends at the larger-area level. The effect of growth constraints like zoning restrictions and seasonal populations such as migrant workers is also likely to be greater for small areas than large areas. Factors like these often distort small-area trends.

Developments

Several developments have broadened the scope and improved the quality of small-area analyses around the turn of the twenty-first century. A wider variety of small-area data has become available in many countries, primarily through administrative records and sample surveys. The Internet has greatly enhanced access to these data, and the rapid growth of computing power, data storage capacity, and software applications has expanded their potential usefulness. Geographic information systems (GIS) technology has facilitated the collection, organization, manipulation, analysis, and presentation of geographically-referenced data. These developments have prompted many new uses of small-area data, at ever finer levels of detail.

Concerns about privacy and confidentiality, however, pose a formidable barrier to the continued advancement of small-area analysis. To many citizens, the collection of personal information, whether by businesses or government, is an invasion of privacy. Confidentiality is potentially at risk when personal data are shared among public and private agencies. Such concerns have caused many government statistical offices to curtail the release of demographic data, and the use of administrative records has been restricted in the United States, Germany, the United Kingdom, and elsewhere. Devising acceptable ways to utilize information while preserving privacy and confidentiality is a major challenge for small-area analysts.

See also: *Business Demography; Census; Geographic Information Systems; Projections and Forecasts, Population; State and Local Government Demography.*

BIBLIOGRAPHY

Beeson, Patricia E., David N. DeJong, and Werner Troesken. 2001. "Population Growth in U.S. Counties, 1840–1990." *Regional Science and Urban Economics* 31: 669–699.

Borroto, Rene J., and Ramon Martinez-Piedra. 2000. "Geographical Patterns of Cholera in Mexico, 1991–1996." *International Journal of Epidemiology* 29: 764–772.

Cleland, John. 1996. "Demographic Data Collection in Less Developed Countries 1946–1996." *Population Studies* 50: 433–450.

Day, Kathleen M. 1992. "Interprovincial Migration and Local Public Goods." *Canadian Journal of Economics* 25: 123–144.

Gould, Jeffrey B., Beate Herrchen, Tanya Pham, Stephan Bera, and Claire Brindis. 1998. "Small-Area Analysis: Targeting High-Risk Areas for Adolescent Pregnancy Prevention Programs." *Family Planning Perspectives* 30: 173–176.

Hamilton, C. Horace, and Josef Perry. 1962. "A Short Method for Projecting Population by Age from One Decennial Census to Another." *Social Forces* 41: 163–170.

Hashimoto, Shuji, Yoshataka Murakami, Kiyosu Taniguchi, and Masaki Nagai. 2000. "Detection of Epidemics in their Early Stage through Infectious Disease Surveillance." *International Journal of Epidemiology* 29: 905–910.

Morrison, Peter A., and Allan F. Abrahamse. 1996. "Applying Demographic Analysis to Store Site

Selection." *Population Research and Policy Review* 15: 479–489.

Murdock, Steven H., and Rita R. Hamm. 1997. "A Demographic Analysis of the Market for a Long-Term Care Facility: A Case Study in Applied Demography." In *Demographics: A Casebook for Business and Government,* ed. Hallie J. Kintner, Thomas W. Merrick, Peter A. Morrison, and Paul R. Voss. Santa Monica, CA: Rand.

Siegel, Jacob S. 2002. *Applied Demography: Applications to Business, Government, Law and Public Policy.* San Diego, CA: Academic Press.

Smith, Stanley K., Jeff Tayman, and David A Swanson. 2001. *State and Local Population Projections: Methodology and Analysis.* New York: Kluwer Academic/Plenum Publishers.

Tayman, Jeff, Bob Parrott, and Sue Carnevale. 1997. "Locating Fire Station Sites: The Response Time Component." In *Demographics: A Casebook for Business and Government,* ed. Hallie J. Kintner, Thomas W. Merrick, Peter A. Morrison, and Paul R. Voss. Santa Monica, CA: Rand.

Thomas, Richard K. 1997. "Using Demographic Analysis in Health Services Planning: A Case Study in Obstetrical Services." In *Demographics: A Casebook for Business and Government,* ed. Hallie J. Kintner, Thomas W. Merrick, Peter A. Morrison, and Paul R. Voss. Santa Monica, CA: Rand.

Stanley K. Smith

SOCIAL CAPITAL

Social capital has been defined as "the resources that emerge from one's social ties" (Portes and Landolt 1996, p. 26). One of the first scholars to use the term was George Homans in *Social Behavior: Its Elementary Forms* (1961). Homans was interested in understanding how people in some small groups but not others are able to expand a group and transform it into a complex organization. This is accomplished, he argued, by group members engaging in social exchange to such a large extent that a "surplus" of interaction, activity, and sentiment (the building blocks of social exchange) accumulates (Homans 1950). That surplus can be directed toward the creation and maintenance of elaborate social structures, which facilitate more interaction and activity among group members in an iterative and self-reinforcing process. An input to production (in this case the production of a social form) that has been produced by a prior process (in this case a prior process of social exchange) is referred to by economists as a capital resource and, in this instance, as *social capital.*

Explorations of Social Capital

In the late 1970s the sociologist Pierre Bourdieu and the economist Glen Loury independently began to use the term. Bourdieu (1986) incorporated into his definition of social capital the Marxist idea that the raw material that produces a capital resource is always, at its ultimate origin, human labor. Loury's (1977) work examined the effect of differential access to social capital by ethnic group. His analysis found that in a society that is ethnically stratified, differential levels of resources by ethnicity at the group level are an important determinant of individual earnings.

Building on the work of Bourdieu and Loury as well as that of Mark Granovetter (1973, 1974, 1985) and Nan Lin (Lin 1982, 1988; Lin, Ensel, and Vaughn 1981), the sociologist James S. Coleman brought the concept of social capital into widespread use in the social sciences (Coleman 1988, 1990). Notable examples of its use are found in the work of the political scientist Robert D. Putnam. Putnam has been concerned mainly with the effects of social capital on political forms and levels of participation, such as the contrasting political outcomes in northern and southern Italy and the apparent fall in the level of associational activity in the United States. Other researchers have examined how social capital promotes child development and affects health outcomes for individuals.

Group Resource versus Individual Resource

There are two distinct views of social capital in this research. In one view social capital is considered a group-level resource to which all the members of a group have access; in the other it is considered an individual resource that is inherent in social structures. Coleman took the former position, in which it is thought that an individual's level of social capital can be measured by that individual's membership in a particular group.

Critics argue that construing social capital as a group resource leads to measurement ambiguities, for example, making it impossible to distinguish between social capital and its putative benefits, such as trust and norms. This position tends to downplay the effects of stratification within a group, making social capital merely a public good that is equally accessible to all. Moreover, this approach leads to the view that social capital by necessity confers benefits on individuals, which need not be the case.

The alternative view—social capital as a resource specific to individuals—ties the concept to the literature on social networks. Network analysis provides conceptual and analytic tools that can be applied to the study of social capital, investigating, for example, how a person's location in a social network affects that person's access to social capital or how the embedded resources in a particular social network affect network members' levels of social capital.

Applications in Population Research

For population scientists the concept of social capital has potential value in illuminating both the motivations of individuals to form social relationships and the consequences of social relationships for individual well-being. Many of the individual behaviors that in the aggregate produce demographic outcomes can be seen as investments (or disinvestments) in social capital. Such behaviors include forming sexual partnerships, rearing children, moving, coresidence, intergenerational exchange, and caring for the frail, the disabled, and the ill. Trends and differentials in these behaviors can be interpreted in part as resulting from shifts in the value of the social capital available to those who engage in them (Astone et al. 1999). Fertility transition, for example, could be seen as the outcome of a shift in investment from social capital to other kinds of capital, particularly human capital, perceived as offering higher returns.

See also: *Culture and Population; Diffusion in Population Theory; Social Networks.*

BIBLIOGRAPHY

Astone, Nan Marie, Constance A. Nathanson, Robert Schoen, and Young J. Kim. 1999. "Family Demography, Social Theory and Investment in Social Capital." *Population and Development Review* 25(1):1–32.

Bourdieu, Pierre. 1986. "The Forms of Capital." In *Handbook of Theory and Research for the Sociology of Education,* ed. John G. Richardson. New York: Greenwood.

Coleman, James S. 1988. "Social Capital in the Creation of Human Capital." *American Journal of Sociology* 94: S95–S120.

———. 1990. *Foundations of Social Theory.* Cambridge, MA: Harvard University Press.

Granovetter, Mark. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78(6): 1,360–1,380.

———. 1974. *Getting a Job: A Study of Contacts and Careers.* Cambridge, MA: Harvard University Press.

———. 1985. "Economic Action and Social Structure: The Problem of Embeddedness." *American Journal of Sociology* 91(3): 481–510.

Homans, George C. 1950. *The Human Group.* New York: Harcourt, Brace and World.

———. 1961. *Social Behavior: Its Elementary Forms.* New York: Harcourt, Brace and World.

Lin, Nan. 1982. "Social Resources and Instrumental Action." In *Social Structure and Network Analysis,* ed. Peter Marsden and Nan Lin. Beverly Hills, CA: Sage.

———. 1988. "Social Resources and Social Mobility: A Structural Theory of Status Attainment." In *Social Mobility and Social Structure,* ed. R. L. Breiger. Cambridge, Eng.: Cambridge University Press.

Lin, Nan, Walter M. Ensel, and John C. Vaughn. 1981. "Social Resources and Strength of Ties: Structural Factors in Occupational Attainment." *American Sociological Review* 46: 393–405.

Loury, Glenn C. 1977. "A Dynamic Theory of Racial Income Differences." In *Women, Minorities, and Employment Discrimination,* ed. Phyllis A. Wallace and Annette M. LaMond. Lexington, MA: Lexington Books.

Portes, Alejandro, and Patricia Landolt. 1996. "The Downside of Social Capital." *The American Prospect* 26: 18ff.

Putnam, Robert D. 1993a. *Making Democracy Work.* Princeton, NJ: Princeton University Press.

———. 1993b. "The Prosperous Community: Social Capital and Economic Growth." *The American Prospect* 13: 35–42.

———. 1995. "Bowling Alone: America's Declining Social Capital." *Journal of Democracy* 6: 65–78.

NAN MARIE ASTONE

SOCIAL INSTITUTIONS

Social institutions are the significant social structures and practices that organize societies in regular, patterned ways. Social norms and sanctions guide and maintain these institutions. Individuals' demographic decisions and behaviors are channeled by social institutions, which create constrained opportunities and choices. Social institutions help to define demographically relevant statuses, such as student, spouse, parent, and worker. Normative prescriptions associated with institutions further delineate the appropriate age for adopting one of these statuses, and the appropriate sequencing of associated "roles." Changes in social institutions may give rise to alternative life pathways for individuals, as with changes in marital roles in the United States when the labor market presented new work opportunities for married women.

The term "institution" is widely used within the discipline of sociology, but is not uniformly defined. Precise understandings vary with theoretical orientation. For example, functionalists are more inclined to conceive of institutions as structures that perform particular functions or roles in society. By contrast, social interactionists emphasize the fluid set of practices and behaviors which define institutions. Recent theoretical work on the life course points to the key role of institutions in connecting individual life histories to community influences and the forces of social history. This is a view of institutions as structures that channel behaviors. But social institutions also provide the way in which social historical changes are made real through their connection to individual persons. In economics the market system of capitalist states is a key institution, with effects on nearly every aspect of family life. Shifts from socialist to more market-oriented economies, as occurred in China and Vietnam at the end of the twentieth century, have had pervasive effects on demographic behavior.

Beyond structures and practices, more general terms have been used to define social institutions, including "ideas" about how to accomplish societal goals and "focuses" of social organization. Despite diversity in precise definition, most social scientists agree that universality is a characteristic of significant social institutions. Social institutions are recognized for their place in organizing social life within and across societies. As such, they are significant in any given society, and provide a useful prism for organizing comparative analyses of population across societies.

Population events influence and are influenced by social institutions. These relationships are dynamic and subject to feedback. They are central to any understanding of the determinants and consequences of population change. The social institutions that are most widely recognized as relevant to population change include family and kinship systems, religious institutions, the education system, the health system, political organization, and the economy. These institutions are the social structures through which changes in fertility outcomes, infant and adult mortality, immigration and emigration, and the age structure of the population come about. Conversely, population processes are key to the shape and form of social institutions, creating a constant interplay between the two. The complexities of this interrelationship may be illustrated by drawing attention to three important features:

1. The multiple dimensions of interdependence of social institutions and population;
2. The multilevel and across-level aspects of the interdependence within and between social institutions and population processes; and
3. The embeddedness of the relationships between social institutions and population processes in social, economic, historical, and political contexts.

Institutions and Population Change

Educational and economic institutions structure individual demographic behaviors with resultant effects on population processes. Government decisions concerning universal education, the structure of the schools (local or national control, performance standards, single or mixed sex), and the location of schools are the basis for family calculations about the costs and benefits of education for sons and daughters. The educational system—through enrollment differentials by place of residence, class, and gender, as well as by the form and content of lessons taught in schools—shapes population-relevant knowledge, attitudes, and behavior. Educational content can make schooling a strong or a weak tool for obtaining human capital. Educational systems that train children from rural areas in basic intellectual and work skills help determine whether an individual will work locally or will migrate elsewhere in search of further schooling or other employment opportunities. Schools can increase knowledge about contraceptive use, and alter couple dynamics in ways that promote or hinder adoption of contraception.

Families recognize the value of education, and see education as one way to produce "higher quality" children. This growth in the demand for education, in turn, may overwhelm educational systems, which often lack the resources, school facilities, and teachers needed to meet the new demand. In cases where the public education system is not able to satisfy the demand for accessible and high quality education, parents may enroll their children in private schools, recasting the institutional structure of education.

The rapid decline in the infant and childhood mortality rates in much of Asia and parts of Africa over the second half of the twentieth century came about largely through improved public health systems and better transportation and communication systems, fostered by the development plans of national governments. These improved survival rates had unforeseen consequences, including rapid population growth, a younger age structure, and greatly increased successive cohort sizes. Such changes are particularly problematic for social institutions that are highly age-structured.

Typically, increased demand for skilled labor during economic development is met by improvements in the education of urban populations, by migration from rural to urban places, and by immigration. The result is the urbanization of society. As cities grow in size, national and local governments increasingly are faced with the need to provide expensive urban infrastructures and to address the interests of large cohorts of young persons whose aspirations are unmet.

Improvement in earnings opportunities for women leads to their higher labor force participation rates and, depending on the form of labor, more autonomy in determining the use of resources (such as the purchase of contraceptives and medical care for young children). The rising opportunity costs of withdrawing from the labor force lead to later marriage and smaller family size, and make it increasingly likely that more mothers of young children will work. Changes in the market demand for labor (a demand that is sensitive to internal migration, immigration, fertility, and mortality) can transform the family by redefining appropriate gendered activities, including expectations of mothers and fathers concerning their appropriate roles in the family.

Population and Institutional Change

Social institutions are enduring entities but they are not static. Changes in social institutions can be shaped by demographic change. Take fertility decline: fertility declines can have pervasive effects on the family. A primary activity of that institution is the nurturance of children. As the number of children in a family decreases, the activity of caring for children changes. Family members may spend less time in the activity of caregiving because there are fewer children. Traditional tasks of motherhood often become concentrated in a shorter time-span within women's lifetimes, freeing women to pursue alternative activities. Alternatively, children's needs may be redefined in a way that does not reduce family members' time in caring for young children, but instead qualitatively changes the nature of caregiving.

Fertility change also has implications for family and other social institutions through its effects on the age structure of a population. In Asia, where fertility decline has been rapid and pension schemes are limited, concern is emerging over the increasing burden of providing care to aging elders, a responsibility expected to fall to a generation of children that grows smaller with each successive cohort. Similarly, at the aggregate level, declines in fertility through the birth of smaller cohorts are linked to cohort size. Instability in successive birth cohorts has implications for the economy, as workers retire and are not easily replaced by the generations that follow.

Population change, especially that involving delays in marriage and limitation in family size (to levels below replacement) have produced an economically less favorable (older) population age structure in many countries. States are responding to this changed population age structure. Change in the population age structure affects the structure and composition of the labor force, and the schools that train workers. As schools become increasingly willing to admit girls and young women, women's educational attainment and labor force participation grows, creating new potential for increases in labor force size and productivity. In some countries where fertility rates have been below replacement for two or more decades, immigration has been encouraged as a way to facilitate adjustments to a declining indigenous labor force size. With such immigration new groups appear in the population that may espouse different religious beliefs, family roles and practices, and gender roles, challenging existing social institutions.

The connections between social institutions and demographic change depend on context. While particular relationships—such as that between education and union formation—exist across time and place, their form and content depend on social, economic, historical, and political context. Population policies, with their demographic consequences, are inherently political. States may set population goals and implement policies and programs to promote the achievement of those goals, usually with specific related aims in view. States can encourage population growth, perhaps of selected groups, to win or maintain political power, or to enhance their military strength. Or, as was more common in recent decades, states can discourage rapid population growth, hoping thereby to promote economic development.

In 1979 China adopted a one-child policy to spur modernization and development. In the implementation of this policy, which enforces fertility reduction, numerous social institutions were enlisted. Schools taught a curriculum that emphasized the importance of smaller families and the citizen's duty to the nation to abide by the policy. A family planning system, separate from the health system, was developed to promote birth control and ensure availability of related services even in the most remote places. Local governance and relationships between individuals and local leaders were shaped by the state's promotion of this policy. Local leaders were given birth quotas and could lose their jobs for failure to meet these targets. The resulting pressures were felt in daily interaction at the village or neighborhood level, as families were rewarded for adopting the prescribed behavior or sanctioned for violating state policy. In short, social institutions were used by the state to promote desired population change. These institutions (family, health care, education, and government), in turn, were substantially altered not only by the policy's demographic results, but also by the means adopted to implement it.

Conclusion

The study of social institutions, their structures and processes, is a first step toward understanding population processes and the causes of population change. Anthropological demographers and social historians have been among the leaders in emphasizing this approach, seeking to delineate the "opportunity structure" or "choice set" bounding individual demographic behaviors. Quantitative analyses of population survey data can benefit from understanding the impact of institutions on personal lives, although they often fail to do so. Changes over time in individual demographic behavior need to be interpreted in terms of the broad shape of social history, as filtered by institutional structure and change, linking individual lives to historical time. Gender, religion, and ethnicity are personal factors especially central to understanding whether and how these linkages are handled by families and individuals. Thus, attention to social institutions is critical to understanding nearly all aspects of demographic behavior and population change.

See also: *Action Theory in Population Research; Culture and Population; Social Mobility; Social Networks.*

BIBLIOGRAPHY

Davis, Kingsley. 1963. "The Theory of Change and Response in Modern Demographic History." *Population Index* 29: 345–366.

Easterlin, Richard A. 1980. *Birth and Fortune: The Impact of Numbers on Personal Welfare.* New York: Basic Books, Inc.

Elder, Glen H. 1974. *Children of the Great Depression: Social Change in Life Experience.* Chicago: University of Chicago Press.

Greenhalgh, Susan, ed. 1995. *Situating Fertility: Anthropological and Demographic Inquiry.* New York: Cambridge University Press.

Kertzer, David I., and Dennis P. Hogan. 1989. *Family, Political Economy, and Demographic Change:*

The Transformation of Life in Casalecchio, Italy, 1861–1921. Madison: University of Wisconsin Press.

McNicoll, Geoffrey. 1994. "Institutional Analysis of Fertility." In *Population, Economic Development, and the Environment,* ed. Kerstin Lindahl-Kiessling and Hans Landberg. Oxford: Oxford University Press.

Pampel, Fred C. 2001. *Institutional Context of Population Change.* Chicago: University of Chicago Press.

Dennis Hogan
Susan Short

SOCIAL MOBILITY

Social mobility is the movement of individuals or other social units between social statuses and positions. This mobility can be between the status of individuals and that of their forbears or their offspring ("intergenerational" mobility), or between different statuses of individuals within their own lifetimes ("intragenerational" mobility). The study of social mobility focuses on movement between occupations or, to a lesser extent, on changes in status signaled by income, wealth, poverty, or educational attainment. In principle, however, social mobility encompasses a wider set of social and cultural traits, such as family structure, religious affiliation, language, and political party identification.

Most modern research on social mobility focuses on the conceptualization, measurement, and description of mobility patterns at the national level for a variety of countries and periods. Motivated by an effort to examine the "openness" or "rigidity" of systems of social stratification and inequality, the study of mobility is part of the analysis of population composition. Social mobility, however, is also linked to dynamic aspects of demography because of its interdependence with basic demographic processes at both the individual and population levels.

Measurement and Analysis of Social Mobility

Research on social mobility focuses on either bivariate or multivariate relationships between dimensions of social position. Bivariate analyses of occupational mobility typically compare individuals by their occupational categories at their places of social origin and destination. The classification of occupations may be highly aggregated, focusing on only a small number of analytically important categories, or disaggregated to detailed occupations. Analytical categories may emphasize a general socioeconomic hierarchy or follow more relational, nonhierarchical class schemes. Regardless of the type of occupational classification, mobility analyses focus on the patterns of association between origins and destinations.

In the context of intergenerational occupational mobility, patterns include the degree to which offspring occupy the same social positions as their parents and, for those who are in different locations from those of their parents, whether flows between particular combinations of discrepant origins and destinations are unusually large or small. Using modern methods of categorical data analysis applied to mobility tables, researchers investigate the complex patterns of associations between origins and destinations. A cross tabulation of individuals by their origins and destinations is affected by the relative numbers of persons in the various categories of origins and destinations considered separately—the "marginal distributions" of the mobility table—and the associations between origins and destinations. Some degree of mobility may occur simply because the relative numbers of persons in origin positions differ from the relative numbers in destination positions. This mobility is often termed "structural mobility" because it is interpreted as resulting from changes in the occupational structure. Even in the absence of change in the occupational structure, however, substantial mobility typically occurs because of a certain degree of openness in a society. This mobility is termed "exchange," "circulation," or "relative" mobility.

A common focus of mobility analyses is to compare mobility patterns across populations and to discern the degree to which differences result from variation in the changes between the origin and destination marginal distributions, and which result from variation in the associations between origin and destination once the marginal distributions have been statistically controlled. In most Western societies during the twentieth century, secular changes in occupational mobility were mainly the result of changes in the distribution of occupations. These changes resulted from the shrinkage of agriculture, the shift from a manual to a largely non-manual workforce, and the shift from an industrial to a service economy. In comparison to these large changes in structural mobility, fluctuations in exchange or circulation mobility have been modest. Similarly, occupational mobility variations among industrial societies are mainly attributable to variations in occupational structure per se rather than cross-national variations in the net association between social origins and destinations.

The theoretical distinction between structural and circulation mobility, however, corresponds only roughly to the empirical distinction between marginal and associational variations in intergenerational mobility tables. The two marginal distributions of a social mobility table cannot both correspond directly to occupational structures at two points in time. For example, in mobility data derived from a cross-section survey of adult offspring, the destination marginal of the table does represent the occupational structure at the time of survey. The origin marginal of the table, however, does not represent the occupational structure at any single point in time because of variations in the timing of fertility among parents. Moreover, the relative numbers of parents in different occupation categories are affected by differentials in the level of fertility by parents' occupation, as well as by the occupational structures that prevailed during the periods when they raised their offspring.

Multivariate analyses of social mobility follow two general strategies. One is to examine the processes through which the statuses of social origins affect the statuses of destinations by identifying variables and statistical relationships that intervene between characteristics of parents and those of their adult offspring. These analyses typically focus on scalar measures, such as occupational status, years of school completed, earnings, and number of siblings, and attempt to isolate the direct and indirect effects of antecedent statuses on adult outcomes. For example, the gross effect of parent's occupational status on offspring's occupational status is attributable in part to the smaller average number of children born to higher status parents, the higher level of education acquired by offspring in such families, and the advantages that higher levels of education and fewer siblings bring to adult achievement. In most industrial and postindustrial societies, educational attainment plays a pivotal role in social mobility and achievement. Much of the association between parent's and offspring's adult socioeconomic statuses is accounted for by the dependence of offspring's educational attainment on parents' socioeconomic position and by the strong effect of offspring's educational attainment on the offspring's own socioeconomic attainment. Across cohorts born during the twentieth century, moreover, the indirect effect of social origins on destinations via educational attainment has increased, while the direct effect of social origins net of educational attainment has decreased. A second multivariate approach to the investigation of social mobility is the direct investigation of movement between education levels, jobs, occupations, or wage levels. This approach relies on variants of event history and multivariate life table analysis and uses data on the detailed temporal sequences of statuses or positions that individuals hold. Such analyses are well suited for the description of careers and the interdependence of socioeconomic mobility and other demographic transitions, such as movement between marital and childbearing statuses.

Social Mobility and Population Renewal

Social mobility is linked to population renewal in a variety of ways at the individual, family, and aggregate population levels. A longstanding concern of demographers is the potential impact of intergenerational social mobility on the fertility of women. The social mobility hypothesis suggests that upwardly mobile individuals may have unusually low fertility because low fertility may facilitate career success and wealth accumulation. Rigorous efforts to substantiate this hypothesis, however, have been largely negative, showing that apparent mobility effects are largely reducible to the effects of fertility norms specific to a woman's socioeconomic origin and to her destination rather than to social mobility per se. In contrast, a much better established relationship is a negative effect of fertility in the family of *orientation*—that is, number of siblings—on adult socioeconomic success. This relationship occurs because number of siblings indexes the degree of dilution of the economic, social, and psychological resources that parents provide their children. It holds for most Western societies, even when multiple indicators of parental socioeconomic background and family structure are controlled. Exceptions to the generally negative effect of number of siblings, however, occur in populations in which larger kin networks provide a socioeconomic advantage.

At the aggregate level, social mobility is a key mechanism through which fertility, marriage, and immigration may affect population composition. The classic model of population renewal assumes an age-differentiated but otherwise homogeneous one-sex closed population subject to age-specific rates of fertility and mortality. This model can be extended to two-sex populations, to geographically heterogeneous populations, and to populations open to immigration and emigration. When considering how population renewal affects changes in the makeup of socially differentiated populations, however, it is usually necessary to also incorporate social mobility into the models. Differential fertility of social groups defined by, for example, language, religious affiliation, educational attainment, measured intelligence, or income strata, may affect the subsequent makeup of the population in these groups. The effect of fertility differentials on population composition, however, depends on the degree to which membership in these groups is open or closed across generations. In populations in which intergenerational social mobility is low—that is, in which the correlation between parental and offspring characteristics is high—differential fertility may strongly affect the differential growth rates of social groups. Conversely, when social mobility is high, the effects of differential fertility are offset by the tendency for offspring to belong to different social groups from their parents'. Similarly, high correlations between the socioeconomic characteristics of marriage partners may create higher levels of inequality in subsequent generations because of the reinforcing effects of both variation and covariation in parents' characteristics on inequality among their children. The inequality-producing effects of assortative marriage, however, may be nullified if high rates of intergenerational social mobility cause large proportions of offspring to belong to different social groups from their parents'. The few studies of the interdependence of social mobility, differential fertility, and assortative mating that have been carried out indicate that intergenerational social mobility rates in Western industrial societies are high enough to offset almost all of the potential effects of differential fertility and assortative mating on differential rates of population growth.

See also: *Caste; Dumont, Arsène; Intergenerational Transfers; Partner Choice; Social Institutions; Social Reproduction.*

BIBLIOGRAPHY

Blake, Judith. 1989. *Family Size and Achievement.* Berkeley: University of California Press.

Blau, Peter M., and Otis Dudley Duncan. 1967. *The American Occupational Structure.* New York: Wiley.

Duncan, Otis Dudley. 1966. "Methodological Issues in the Analysis of Social Mobility." In *Social Structure and Mobility in Economic Development,* ed. N. J. Smelser and S. M. Lipset. Chicago: Aldine.

Erikson, Robert, and John H. Goldthorpe. 1992. *The Constant Flux: A Study of Class Mobility in Industrial Societies.* Oxford: Clarendon Press.

Featherman, David L., and Robert M. Hauser. 1978. *Opportunity and Change.* New York: Academic Press.

Ganzeboom, Harry B. G., Donald J. Treiman, and Wout C. Ultee. 1991. "Comparative Intergenerational Stratification Research: Three Generations and Beyond." *Annual Review of Sociology* 17: 277–302.

Hauser, Robert M., and John Robert Warren. 1997. "Socioeconomic Indexes for Occupations: A Review, Update, and Critique." In *Sociological Methodology 1997,* ed. Adrian E. Raftery. Washington, D.C.: The American Sociological Association.

Hout, Michael. 1988. "More Universalism, Less Structural Mobility: The American Occupational Structure in the 1980s." *American Journal of Sociology* 93: 1,358–1,400.

Mare, Robert D. 1997. "Differential Fertility, Intergenerational Educational Mobility, and Racial Inequality." *Social Science Research* 26: 263–291.

Rosenfeld, Rachel. 1992. "Job Mobility and Career Processes." *Annual Review of Sociology* 18: 39–61.

Sørensen, Jesper B., and David B. Grusky. 1996. "The Structure of Career Mobility in Microscopic Perspective." In *Social Differentiation and Social Inequality: Essays in Honor of John C. Pock,* ed. J. N. Baron, D. B. Grusky, and D. J. Treiman. Boulder, CO: Westview Press.

Robert D. Mare

SOCIAL NETWORKS

Social network theory assumes that social interactions have the potential to influence attitudes and behavior. In the sphere of population this assumption has begun to be confirmed by demographers. Network models bear some similarity to diffusion models, but they offer a more structured approach to social interaction by focusing on the specific links that connect individuals and groups. In the 1980s interest in social networks by sociologists led to the collection of network data, the elaboration of theory, and the development of new analytic methods. Demographers have borrowed heavily from this theoretical and methodological work to guide their empirical analyses. Most have concentrated on fertility, investigating the fertility transitions of individuals in local communities, but network approaches have also been used in the study of migration and mortality, clusters of villages, population elites, and organizations.

Evidence that people do indeed talk with friends, relatives, and neighbors about fertility control can be found in historical sources, interviews with elderly people, and surveys conducted in developing countries in the 1960s and 1970s. In these surveys, the content and context of the conversations are missing. When researchers have collected qualitative data, they have found that talk about subjects such as family planning may be open, casual, and quite specific rather than private, formal, and vague. Qualitative data also provide insight into how network partners are selected, an issue relevant for determining appropriate statistical techniques. Both theory and data suggest that social interactions concerning fertility control are especially likely in situations of uncertainty.

Network theory postulates a variety of effects of networks, but in the study of fertility transitions the focus has been on new information transmitted and evaluated in networks and on the influence that networks exert on its members to adopt or resist innovations. Links among network partners are characterized in a variety of ways. An important distinction is that between strong and weak links: strong links are hypothesized to constrain the flow of new information and to exert more social influence than weak links. A variety of indicators of the strength of ties has been proposed, such as whether the network partner is a confidant, a friend, or an acquaintance and the duration of the relationship. Networks have also been characterized by the degree of homogeneity of members with respect to characteristics such as age, education, gender, and ethnicity. Heterogeneous networks may facilitate the spread of new information, whereas homogeneous networks may be more effective in exerting social influence.

Studies using cross-sectional data provide convincing evidence of an association between the attitudes and behavior of individuals and the characteristics of their networks. For example, the probability that a woman is using contraception is typically higher if her network partners are also using contraception, and the method she uses is likely to be the same as the methods used by those with whom she interacts. This probability has been found to depend also on the characteristics of the individual and her networks, as well as on the particular context; networks may also impede contraceptive use. Because of the dearth of network data, some analysts have used aggregate data to represent local or transnational networks, again finding associations that suggest the importance of networks.

While there is a clear empirical association between network characteristics and attitudes and behaviors, establishing a causal effect of networks on attitudes and behaviors has been difficult. Because actors may select those with whom they discuss topics such as family size and family planning or whether and when to migrate, determining the direction of causality requires longitudinal data or analytic techniques that take the selectivity of networks into account.

In summary, empirical work by demographers has established the potential significance of network approaches for examining processes of demographic change. By implication, analyses that treat individual actors in isolation are not sufficient. Fully realizing this potential may require further theoretical development; it will certainly require new efforts at data collection, including qualitative and survey data on the links among network partners, as well as further development of analytic techniques.

See also: *Diffusion in Population Theory; Fertility Transition, Socioeconomic Determinants of; Social Capital.*

BIBLIOGRAPHY

Bongaarts, John, and Susan C. Watkins. 1996. "Social Interactions and Contemporary Fertility

Transitions." *Population and Development Review* 22: 639–682.

Casterline, John B. 2001. "Diffusion Processes and Fertility Transition: Introduction." In *Diffusion Processes and Fertility Transition,* ed. John B. Casterline. Washington, D.C.: National Academy Press.

Entwisle, Barbara., Ronald R. Rindfuss, David K. Guilkey, Apichat Chamratrithirong, Sara R. Curran, and Yothin Sawangdee. 1997. "Community and Contraceptive Choice in Thailand: A Case Study of Nan Rong." *Demography* 33: 1–11.

Kohler, Hans-Peter. 2001. *Fertility and Social Interaction.* Oxford: Oxford University Press.

Kohler, Hans-Peter, Jere R. Behrman, and Susan C. Watkins. 2001. "The Density of Social Networks and Fertility Decisions: Evidence from South Nyanza District, Kenya." *Demography* 38: 43–58.

Montgomery, Mark R. and John B. Casterline. 1996. "Social Influence, Social Learning, and New Models of Fertility." In *Fertility in the United States: New Patterns, New Theories,* ed. John B. Casterline, R. D. Lee, and K. A. Foote. Supplement to *Population and Development Review.* New York: Population Council.

Valente, Thomas W. 1995. *Network Models in the Diffusion of Innovations.* Cresskill, NJ: Hampton Press.

Susan Cotts Watkins

SOCIAL REPRODUCTION

Social reproduction refers to the processes that ensure the self-perpetuation of a social structure over time, in rough analogy to biological reproduction for a population.

The idea of social reproduction has its origins in Karl Marx's analysis of capitalist society in Volume 1 of *Capital.* One of Marx's key sociological insights is that "every social process of production is at the same time a process of reproduction" (p. 71). Although his work is concerned specifically with economic processes, Marx discusses the subject in a broad social context, specifically the application of these processes to reproduction of social relations of capitalism. This idea was generalized by later Marxists to an argument that any mode of production also reproduces the conditions of its own existence. Further generalization extended use of the term beyond the ranks of Marxist writers. Although much of sociology might be said to be concerned with the ways in which social practices and institutions are self-perpetuating, the concept has tended to be used largely in relation to social inequalities. The fact that disadvantaged members of society engage in practices that contribute to the maintenance of a situation in which they are disadvantaged has often been seen as particularly problematic. For example, the revisionist socialists of the late nineteenth century, especially in Germany, argued that the high fertility of the proletariat—the producers of children—perpetuated their low-wage conditions; they advocated birth control (even a "birth strike") as a means of undermining capitalist exploitation.

The most extensive modern development of the concept of social reproduction has been by the sociologist Pierre Bourdieu (1930–2002). Bourdieu associates social reproduction with his concept of *habitus* which he defines in *The Logic of Practice* (1990) as something that "ensures the active presence of past experiences, which, deposited in each organism in the form of schemes of perception, thought and action, tend to guarantee the *correctness* of practices and their constancy over time" (p. 54). His work on different forms of style of life and of "taste" suggests how this process might operate. Bourdieu was also particularly concerned with the way in which the educational system functions, contrary to much conventional thought, to inhibit, rather than encourage, individual social mobility.

Despite the qualifying term "tend to," the use of "guarantee" in the above quotation does leave Bourdieu open to the charge, by Richard Jenkins, for example, of offering a structuralist account in which individual motivation and actions are ignored. The latter debate points to the general problem with theories of social reproduction: that they appear to be deterministic in character and do not allow for the possibility of social change. In that respect such theories are clearly deficient. However, the idea of social reproduction is valuable in suggesting areas of empirical investigation and theoretical development. In particular, it offers a useful corrective to the approach typically adopted in studies of social mobility. The very term social mobility carries with it the idea of intergenerational movement and so necessarily seems to require a theory of such movement. Lack of movement tends to remain untheorized. Conversely, the term social reproduction carries with it the idea of stability and calls for a theory that explains lack of movement; its difficulty, however, lies in the development of a theory of change. Empirical investigation requires an integration of both approaches.

See also: *Marx, Karl; Social Mobility.*

BIBLIOGRAPHY

Bourdieu, Pierre. 1984 [1979]. *Distinction: A Social Critique of the Judgement of Taste.* London: Routledge and Kegan Paul.

———. [1980] 1990. *The Logic of Practice.* Cambridge, Eng.: Polity Press.

Bourdieu, Pierre, and Jean-Claude Passeron. 1977 [1970]. *Reproduction in Education, Society and Culture.* London: Sage.

Jenkins, Richard. 1992. *Pierre Bourdieu.* London: Routledge.

Marx, Karl. 1976 [1886]. *Capital: A Critique of Political Economy,* Vol. 1. Harmondsworth, England: Penguin Books.

Kenneth Prandy

SOCIOBIOLOGY

Sociobiology is the study of social behavior from a Darwinian evolutionary perspective. Edward O. Wilson named the field in 1975, when he published *Sociobiology, The New Synthesis.* Although the book stimulated controversy initially because some mistakenly believed that Wilson's ideas gave aid and comfort to political reactionaries, in the early twenty-first century sociobiology is a well-established field within evolutionary biology.

Sociobiologists (or behavioral ecologists or evolutionary psychologists, as they are also known) analyze the evolutionary foundations of social behavior for all animal species. These researchers treat a social ability as if it were the historical product of natural selection. The process of selection occurs whenever individuals differ genetically in ways that affect their capacity to leave copies of their genes to the next generation, which is usually achieved by having surviving offspring. Selection theory enables the sociobiologist to identify puzzling social traits—namely, those that appear to reduce an individual's reproductive, and thus genetic, success.

Because of their interest in the genetic consequences of social behavior, sociobiologists have focused on those aspects of group formation, cooperation, reciprocity, parental care, and sexual interaction that carry disadvantages, as well as benefits, in terms of individual genetic success. For example, how can one explain the evolution of altruism, in which some individuals forego reproduction in order to help others survive and reproduce? Although altruism would seem to reduce genetic success, the trait is widespread—as, for example, in the self-sacrificing sterile worker and soldier castes of the social ants, bees, wasps, and termites. Moreover, in many social birds and mammals, helpers at the nest also give up a chance to reproduce in order to help rear the offspring of other adults.

In 1964 the biologist William D. Hamilton (1936–2000) offered a novel evolutionary explanation for altruism. He showed mathematically that altruists could increase their genetic success if their personal sacrifices resulted in an increase in the reproductive success of close relatives. Because relatives inherit some of the same genes from their recent common ancestors, discriminating altruism can enable the altruist to pass on his or her genes indirectly via helped kin. Hamilton's theory has been tested and supported by the discovery that altruists of most species generally only assist close relatives, thereby propagating the genes they share with these individuals, which helps maintain the potential for carefully targeted altruism within their species.

The Sociobiology of Human Behavior

Sociobiologists have used the logic of evolutionary theory to examine the social behavior of humans as well as that of ants and antelopes. This approach is based on the grounds that humans have certainly differed genetically in the past (just as they do currently). Some hereditary differences have had small but real effects on the development of the brain, thus influencing sensory and motor abilities with corresponding effects on one or another social behavior. If natural selection on hominids occurred in the past, people living in the twenty-first century can be assumed to carry the hereditary social predispositions exhibited by their reproductively successful predecessors.

The logic of the argument means that people, as well as other animals, are expected to act in ways that maximize their genetic success. Thus, if evolutionary theory is correct, altruism in humans should tend to be directed toward close relatives rather than toward genetic strangers, and there is considerable evidence that persons are predisposed to help their kin. Likewise, if past selection has shaped the human sexual psyche, then men in cultures around the world are predicted to find youthfulness, and therefore high fertility, attractive in potential partners whereas women are predicted to find strength, high social status, and thus, wealth to be sexually attractive attributes in men. In the past, men and women with these adaptively different mate preferences surely left more descendants than those people who chose mates at random. Cross-cultural data generally confirm these predictions. Men are endowed with evolved psychological systems that "encouraged" their male ancestors to seek out mates most likely to produce children. Women evidently possess quite different systems that "encouraged" their female ancestors to select protective, wealthy men able to offer above-average parental care to their children, a critical factor in determining the survival of offspring in the past.

The significance of sociobiological analyses for human population issues is obvious. The traits of humans (and all other organisms) that have been shaped by natural selection are expected to have promoted the genetic success of individuals in the past—and in the present as well, to the extent that modern environments resemble those of the past. Because present-day humans are the descendants of individuals who reproduced most successfully, human populations have the capacity to grow exponentially, just as do the populations of all other organisms. The evolutionarily-adaptive drive to reproduce leads the great majority of married couples to have at least one child rather than none at all, with infertile couples often divorcing or adopting or undergoing fertility treatments, despite the onerousness and expense of these options.

Not all aspects of human behavior, however, can be easily explained in evolutionary terms. Currently, the paramount problem in human social behavior for sociobiologists is the demographic transition, the decline in fertility that has occurred as countries have moved toward becoming modern industrial states. Among the several still incompletely-tested evolutionary hypotheses on the demographic transition is one that begins with the assumption that people have an evolved drive for high social status (because in the past this striving was correlated with better-than-average reproductive success). If so, wealthy persons in modern nations with an economically advantaged class may consider themselves in social competition with others of similar status. If this is true, then major investments are required for each offspring in order to provide him or her with the wherewithal for social success. These investments are possible only through a reduction in fertility. Thus, according to this hypothesis, humans' evolved psychological mechanisms might lead individuals in novel modern environments to act in ways that reduce, rather than increase, the absolute number of surviving offspring they produce. Additional research is required to evaluate this and other sociobiological hypotheses, but the discipline has already demonstrated the productivity of evolutionary theory as a tool for investigating human behavior.

See also: *Animal Ecology; Biodemography; Darwin, Charles; Evolutionary Demography; Primate Demography.*

BIBLIOGRAPHY

Alcock, John. 2001. *The Triumph of Sociobiology.* New York: Oxford University Press.

———. 2001. *Animal Behavior, An Evolutionary Approach.* Sunderland, MA: Sinauer Associates.

Dawkins, R. 1989. *The Selfish Gene,* 2nd edition. New York: Oxford University Press.

Gaulin, Steven J. H., and Donald H. McBurney. 2001. *Psychology, An Evolutionary Approach.* Upper Saddle River, NJ: Prentice Hall.

Trivers, Robert. 1985. *Social Evolution.* Menlo Park, CA: Benjamin Cummings.

Williams, George C. 1966. *Adaptation and Natural Selection.* Princeton, NJ: Princeton University Press.

Wilson, Edward O. 1975. *Sociobiology, The New Synthesis.* Cambridge, MA: Belknap Press.

JOHN ALCOCK

SOMBART, WERNER

(1863–1941)

Werner Friedrich Wilhelm Carl Sombart was a German economist and sociologist. He was born in the Harz mountains and studied law and economics from 1882 to 1888 in Pisa, Rome, and Berlin, together with Adolph Wagner and Gustav Schmoller. In his dissertation on *The Roman Campagna* (1888), he discussed the relationship between landowners and agrarian labor in Italy. He became an expert on Italian economics; his studies were rich in statistical and historical detail. At the age of 27 he was appointed professor at Breslau University in Silesia. His studies of Fredrick Engels and Karl Marx, together with a widely-read collection of his lectures, *Socialism and Social Movements during the Nineteenth Century* (1896), were seen as endorsements of Marxism and delayed further advancement in his academic career until 1916, when he became a full professor at Berlin University. His later work became more nationalist and, in a 1934 tract, *A New Social Philosophy,* even sympathetic to the then new Nazi regime. Sombart was a colleague of Max Weber and participated with him in the *Verein für Socialpolitik* as well as in founding the German Society for Sociology in 1909. Sombart's major work, the three-volume treatise, *Modern Capitalism* (1902–1927), traced capitalism's origins to Enlightenment ideas rather than, as Weber did, to Protestantism.

Sombart's historical and economic studies on population are contained in the third (1927) volume of *Modern Capitalism* and in a later book, *Humanistic Anthropology* (*Vom Menschen* [1938]). In the former work, the main population-related question he tackled, like Marx, was how early capitalist development recruited the masses of workers that were needed, and how this population surplus developed in agrarian societies. Marx had famously asserted that there cannot be a general theory of population but only a theory specific to each period of economic development and structure; Sombart's sociological theory of population applied to the conditions of early and high capitalism. *Humanistic Anthropology* proposed another theory of population. There his main argument was that all action, including all demographically relevant action, was founded in mental concepts and motives, and thus cannot be explained in biological terms. In 1938 such a stance was in explicit opposition to the racial, eugenic, and Volk-theories of the Nazi regime. The book was banned during the Third Reich and was almost forgotten afterwards, but it deserves a secure place in the history of population thought.

See also: *Population Thought, Contemporary.*

BIBLIOGRAPHY

SELECTED WORKS BY WERNER SOMBART.

Sombart, Werner. 1896. *Sozialismus und Soziale Bewegung.* Jena: Fischer. (Translated as: *Socialism and the Social Movement.* New York: Putnam, 1898.)

———. 1915. *The Quintessence of Capitalism.* London: Unwin.

———. 1927: *Der Moderne Kapitalismus.* Vol. 3: Das Wirtschaftsleben im Zeitalter des Hochkapitalismus. München u. Leipzig: Duncker u. Humblot.

———. 1933. *History of the Economic Institutions of Modern Europe: An Introduction to Der Moderne Kapitalismus of Werner Sombart,* ed. Frederick L. Nussbaum. New York: Crofts.

———. 1938. *Vom Menschen. Versuch einer geistwissenschaftlichen Anthropologie.* Berlin: Buchholz & Weisswange.

———. 2001. *Economic Life in the Modern Age.* New Brunswick, NJ: Transaction Publishers.

RAINER MACKENSEN

SPONTANEOUS ABORTION

Spontaneous abortion is defined as the involuntary loss of the fetus before the 20th week of pregnancy. Later involuntary loss of pregnancy is considered preterm birth. The definition is less clear on the starting point: at what stage after conception should the loss of the products of fertilization be counted as a spontaneous abortion. Many of these losses occur to women who never recognized that they were "pregnant," and there are no chemical or laboratory tests to establish the presence of a fertilized egg until about seven to ten days after fertilization takes place. The general term "abortion" refers to the interruption of a pregnancy after nidation has begun (the nesting of the developing zygote in the wall of the uterus, which generally occurs around the sixth day after fertilization). According to the definition accepted by the American College of Obstetrics and Gynecology and the World Health Organization, it is reasonable to use this starting point for calculating rates of spontaneous abortion. On this basis, the incidence of spontaneous abortion is approximately 20 percent of recognized pregnancies between the 4th and 20th weeks of gestation (counting from the last menstrual period). Approximately 80 percent of these losses occur in the first 12 weeks and the rate declines steadily thereafter, so that in week 20 the incidence of spontaneous abortion is less than 4 percent. Extrapolating back to immediately after fertilization, the rate of loss of all fertilized eggs may be as high as 50 percent, according to published accounts.Most of these very early losses occur between fertilization at mid-cycle and the onset of the next expected menses. In these cases the woman is unlikely to be aware of the prospective pregnancy.

Early spontaneous abortion is usually due to chromosomal abnormalities or fetal malformations. One study has reported that 60 percent of spontaneous abortions have polyploidy, trisomy, or aberrations of the sex chromosomes. Both maternal and paternal factors have been causally linked to spontaneous abortion. Caffeine or alcohol consumption by the mother increases the frequency of pregnancy loss on a dose-related basis. Maternal smoking results in lower birth weight of newborns, and several constituents of tobacco smoke have been associated with fetal death. While active smoking increases the rate of spontaneous abortion by a statistically significant amount, the epidemiological data available on the effect of passive smoking (exposure to environmental tobacco smoke) are too limited to reach a definitive conclusion. Similarly, paternal exposure to toxins may increase the risk of spontaneous abortion, but there is conflicting evidence on this subject.

An accurate determination of the primary sex ratio at fertilization in humans is impractical, for it would require recovery and assignment of sex to zygotes that fail to cleave, blastocysts that fail to implant, and early pregnancy losses. The secondary sex ratio, the ratio at delivery, is usually quoted as approximately 106 males to 100 females. Hence there are either more XY zygotes than XX zygotes at the time of fertilization or there is a greater loss of female than male embryos. The primary sex ratio may be even higher than 106:100 if there is a greater loss of males than females during gestation. The limited epidemiological evidence on the sex distribution of spontaneous abortions in humans supports this possibility: male conceptuses appear to be spontaneously aborted more frequently than females. Thus, the normally higher age-specific mortality rate of males for every age group may prevail even in pre-natal life.

See also: *Fertility, Proximate Determinants of; Sex Ratio; Tobacco-Related Mortality.*

BIBLIOGRAPHY

American College of Obstetricians and Gynecologists. "Methods of Mid-trimester Abortion." October 1987. *Technical Bulletin* No. 109.

Armstrong, B. G., A. D. McDonald, and M. Sloan. 1992. "Cigarette, Alcohol, and Coffee Consumption and Spontaneous Abortion." *American Journal of Public Health* 82: 85.

Cunningham, F. Gary, et al. 2001. *Williams Obstetrics.* 21st edition. New York: McGraw Hill.

Simpson, J. L. 1980. "Genes, Chromosomes, and Reproductive Failure." *Fertility and Sterility* 33: 107.

Snijders, R. J. M., N. J. Sebire, and K. H. Nocholaides. 1995. "Maternal Age and Gestational Age-specific Risk for Chromosomal Defects." *Fetal Diagnosis and Therapy* 10: 356.

Sheldon J. Segal

STATE AND LOCAL GOVERNMENT DEMOGRAPHY

State and local government demography involves the application of demographic concepts, data, and techniques to public-sector problems at the sub-national level.

The field is considered part of applied demography, in which demographic data and methods are used to solve real-world problems. (Another closely-related field is business demography: the application of demography to private-sector issues and decisions.) As Hallie J. Kintner and colleagues (1994) and Jacob S. Siegel (2002) explain, applied demographers' work products are used by government agencies, schools, businesses, legal practitioners, and policy makers. State and local government demography, along with the rest of applied demography, tends to be practical rather than theoretical.

This article describes contemporary state and local demographic practice in the United States, where demographic data (mainly from the national census and birth and death records) are fairly current and reasonably accurate. In a few other countries, universal population registers and frequent censuses simplify the work of demographers on sub-national geographic units because it is much easier to quantify migration. In many other countries, there are fewer sources of reliable and current data on such sub-national units.

The scope of the field continues to broaden, however, as additional data sources, analytical tools, and data processing technology are developed. The lag time associated with data collection has shortened markedly—suggesting the eventual possibility of almost "real time" population estimates. Increasingly, the results of state and local demographers' work are available to potential users through the Internet.

Fundamentals of State and Local Demography

The core activity in this field is small-area population estimation. State and local agencies often engage individuals with demographic training to do this work, some contract with academic consultants, and some purchase estimates for small geographic areas from commercial data vendors. Regardless of the source, these estimates are the foundation of state and local demographic work. In addition to population estimates, state and local demographers also provide population forecasts for states and smaller geographic areas.

Data used for state and local population estimates include national and sub-national censuses, administrative records, and other surveys. Periodic census results provide a check of the quality of the procedures used in deriving those estimates. Recent U.S. censuses have included extensive data on population characteristics and information (much of it on a sample basis) on housing and various socioeconomic measures. Census data releases reflect imposition of stringent restrictions protecting individuals's privacy, but allow detailed cross-tabulations and provide some data for areas as small as a single city block.

Administrative records consist of federal, state, and local governmental data gathered for purposes of registration, licensing, regulation, and program administration (e.g., Stanley K. Smith, et al. 2001). They include vital statistics (births, deaths, marriages, divorces); measures of income and poverty; some information on health, employment, and housing; school enrollment data; and records of other activities that are registered or known to the government.

Sample survey data are also sometimes used in state and local demography. In the United States, the Current Population Survey (for larger geographic entities) and the American Community Survey are important sources of such data. State and local government agencies (such as public health departments, housing agencies, and school systems) sometimes conduct special-purpose sample surveys.

Several methods are commonly used to make small-area population estimates. Stanley K. Smith and colleagues describe these methods in detail. The simplest involves multiplying the number of housing units in the area of interest by the average number of persons per household, and adding the estimated numbers in group quarters and the homeless population. The number of housing units can be derived from administrative records like building permits, utility customers, and property tax records. Persons per household can be estimated in a variety of ways, but is typically calculated from census data. This is called the housing unit method.

The component method of population estimation starts with the area's base population (often the latest census count) and adjusts it for the subsequent numbers of births, deaths, in-migrants, and out-migrants. Vital statistics provide birth and death data. Migration is estimated using a combination of administrative records, which may include data from income tax returns, public health insurance membership (in the United States, Medicare), school enrollments, driver's license applications and address changes, and international immigration records. The method can be used to provide separate estimates by age, sex, race or ethnicity, and other characteristics.

Demographers also use regression methods to adjust base populations for current small-area estimates. Regression models may incorporate data on vital events (births and deaths), school enrollment, utility customers, building permits, voter registration, driver's license applications and address changes, tax returns, and other data from administrative records as independent variables. A variety of such models have been developed and applied by the U.S. Census Bureau and similar organizations.

State and local demographers use small units of geographic analysis. These include individual real estate parcels or street addresses, neighborhoods, census divisions (city blocks, block groups, tracts, places, counties, groups of counties), postal codes, special administrative districts (school, water, hospital, sanitation, etc.), public health regions, traffic zones, and political entities like city council and state legislative districts. Population estimates tend to be more accurate for larger geographical areas and those that have relatively stable populations; greater uncertainty attaches to population estimates for smaller geographical units and those that have unstable demographic processes.

State and local demographers increasingly make use of geographic information systems (GIS) software in addition to statistical and database software. GIS can link all types of data to relevant geographical features and thus facilitate the spatial analysis and mapping that are essential to understanding regional variation in many variables of interest. GIS software uses an electronic base map of a region (such as the U.S. Census Bureau's TIGER) identifying roads, political boundaries, census geography, and other manmade and natural geographical features. Each type of feature may be depicted as a separate region, line, or point layer that can be turned on or off as needed. Databases can be linked to each layer. Individual data records with street addresses can be geocoded (assigned latitude and longitude coordinates, or electronically pin-mapped) and aggregated by the enclosing regions. Satellite and aerial photographic images can also be incorporated into a GIS database. The software allows data associated with any type of feature to be aggregated, disaggregated, transferred to other layers, and analyzed.

Many U.S. states have official state demographers, as well as web sites with extensive offerings of data and reports that can be viewed online and downloaded. For example, the California Department of Finance's Demographic Research Unit has posted population estimates (historical and current), projections, and research papers on its web site. Many states' web sites offer census data for the state and its political subdivisions.

Some cities and regional government councils or associations also have web sites containing census and other specialized demographic data (see, for example, the site of the San Diego Association of Governments). Data sometimes include estimates and forecasts of employment, economic conditions, household numbers, and housing, as well as other demographic information. Universities sometimes perform these services for states and smaller jurisdictions (for example, the Bureau of Economic and Business Research (BEBR) at the University of Florida web site).

Applications of State and Local Government Demographic Analysis

The work of state and local government demographers is used by urban, rural, and regional planners, as well as by public organizations and businesses. Fields of application include housing, public health, education, law enforcement, traffic control, environmental impact analysis, disaster planning, and electoral redistricting.

Housing. Demographers can track housing stock at the local and regional levels using permit data on building construction and demolition, utility hookups, and property tax records. Data on housing numbers and characteristics are used to target areas for redevelopment and for the location of public housing, subsidized housing, and housing for the elderly. Housing data by age and race or ethnicity are used to identify possible housing discrimination. Database software makes it simple to connect housing data from administrative records (such as property tax rolls) with population characteristics. GIS software permits mapping and visualization of geographical variation.

Public health. Public health agencies use state and local demographic data to develop community health indicators, analyze population health in terms of outcomes as well as social and environmental determinants, locate clinics and health services, and for disease surveillance. Epidemiologists need population estimates for calculation of fertility, morbidity, mortality, and other rates, which are often calculated by age, sex, race or ethnicity, and other demographic variables. Health maintenance organizations, hospitals, and health insurers also use demographic data. Su-Lin Wilkinson and colleagues (1999), and Jeanne G. Gobalet and Richard K. Thomas (1996) give examples of demographic techniques used in the public health field. The work of Louis G. Pol and Richard K. Thomas (2001) provides an extensive discussion of health and health care demography.

School enrollment. State and local government demographers help public schools forecast enrollments. They make projections of future student body size by grade using past data on grade progression rates and information on births five years earlier (to forecast kindergarten enrollments). Alternatively, or additionally, future enrollments can be gauged from housing data.

Demographic data are an important input to educational planning: in siting schools, deciding on school closure, realignment of internal attendance area boundaries, and design of desegregation strategies. GIS software is particularly useful in these activities.

Law enforcement. Law enforcement agencies use demographic data to compute crime rates and plan enforcement and prevention measures. Demographic data are used to select trial jury members when laws require that juries be representative cross-sections of the community. State and local demographic data are also used for drawing political boundaries that conform to legal requirements. For example, in the United States, most political subdivision boundaries must be evaluated after each national census and redrawn, if necessary, to achieve population equality across the subdivisions. Civil rights laws also require that political subdivision boundaries permit protected minority group members the opportunity to elect representatives of their choice. State and local government demographers sometimes provide technical support for political redistricting.

Accident patterns and disaster response. State and local government agencies use demographic data to understand traffic accident patterns, to assess environmental impacts, and in planning for major natural disasters. For example, Stanley K. Smith (1996) and the California Department of Finance (1995) have analyzed the effects of hurricanes, earthquakes, and other natural disasters. Programs are developed to assist particular at-risk populations, such as the elderly, poor children, substance abusers, and school dropouts on the basis of local-area demographic characteristics.

Sharing Demographic Data

The Population Association of America's Committee on Applied Demography facilitates interaction among state and local government demographers. The Census Bureau's Federal State Cooperative for Population Estimates and Federal State Cooperative for Population Projections, and the State Data Centers provide a forum for sharing census data with state and local agencies. A significant share of state and local demographers' work entails making national census and other types of demographic, social, and economic data accessible to the public. This sub-area of demographic practice is likely to grow rapidly for the foreseeable future.

See also: *Business Demography; Census; Geographic Information Systems; Population Registers; Small-Area Analysis.*

BIBLIOGRAPHY

Gobalet, Jeanne G., and R. K. Thomas. 1996. "Demographic Data and Geographic Information Systems for Decision Making: The Case of Public Health." *Population Research and Policy Review* 15: 537–548.

Kintner, Hallie J., Thomas W. Merrick, Peter A. Morrison, and Paul R. Voss, eds. 1994. *Demographics: A Casebook for Business and Government.* Boulder, CO: Westview Press.

Myers, Dowell. 1992. *Analysis with Local Census Data: Portraits of Change.* New York: Academic Press.

Pol, Louis G., and Richard K. Thomas. 2001. *The Demography of Health and Health Care,* 2nd edition. New York: Kluwer Academic/Plenum Publishers.

Siegel, Jacob S. 2001. *Applied Demography: Applications to Business, Government, Law and Public Policy.* San Diego: Academic Press.

Smith, S. K. 1996. "Demography of Disaster: Population Estimates after Hurricane Andrew." *Population Research and Policy Review* 15: 459–477.

Smith, Stanley K., Jeff Tayman, and David A. Swanson. 2001. *State and Local Population Projections: Methodology and Analysis.* New York: Kluwer Academic/Plenum Publishers.

Wilkinson, S. L., Jeanne G. Gobalet, M. Majoros, B. Zebrowski, and G. S. Olivas. 1999. "Lead Hot Zones and Childhood Lead Poisoning Cases, Santa Clara County, California, 1995." *Journal of Public Health Management and Practice* 5(2): 11–12.

INTERNET RESOURCES.

Bureau of Economic and Business Research (BEBR) at the University of Florida Website. <http://www.bebr.ufl.edu>.

California Department of Finance's Demographic Research Unit. <http://www.dof.ca.gov>.

Hoag, Elizabeth, and California Department of Finance. 1995. "The Effect of the Loma Prieta Earthquake on California Migration." <http://www.dof.ca.gov/HTML/DEMOGRAP/Disaster.pdf>.

San Diego Association of Governments. <http://www.sandag.org>.

JEANNE GOBALET

STATES SYSTEM, DEMOGRAPHIC HISTORY OF

It is commonplace in the early twenty-first century, as it has been for the past two centuries, to speak of nation states as the primary unit of territory, identity, and citizenship for the world's population. Indeed, it is difficult to conceive of a world without nation states. The nation state system however has a specific history of geographic, social, political, and economic organization and is a comparatively recent phenomenon. There is also an emerging body of work on globalization that questions the longevity of the nation state system and proposes scenarios for a post-national world. Intriguing as the "end of the nation state" thesis may be, the nation state system appears to be firmly intact without any outward signs of collapse or major reconfiguration—although still characterized by the rise and fall of nations. How natural is this system? What historical shifts have taken place to shape the present geography of nation states? What, if any, are the indications that this "natural order of things" is undergoing a transformation?

The nation state system developed in Europe between the sixteenth and nineteenth centuries after the collapse of the Holy Roman Empire and the emergence of the centralized state upholding the right of exclusive authority within the defined territorial state. The concept of *we the people, we the nation* became the new geography of association and citizenship. Hence, the people constituting the nation became the ultimate source of the state's legitimacy and the idea of the nation itself became the natural repository of political loyalty. This emergence, however, is the product of complex circumstances and historical contexts that warrant careful scrutiny.

Many commentators refer to the Treaty of Westphalia (1648) as representing the beginning of the modern system of states. The Treaty, really a series of treaties that collectively ended the hostilities of the Thirty Years War, marked the culmination of the anti-hegemonic struggle against the Hapsburg ambitions for a supranational empire while also signifying the collapse of Spanish power outside the Iberian Peninsula, the fragmentation of Germany, and the rise of France as a major power in Europe. The principles that were established at Westphalia are of critical importance. It was now to be an accepted organizational pattern that the independence of a state invariably meant that it had jural rights, which all other states were bound to respect. This was the beginning of the modern framework of interstate relations. The Treaty established a secular concept of international relations, permanently replacing the medieval idea of a universal religious authority acting as the final arbiter of Christendom. Thus, any notion of an authority above the sovereign state was now rendered redundant.

An Old World Geography

The treaty of Westphalia may have set the stage for a new global geography of independent nation states and its associated claims over sovereignty and citizenship. However, this took place on an already networked globe. Some of the newly salient borders seemed natural, others completely arbitrary. Well before the European imperial expansion there were wide-ranging linkages among populations that were the result of identifiable material processes. One such linkage derived from the development of contending hegemonic political and military systems, which sought to extract surpluses from distant populations through conquest and empire building. Another linkage was the growth of long-distance trade, which connected zones of specialization along the routes of commerce. These developments in turn produced extensive grids of communication, which bound together different populations under the aegis of dominant religious or political ideologies.

The extension of this system beyond the European heartland has been a contradictory and profoundly disturbing process. In the nineteenth century the system of states each claiming sovereign rule was far from complete. Through various colonial and imperial arrangements, the "comity of nations" spread into lands distant from its origin; but it was not yet coterminous with the globe. The system was economically, culturally, and ideologically less heterogeneous than it was to become in the twentieth century.

The expansion of European powers and the secular transformations of culture, science, political and administrative organization, and technology provided the framework for the modern system. The demographic shifts associated with the crisis of feudalism, involving changing relationships between town and country, and between city and city, were also significant factors.

For some scholars the obvious context within which to analyze and understand the origins of nation states is the historical emergence of the capitalist world economy. Most of Europe in the late Middle Ages was feudal—consisting of relatively small, self-sufficient economic units based on the direct appropriation of the small agricultural surplus produced within a manorial economy by a small class of nobility. Areas of economic activity and trade were well defined. Expansion and contraction occurred at three levels—geography, commerce, and demography—each of which played a part in the establishment of new forms of surplus extraction based on more efficient and expanding production and the development of core states within this world system.

State formation is also inextricably linked to various attributes of civilizations quite apart from commercial activity. The historian Fernand Braudel points out that an expanding Europe should also be juxtaposed with biological and demographic circumstances of equal historical significance. Famines, overpopulation, falls in real earnings, popular uprisings, and grim periods of slump were characteristic of early European civilization. Epidemics and biological disasters such as the Black Death and the epidemics that followed, which occurred in the second half of the fourteenth century, produced major contractions in populations.

The concept of nation states became a natural part of Western political thinking as commerce, industry, and trade intensified around the globe. The expansion in the mid-eighteenth-century, from about 1733 onward, was also a period of setbacks such as those experienced on the eve of the French Revolution, but overall economic growth continued throughout this transformative period. Material gain and growing and more concentrated populations provided the context for the intellectual development of the Enlightenment.

European Romanticism coincided with a long economic downturn between 1817 and 1852. But apart from the effects of economic change, the development of nation states and their demographic history are inextricably linked to the cultural, political, and intellectual canvas involving real and perceived notions of collective identity and unity. The medieval image was one of reasonably stable feudal states ruled by monarchs who held authority over populations divided into classes or estates, from nobility to peasant. As Europe expanded this image gradually disappeared. As the civilizing forces of modern state formation progressed, a new consciousness about borders and new conceptions of national differences emerged. But this was not a simple transition from medieval geography into neatly divided territories replete with nationalist fervor. In what resembles the ebb and flow of sentiment in the world at the start of the twenty-first century, early forms of national identity involved a struggle between nationalism and universalism.

The Italian patriot and revolutionist Giuseppe Mazzini proclaimed the nineteenth century as the age of the arrival of the nations. The nation was a confraternity, a sharing of the same destiny. Its appearance signified the arrival of the masses, the decline of privilege, the emergence of political and religious freedom, and equality before the law, while providing a meaningful counter to excessive self-indulgence and rabid individualism. For Mazzini, the nation was the essence of morality although not a law unto itself. Germany stood in contrast to this model: For a long time it celebrated disunity with the claim that the destiny of the Germans was that of the Greeks of the modern world—a nation composed of many states, but a single flourishing civilization. Indeed in the late eighteenth and early nineteenth centuries, Germans took pride in being free of any feelings of nationalism. Later, of course, forms of German nationalism were to take on a pathological dimension concerned with domination and racial purity, though this development can be linked to the concept of universal empire building that transcended territorial Germany.

The history of states is thus inescapably bound to the political and cultural aspirations of people—often encapsulated in heroic myths about the past. Demography was an essential ingredient of such mythmaking. Natural shifts in population size and density became the basis of contested claims over territory and tradition. Some nationalist movements seek to regain "authenticity"—reacquiring what was taken from them through colonization or conquest by neighboring states. Viewed from this perspective the geographical borders of nation states are quite arbitrary; they can be altered or indeed created where none existed previously, as was the case for much of the African continent, in Europe, through the Treaties that followed the two World Wars, and, more recently, in the break-up of the USSR and Yugoslavia into component nations.

States, Nations, and Globalization

Some commentators claim that the forces of globalization are reshaping the world of nation states, possibly creating a postnationalist order. The combined influence of transnational trade, economic relations, and the virtual fields of telecommunications and finance are said to be creating a world without borders. A new system of global politics, one that is not nation-state-centered, is supposedly emerging. Other observers take the opposite view, suggesting a new era of balkanization and instability, wherein nations will become even more important.

Demographic change is an important consideration in any debate over the salience and permanence of state borders. Population shifts, brought about particularly by migration and refugee flows, are altering the demographic composition of nations. Optimistic visions of transnational democracy and, more generally, of the end of the nation state, need to be balanced against the rise of aggressive nationalism based on xenophobic sentiment concerning the protection of borders. Globalization does not necessarily produce a stable world polity and reduction in nation state conflict. The new worlds of communications and economics may be globalized but all indications suggest that the politics of this transformation is thoroughly grounded in an old-world territorial geography. Concepts and terms like sovereignty and citizenship that have previously been taken for granted by scholars of international politics are being placed under scrutiny by shifts in migration patterns.

The demographic history of nation states is associated with a dynamic geography. The global system of states at the beginning of the nineteenth century does not resemble the mosaic of nation states at the beginning of the twenty-first century. New states have emerged; old states have disappeared. The nation state system has evolved through the ravages of war, the demise of colonialism, and the creation of new states as communities gained or regained collective identities and sought to establish territorial homes. Regional groupings of nations explore arrangements that relinquish some elements of sovereignty to a supranational entity—most notably, as in the European Union. And international organizations with global reach, if little sway, proliferate under the United Nations system. Contemporary problems of border surveillance and migration control, the growing movement of refugees, and the increasing demands by populations for national autonomy suggest that the system of states will remain a dominant feature of the global political system for some considerable time. That notwithstanding, emerging global issues such as how to deal with ominous environmental trends, and the transnational impact of anti-globalization social movements, indicate that the charmed life of state sovereignty may be entering unsettling times.

See also: *Geopolitics.*

BIBLIOGRAPHY

Braudel, Fernand. 1993. *A History of Civilizations.* New York: Penguin.

Held, David, Anthony McGrew, David Goldblatt, and Jonathan Perraton. 2000. *Global Transformations.* Oxford: Polity.

Huizinga, Johan. 1966. *The Autumn of the Middle Ages.* trans. Rodney Payton and Ulrich Mammitzsch. Chicago: University of Chicago Press.

Poggi, Gianfranco. 1978. *The Development of the Modern State.* Stanford CA: Stanford University Press.

Talmon, Jacob L. 1979. *Romanticism and Revolt: Europe 1815–1848.* New York: W. W. Norton and Company.

Wallerstein, Immanuel. 1974. *The Modern World System.* New York: Academic Press.

Peter Marden

STATISTICAL METHODS

See *Data Assessment; Estimation Methods, Demographic; Event-History Analysis; Life Tables; Simulation Models*

STERILIZATION

See *Birth Control, History of; Contraception, Modern Methods of; Family Planning Programs*

STOCHASTIC POPULATION THEORY

Stochastic theory deals with random influences on populations and on the vital events experienced by their members. It builds on the deterministic mathematical theory of renewal processes and stable populations. Concentrating on structural and predictive models, it is distinct from statistical demography, which also deals with randomness but in the context of data analysis and inference under uncertainty. This entry treats macrodemographic processes of population growth and structure first, and microdemographic processes of individual experience second. Basic background for all these subjects is found in the classic textbooks by the demographer Nathan Keyfitz published in 1968 and 1985.

Random Rates and Random Draws

The population theorist Joel Cohen, in a 1987 encyclopedia article, has drawn a useful distinction between two sources of randomness, which he called *environmental* and *demographic* and that are also denoted with the terms *random rates* and *random draws.* Random rate models assume that the schedules of fertility, mortality, and migration that govern population change are not fixed but themselves fluctuate in response to partly haphazard exogenous influences from climate, economic and political factors, resources, or disease. Models with random draws take the population-level schedules as fixed and concentrate on the chance outcomes for individuals, like drawing cards from a shuffled deck. The lifetable is a model for random draws. Its l_x column tells the probability that a randomly selected member of the population will "draw" an age at death older than x from the lottery of fate.

Random rate models for population growth and age structure have been proved to share some of the best properties of deterministic models. In particular, population age pyramids tend to forget their past, in the sense that the distribution of the population by age tends over time to become independent of the initial age distribution. This property is called *ergodicity.* Following the work of Z. M. Sykes, which was expanded upon by Young Kim, powerful theorems were proved by Hervé LeBras in 1971 and 1974 and by Cohen in 1976 and 1977. For example, under certain reasonable conditions, means, variances, and other moments of the proportions in age groups become independent of the initial age distribution and the number of births per year comes to fit a lognormal distribution. Much of the general theory of population dynamics in variable environments can be brought to bear; Shripad Tuljapurkar's 1990 book *Population Dynamics in Variable Environments* is a good source.

Time series models from economic demography, like ARIMA (Autoregressive Integrated Moving Average) models, are examples of random rate models. The economic demographer Ronald Lee and his colleagues, from the 1970s onward, studied short-term fluctuations in births and deaths in European preindustrial populations. They discovered systematic patterns of lagged responses to prices and previous vital rates, shedding light on historical population regulation.

In the 1990s random rate models were applied to the practical problem of putting measures of uncertainty analogous to confidence intervals around population projections. In 1992 Lee and Larry Carter introduced a stochastic model for forecasting mortality from historical trends and fluctuations in the logarithms of age-specific death rates. For many developing countries, the index of the level of overall mortality turns out to be well-modeled by a random walk with a constant country-specific drift. However, variability from age to age around the overall level remains poorly understood. Harking back to work of Keyfitz and Michael Stoto, Nico Keilman, Wolfgang Lutz and other demographers and statisticians have modeled historical patterns of errors in earlier forecasts and used them to generate uncertainty bounds for new forecasts, an approach surveyed in the National Research Council's 2000 volume "Beyond Six Billion," edited by John Bongaarts and Randy Bulatao.

Models for random draws, given fixed vital schedules, underlie much of demography. Branching processes were invented by I. J. Bienyamé in 1845 and rediscovered by Francis Galton and H. W. Watson around 1873. The number of progeny (males or females but not both) in each family in a population is assumed to be drawn independently from a given family-size distribution, and lines of descent form a random tree through succeeding generations. If the mean number of progeny is less than or equal to one, the probability of extinction is one. The randomness rules out eternally stationary populations.

The general model for random population dynamics in use by demographers, with age-dependent branching structure, was given its full mathematical specification by the statistician David Kendall in 1949. With random draws, the assumed statistical independence from unit to unit makes the standard deviations in demographic observables (like the sizes of age groups or counts of births and deaths) tend to vary like the square root of population size, but with a constant of proportionality that can be predicted from the models. With random rates (random from time to time but uniform across members of a population), the standard deviations tend to vary like the population size itself, and the constant of proportionality is a free parameter. Kenneth Wachter has studied the relative strengths of the two kinds of randomness in historical populations. Mixed models with partial independence from place to place and group to group are now on the horizon, drawing on measurements of geographical heterogeneity and covariation featured, for instance, by LeBras.

The rise of genomics has created new interest in stochastic models like branching processes which generate genealogical trees for individuals or genes in populations. With branching processes, total population size varies endogenously from generation to generation. Geneticists tend to prefer the models of Sewell Wright and R. A. Fisher in which total population size is constrained to be constant or to vary in an exogenously specified fashion. Samuel Karlin and Howard Taylor give full accounts in their 1981 textbook. In 1982 John Kingman developed a general theory of coalescence. Coalescent processes work backwards in time, starting, for instance, with living women and tracing their mothers, their mothers' mothers, and their maternal ancestors in each prior generation until all the lines coalesce in a single most recent common ancestress. A central result of this subject is a formula equating the mean number of generations back to coalescence with twice the (constant) "effective" population size. Data on differences in DNA sequences in present-day populations can be combined with these stochastic models to yield estimates, still controversial, of population sizes over hundreds of thousands of years or more. This work promises new opportunities for understanding the balance between random fluctuations and the dynamics of long-term population control.

Microdemographic Processes

At the microdemographic level, elements of chance impinge on most life-course transitions for individuals, on social determinants and motivations, and on the basic biology of conception, childbirth, survival, and death. The attention of demographers has focused particularly on the sources and consequences of heterogeneity from person to person in probabilities of vital events.

Drawing on statistical renewal theory, the demographers Mindel Sheps and Jane Menken, in their classic 1973 study *Mathematical Models of Conception and Birth,* modeled a woman's interval between births as a sum of independent random waiting times with their own parametric probability distributions. An important feature is heterogeneity from woman to woman in fecundability—that is, in probability of conception given full exposure to the risk of conception. James Wood and Maxine Weinstein applied refined models to the analysis of reproductive life history data. Inferring the strength of components of heterogeneity from observational data is difficult, and birth intervals provide one of the prime examples for non-parametric methods for estimating unobserved heterogeneity developed by James Heckman and Burton Singer in 1984.

In microdemography, stochastic models are required when variances are important along with mean values. For instance, the proportion of older people without living children may be more important than the mean number of living children per older person across the population. For such purposes, estimates of mean numbers of kin from stable population theory developed in 1974 by sociologists Leo Goodman, Keyfitz, and Thomas Pullum, need to be extended, generally through the use of demographic microsimulation. In microsimulation, a list of imaginary individuals is kept in the computer, and, time interval after time interval, the individuals are assigned events of marriage, childbirth, migration, death, and other transitions by comparing computer-generated pseudo-random numbers with user-specified schedules of demographic rates. An example is the SOCSIM program (short for "Social Structure Simulation") of Eugene Hammel and Kenneth Wachter. SOCSIM was first applied to estimate demographic constraints on preindustrial English households in collaboration with Peter Laslett, and later applied, as in Wachter's 1997 study, to forecasts of the kin of future seniors in the United States, England, and elsewhere.

Longevity and Frailty

Given that the life table is, in a sense, the oldest stochastic model in demography, it is not surprising that stochastic models for mortality by age, and specifically for heterogeneity in mortality, are prominent. From the 1980s onward, the Duke demographer Kenneth Manton and his colleagues developed multivariate stochastic models for health and survival transitions. These models are macrodemographic models inasmuch as they are driven by transition rates for population aggregates, but they are designed to make efficient use of individual-level data from longitudinal studies. They have become a prime tool for disentangling the roles of interacting covariates, including behaviors like smoking or physical conditions like blood pressure, in risks of death. Singer has pressed stochastic modeling into service for studies of effects of whole sequences of life-course experiences on health.

James Vaupel, Anatoli Yashin, Manton, Eric Stallard, and their colleagues developed, between 1979 and 1985, a model for hazard curves based on a concept of heterogeneous frailty. The hazard curve is a mathematically convenient representation of age-specific rates of mortality in terms of the downward slope of the logarithm of the proportion of a cohort surviving to a given age. In the frailty model, the shape of the hazard curve as a function of age is the same for everyone, but the level varies from person to person by a factor, fixed throughout each person's life, called the person's frailty. Frailties are often assumed to follow a Gamma probability distribution, while the common shape of the hazard curves at older ages is often taken to be an exponential function in line with the model of Benjamin Gompertz introduced in 1825. As a cohort ages, people with higher frailties die more quickly, leaving a set of survivors selected for lower frailties. The 2000 article "Mortality Modeling: A Review" by Yashin, Ivan Iachine and A. Begun is a good introduction.

The frailty model of Vaupel and his colleagues figures prominently in the biodemography of longevity, where human hazard curves are compared with hazard curves in other species including fruit flies, nematode worms, and yeast. Such heterogeneity may be a significant contributor to observed tapering in hazard curves at extreme ages found across species. Alternative stochastic models include models based on statistical reliability theory for complex engineered systems proposed by Leonid Gavrilov and Natalia Gavrilova, and Markov models for the evolution of hazard curves through step-by-step transitions suggested by genetic theory.

The study of fertility transitions, in the aspect in which it emphasizes social interaction and the diffusion of attitudes, information and innovations, relies extensively on a broader class of stochastic models. In 2001 Hans-Peter Kohler drew on random path-dependent models advanced in the 1980s by Brian Arthur and other economists, to explain patterns of contraceptive choice. The amplifying effects of peer-group influences is a significant theme in accounts of very low fertility in developed societies.

Stochastic theory provides a unifying framework which ties together the many substantive areas of demography as a whole and links them with active research fronts in the other biological and social sciences.

See also: *Archaeogenetics; Artificial Social Life; Biodemography; Event-History Analysis; Life Tables; Projections and Forecasts, Population; Renewal Theory and the Stable Population Model; Simulation Models.*

BIBLIOGRAPHY

Bongaarts, John, and R. Bulatao, eds. 2000. *Beyond Six Billion.* Washington, D.C.: National Academy Press.

Cohen, Joel. 1981. "Stochastic Demography." In *Encyclopedia of Statistical Science,* ed. Samuel Kotz and Norman Johnson. New York: John Wiley.

Karlin, Samuel, and Howard Taylor. 1981. *A Second Course in Stochastic Processes.* New York: Academic Press.

Keyfitz, Nathan. 1968. *Introduction to the Mathematics of Population.* Reading, MA: Addison-Wesley.

———. 1985. *Applied Mathematical Demography.* Berlin: Springer.

Kohler, Hans-Peter. 2001. *Fertility and Social Interaction.* Oxford: Oxford University Press.

Sheps, Mindel C., and Jane Menken. 1973. *Mathematical Models of Conception and Birth.* Chicago: University of Chicago Press.

Tuljapurkar, Shripad. 1990. *Population Dynamics in Variable Environments.* Berlin: Springer.

Wachter, Kenneth. 1997. "Kinship Resources for the Elderly." *Philosophical Transactions of the Royal Society of London* B352: 1,811–1,817.

Yashin, Anatoli, Ivan Iachine, and A. Begun. 2000. "Mortality Modeling: A Review." *Mathematical Population Studies* 8: 305–332.

Kenneth W. Wachter

TABLE 1

Distribution of the Population of the United States by Central City, Suburb, and Nonmetropolitan Status, 1960–1990 (percent)

Status	1960	1970	1980	1990
Central city	32.3	31.4	30.0	31.3
Suburb	30.9	37.6	44.8	46.2
Nonmetropolitan	36.7	31.0	25.2	22.5
Total	100.0	100.0	100.0	100.0

SOURCE: U.S. Population Censuses.

SUBURBANIZATION

Suburbanization became a significant dynamic in urban development during the latter part of the nineteenth century, as professional people and better-paid artisans followed the example of successful entrepreneurs in taking up residence in new homes on the outskirts of the growing factory towns and commercial centers. This process was aided by the emergence of inexpensive forms of mass transit that loosened the ties between home and workplace for those with secure jobs and relatively "social" hours of work. With the growth of private car usage beginning in the 1920s, the process surged ahead; by the second half of the twentieth century, suburban living had become the modal pattern in many countries including the United States (see Table 1).

Over time, however, the nature of suburbanization has changed considerably. The most significant change has been in terms of the geographical scale of the process. Once experienced chiefly in the form of the lateral extension of the urban core, suburbanization has come to involve residential decentralization over a much broader commuting field. As in the case of Great Britain (see Table 2), the main commuting "ring" was already the zone of most rapid population growth by the 1950s, but the growth of outer areas accelerated in the 1960s and overtook that of the rings in the 1970s. Also very notable in the British case is the population turnaround of the rural areas since the 1950s, with a growth rate exceeding that of the suburban rings in the 1980s.

This more extensive outward movement of population has been interpreted by many commentators as a distinctive phenomenon going beyond suburbanization. To the extent that it has involved the

TABLE 2

Change in Population Size per Decade in Great Britain by Functional Region Zone Type, 1951–1991 (percent)

Zone Type	1951–1961	1961–1971	1971–1981	1981–1991
Core	4.0	0.7	−4.2	−0.1
Ring	10.5	17.8	9.1	5.9
Outer area	1.7	11.3	10.1	8.9
Rural area	−0.6	5.4	8.8	7.8
All zones	5.0	5.3	0.6	2.5

SOURCE: Great Britain Population Censuses.

growth of relatively self-contained, medium-sized and smaller settlements lying beyond the main commuting reach of the major metropolitan centers, it has been seen as a process of "urban deconcentration" rather than of "urban decentralization." Given that this is not simply overspill from a too-full urban core but is commonly associated with absolute population loss from the latter, urban deconcentration has been interpreted as evidence of the loss of appeal of urban life and of the quest for a rural idyll, hence dubbed "counterurbanization" by Brian Berry (1976). Though most of those involved in this centrifugal movement are destined for small towns rather than the deep countryside, and very few are seeking out an alternative lifestyle without modern urban facilities, the majority see themselves as escaping the hectic pace of metropolitan life, with most sooner or later switching to nearby jobs rather than commuting back to the city.

This notion of an escape from metropolitan life in general is supported by a second major change that has affected the suburbs in recent decades: the urbanization of the suburbs or, in the words of David Birch, a transformation "from suburb to urban place" (1975, p. 25). Traditionally, the term suburb carries connotations of being something less than *urbs,* the city. Suburban areas were once largely residential in character, acting as dormitories and being dependent on the city center for work, recreation, and all but the most basic of shopping needs. Notably since the 1950s, however, outward residential movement has been followed by the decentralization of industrial, commercial, and high-level retail activities, and more recently by the growth of office and high-tech sectors, the latter being seen as the "third wave" of suburbanization in the United States. While commentators seem reluctant to abandon the epithet "suburban"—using terms like "the new suburbanization" with its "suburban downtowns"—it would seem that the once-clear distinction between city and suburb is fading fast. Joel Garreau's (1991) "edge city" concept better captures the nature of recent changes, as these threaten to turn the traditional metropolitan area inside out—or at least replace the monocentric city with an essentially polynuclear form of urban region.

Not surprisingly, the demographic character of the suburbs is also changing. As portrayed most effectively by the Chicago School of urban sociology in the 1920s, the suburbs in the United States were the domain of the white family where the wife was engaged full-time in raising children while the bread-winner husband commuted to work in the city. Partly through the process of *in situ* aging, over time these areas have seen a steady increase in the proportion of older couples whose children have left home and—despite some exodus of retirees—of the elderly. Along with the decentralization of non-dormitory urban functions, these areas have also witnessed a suburban apartment boom, drawing in younger single adults and childless couples.

The ethnic complexion of the suburbs has also been changing. While in aggregate there remains a considerable contrast between city and suburb in the proportion of non-whites, the suburb is now far from being a preserve of white families. According to the 2000 U.S. census, as many as 41 percent of the United States' non-whites lived in suburbs, not far short of the 47 percent accounted for by central cities. In 1990, minorities in the United States already accounted for one in six suburban residents, following a decade when their number grew by 53 percent compared to an increase in the minority population of the city by only 25 percent. In the United Kingdom, too, the suburbanization of ethnic minorities was already well advanced by 1991, with non-whites comprising 17 percent of the residents of Outer London, compared to 26 percent for Inner London. According to William Frey (2002), this process is linked to a "new white flight" that in America is helping to push people further away from suburbia towards the metropolitan periphery and into communities that have a rural ambiance.

See also: *Cities, Systems of; Internal Migration; Residential Segregation; Rural-Urban Balance; Urbanization.*

BIBLIOGRAPHY

Berry, Brian. 1976. *Urbanization and Counterurbanization.* Beverly Hills, CA: Sage.

Birch, David. 1975. "From Suburb to Urban Place." *Annals of the American Academy of Political and Social Science* 422: 25–35.

Cervero, Robert. 1989. *America's Suburban Centers: The Land Use–Transportation Link.* Boston: Unwin Hyman.

Champion, Tony. 2001. "A Changing Demographic Regime: Consequences for the Composition and Distribution of Population in Polycentric Urban Regions." *Urban Studies* 38(3/4): 657–677.

Frey, William. 2002. "The New White Flight." *American Demographics* June: 20–23.

Garreau, Joel. 1991. *Edge City: Life on the New Frontier.* New York: Doubleday.

Robert, Stephen, and William Randolph. 1983. "Beyond Decentralization: The Evolution of Population Distribution in England and Wales, 1961–81." *Geoforum* 14: 175–192.

TONY CHAMPION

SÜSSMILCH, JOHANN

(1707–1767)

Known as the father of German demography, Johann Peter Süssmilch was the eldest child of a Berlin brewer and corn merchant. When he was 17, he began medical studies, but, under parental pressure, changed to law at Halle. Believing that he had a religious vocation, he registered at the Faculty of Divinity. There he was advised to read Canon William Derham's *Physico-Theology* (1713, 1726), which aroused his interest in population matters, albeit viewed from a theological perspective. In 1728, he moved to Jena to study philosophy, oriental languages, mathematics, and physics, and to complete his thesis. He was ordained in 1736. The following year he married, eventually having 10 children, among whom 9 survived. After a short stay in a Brandenburg parish, Süssmilch was called to the Court of Prussia by Frederick the Great. He served as a chaplain during the Silesian war in 1740 and in 1742 was named *pastor primarius* in the Petrikirche of Berlin. The first edition of his massive treatise *Die Göttliche Ordnung* (full title translation, The Divine Order in the Transformations of the Human Race as Demonstrated through Birth, Death, and the Multiplication of the Same) in 1741 gained him entry to the Royal Academy of Sciences. Süssmilch, who was financially independent, spent the following years supplementing his statistical documentation and presenting several historical, linguistic, and demographic papers to the Academy. He was also in an economic position to publish two additional, greatly enlarged, editions of his *magnum opus* (1761–1762, 1765). He died as a result of a stroke in 1767.

This "God-intoxicated man," influenced by German philosopher and mathematician Gottfried Wilhelm Leibniz (1646–1716) and English mathematician and physicist Isaac Newton (1642–1727), who wanted to reconcile Calculation and Revelation, asserted that beyond the chaotic appearance of vital events, humankind obeys a constant, general, beautiful, and harmonious order. This divine order is rendered visible only for large numbers of individuals observed over wide regions and long periods, with the help of the theory of probabilities. Süssmilch did not wish to give a precise numerical account of this order, but, rather, to show that the arithmetic of Life and Death was ruled by the hidden or invisible hand of the Supreme Political Arithmetician. By articulating Political Arithmetic (like English political economist William Petty [1623–1687]) and Physico-Theology, demography, as a faithful *ancilla theologiae,* gave birth to a kind of demographic theology.

From a scientific point of view, Süssmilch was not an innovator, but rather a compiler. He did not make any major technical discovery, nor did he make the most of the methodological possibilities of his time. But his aim was different. He was prepared to set aside "all those algebraic calculations," for, in Süssmilch's opinion, Faith did not need any data. Drawing on his encyclopedic knowledge, he wrote the first general treatise of quantitative and qualitative demography in any language, contributing to the triumph of Anglo-Dutch political arithmetic over the German *Staatenkunde,* or descriptive statistics. At the end of the eighteenth century, Süssmilch's theory of divine order gave way to that of the natural order, and positivist thought displaced theological argument. After a period of relative oblivion, Süssmilch's work experienced an unexpected revival in the second half of the twentieth century. The religious and philosophical origins of demography were again of interest to the scientific community; Süssmilch's contribution was reappraised, and sometimes exaggerated. If it cannot be compared with the mathematical contributions to demographic thinking of figures such as Condorcet Pierre-Simon Laplace, or Antoine Cournot, Süssmilch certainly is the indispensable intermediary linking the political arithmetic of John Graunt to the population theorizing of T. R. Malthus (1766–1834) and Adolphe Quetelet (1796–1874). As such, Süssmilch's work represents a major step forward in the history of demography.

See also: *Demography, History of; Population Thought, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY JOHANN SÜSSMILCH.

Süssmilch, Johann Peter. 1983. English Translation of Sections of the 4th Edition of *Die göttliche Ordnung Population and Development Review* 9: 521–529.

———. 1998 [1741]. *Ordre divin dans les changements de l'espèce humaine, démontré par la naissance, la mort et la propagation de celle-ci*, trans. and ann. Jean-Marc Rohrbasser. (Die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts, aus der Geburt, dem Tode und der Fortpflanzung desselben erwiesen) Paris: Institut National d'Études Démographiques.

SELECTED WORKS ABOUT JOHANN SÜSSMILCH.

Birg, Herwig, ed. 1986. *Ursprünge der Demographie in Deutschland, Leben und Werk Johann Peter Süssmilch (1707–1767).* Institut für Bevölkerungsforschung und Sozialpolitik. Bielefeld/Frankfurt/New York: Campus Verlag.

Hax, Herbert, ed. 2001. *Über Johann Peter Süssmilchs "Göttliche Ordnung." Vademecum zu dem Deutschen Klassiker der Bevölkerungswissenschaft,* annotated reprint of the 1st edition. Düsseldorf, Germany: Verlag Wirtschaft und Finanzen.

Hecht, Jacqueline, ed. 1979–1984. *Johann Peter Süssmilch 1707–1767: L'"Ordre divin" aux origines de la démographie. . .* , partial annotated translation of the 2nd edition, 3 vols. Paris: Institut national d'études démographiques.

JACQUELINE HECHT

SUSTAINABLE DEVELOPMENT

Sustainable development is the process of enhancing all people's well-being while maintaining the integrity of the Earth's ecological systems. The concept brings together two interdependent imperatives: on the one hand, the traditional goal of "development," that is, to provide satisfying lives for all people; and on the other, a concern for "ecological sustainability," to live within the ecological capacity of the planet.

The term sustainable development emerged in the 1980s as a result of a critique of traditional development projects. Conventional economic development efforts were recognized as often contributing to ecological degradation and social injustice, thereby undermining the ecological, social, and even economic capital of communities. The qualifier "sustainable" was intended to remedy this limited idea of development.

The most frequently cited definition of sustainable development is from the Brundtland Commission, established by the UN Secretary-General in 1993 to formulate a global agenda for change that would protect the environment and strengthen development. In their widely read report *Our Common Future* (1987), they proposed sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987, p. 43). The Report helped establish sustainable development as a legitimate goal globally and at all levels of government. However, the inability to operationalize the Brundtland Commission's definition stimulated a wide array of interpretations. As originally proposed by David Pearce and his colleagues in 1989, two particularly relevant interpretations have been identified, called *weak* and *strong* sustainability.

Weak and Strong Sustainability

Weak sustainability is said to be achieved if the per capita monetary value of the combined physical, social, and natural assets is maintained. The underlying assumption is that declining overall asset value ("wealth") likely leads to a decline in future social well-being.

This conceptualization links sustainability to economic thinking. However, its practical application is limited by the difficulty of determining many of the relevant asset values. Monetary values can be assigned for assets traded in a market, such as timber or cereals; it is much more difficult to determine a proper value for social and natural assets. More importantly, even if values can be determined, they may not accurately signal that ecological limits are being breached, with serious consequences for human welfare. Also, measures of overall wealth say little about social justice or equitable access to resources and institutions. In spite of such limitations, monetary accounts extended in this fashion can provide valuable information about the future viability of a nation's economy. The "genuine savings" measure is among the most advanced of these measures.

Strong sustainability addresses the difficulty of monetizing assets and combining social and ecological assets by recognizing that some natural assets do not have substitutes. An example is the ozone layer, the loss of which would entail serious harm to human beings and nature. Strong sustainability requires that some critical amount of the non-substitutable natural capital be preserved, independent of any increases in value of other social or physical assets. This criterion is best captured by biophysical measures of the human enterprise.

Essentially, strong sustainability postulates the need for living within the planet's biological capacity or limits; it emphasizes the ecological bottom-line condition for sustainable development. This can serve as a specific, measurable criterion with direct relevance to ecological health as well as to equitable resource access, since limited ecological capacity links directly to questions of distributional justice. Strong sustainability, therefore, becomes the effort to secure quality of life for all, within the means of nature.

Science-based definitions largely agree with the strong view of sustainability. For example, a joint strategy document of the World Conservation Union, the United Nations Environment Programme, and the World Wide Fund for Nature defines sustainable development as "improving the quality of human life while living within the carrying capacity of supporting ecosystems" (*Caring for the Earth* 1991, p. 10). This is spelled out in more specific terms in the four system conditions for sustainability developed by The Natural Step. Through a consensus process among scientists this organization has developed core conditions for sustainability, which can guide planning decisions at all levels towards sustainability. In essence, these conditions maintain that sustainability requires providing satisfying lives for all without turning the Earth's resources into waste any faster than nature can reconstitute waste back into resources.

Limits, Overshoot, and Accounting

When humanity's demands in terms of resource consumption and waste generation exceed the capacity of nature's sources and sinks, human populations move into what is termed ecological overshoot. Ecological limits are not like a rigid wall that brings a speeding car to a halt. Rather, ecological limits are more like financial budgets—they can be transgressed easily. More timber can be harvested than regrows, more fish can be caught than are spawned, more CO_2 can be emitted than nature can reabsorb, and topsoil can be eroded while crops grow.

Initially, most of these transgressions go unnoticed. The signs that humanity has exceeded the biological limits of the planet are separated from consumption decisions by space and time. This separation is compounded by the fact that, at the country level, governments do not keep track of the use of nature in relation to how much is available. As a result, they are unaware of the degree to which development is being achieved through the running down of natural capital rather than through use of nature's regenerative capacity.

A common misperception is that because there are no apparent shortages of raw materials, the concern over ecological limits has been overstated. This confusion comes from the illusion that ecological limits are elastic. This misperception is created by new technologies that enable more rapid resource extraction and easier access to remote locations. As a simple analogy, if a car is low on gas, the fact that it is still possible to accelerate does not disprove the gas gauge's indication of the decreasing total amount of gas remaining in the tank. Similarly, the ability to pump water out of an aquifer more quickly does not change its ultimate capacity or its recharge rate. For this reason, systematic resource accounting—

documenting the cumulative effect of humanity's consumption of natural capital and generation of waste—is a core necessity for achieving ecological sustainability as well as secure access to resources for all. To detect overshoot in advance and avoid it, decision-makers must know whether human demands on nature exceed nature's rate of renewal.

Measuring the Biophysical Dimension

Overshoot is measured by determining how much nature or, more specifically, biological capacity is available and then comparing this supply with human demand. As a simple indicator of the "supply" of nature available, one can measure all of the Earth's biologically productive land and sea spaces: a total of 11.4 billion hectares. Divided by the human population (6.2 billion in 2002), this means that there is an average of 1.8 hectares of space available per person. Adding more people reduces the amount of space, or the supply of nature, available per person.

Humans coexist on Earth with over 10 million other species, most of which are excluded from the spaces occupied intensively for human purposes. This means some of the 1.8 hectares per person need to be set aside and left relatively untouched if a significant number of those other species will be present also in the future.

Conservation biologists suggest setting aside at least one quarter of the Earth's biologically productive space for biopreservation, and in some areas up to 75 percent. The Brundtland Commission proposed protecting 12 percent, which was politically courageous if perhaps ecologically insufficient. Still, this proposal would lower the available bioproductive space per person to just 1.6 hectares—a figure that will diminish as the size of the world's population grows.

This available capacity can be compared to how much biologically productive space people already appropriate to produce their resources and absorb their wastes. One measurement to capture this demand on nature is the "ecological footprint." Ecological footprint accounts are based on two assumptions: first, that it is possible to keep track of most of the resources people consume and the wastes they generate; second, that it is possible to translate many of these demands into a corresponding land or sea area needed to produce those resources. These areas can then be added up and expressed in "global hectares"—standardized hectares with global average productivity. Because they leave out those human impacts on nature that cannot be associated with ecological area, ecological footprints provide a conservative estimate of the human use of nature.

Calculations for 1999, based on Food and Agriculture Organization and other United Nations statistics and documented in the *Living Planet Report 2002,* show that the average ecological footprint for the United States population amounts to 9.6 global hectares per person, more than five times the average that is available per person worldwide. Over half of this footprint is attributed to fossil fuel use, calculated as the area needed to absorb the CO_2 from fossil fuel burning or to replace the fossil fuel energy consumed with biomass energy.

In contrast, the footprint for the average resident of India is 0.8 global hectares, and for the average Italian, 3.8. Worldwide, the average footprint is 2.3 global hectares per person, exceeding the total ecological supply of 1.8 global hectares per person by one quarter. One interpretation of this calculation is that it would take one year and three months to regenerate the resources that are used in one year by the human population.

See also: *Carrying Capacity; Ecological Perspectives on Population; Land Use; Limits to Growth.*

BIBLIOGRAPHY

Caring for the Earth: A Strategy for Living Sustainable Living. 1991. Gland, Switzerland: The World Conservation Union, United Nations Environment Programme, and World Wide Fund for Nature.

Dasgupta, Partha, and Karl-Goran Mäler. 2000. "Net National Product, Wealth and Social Well-Being." *Environment and Development Economics* 5(1 & 2): 69–93.

Hamilton, Kirk. 2000. *Genuine Savings as a Sustainability Indicator.* Washington, D.C.: World Bank.

———. 2002. *Sustaining Per Capita Welfare with Growing Population: Theory and Measurement.* Presented to the 2nd World Congress on Environmental and Resource Economics, Monterey CA, June 24–27, 2002.

Lélé, Sharachchandra M. 1991. "Sustainable Development: A Critical Review." *World Development* 19(6): 607–621.

Living Planet Report 2002. 2002. Gland, Switzerland: World-Wide Fund for Nature, Redefining Progress, and the United Nations Environment Programme's World Conservation Monitoring Centre.

Meyer, Aubrey. 2001. *Contraction and Convergence: The Global Solution to Climate Change.* Schumacher Briefings No. 5 and Global Commons Institute. Totnes, Eng.: Green Books.

Pearce, David, Anil Markandya, and Edward Barbier. 1989. *Blueprint for a Green Economy.* London: Earthscan Publications.

Robért, Karl-Henrik, Herman Daly, Paul Hawken, and John Holmberg. 1997. "A Compass for Sustainable Development." *International Journal of Sustainable Development and World Ecology* 4: 79–92.

Wackernagel, Mathis, Niels B. Schulz, Diana Deumling, Alejandro Callejas Linares, Martin Jenkins, Valerie Kapos, Chad Monfreda, Jonathan Loh, Norman Myers, Richard Norgaard, and Jørgen Randers. "Tracking the Ecological Overshoot of the Human Economy." *Proceedings of the National Academy of Science USA* 99 (14): 9266–9271.

World Commission on Environment and Development [Brundtland Commission]. 1987. *Our Common Future.* Oxford: Oxford University Press.

INTERNET RESOURCES.

Food and Agriculture Organization. 2002. <http://apps.fao.org>.

Redefining Progress. 2002. <http://www.redefiningprogress.org>.

The Natural Step. 2002. <http://www.naturalstep.org>.

Mathis Wackernagel
Karl Steyaert
Kim Rodgers

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TAEUBER, IRENE B.

(1906–1974)

One of the most distinguished demographers of her generation, Irene Taeuber was born in Missouri and graduated from the University of Missouri in 1927. Her graduate training was at Northwestern University and the University of Minnesota from which she received a doctorate in sociology in 1931. Married to Conrad Taeuber, a noted demographer employed for many years at the U.S. Bureau of the Census, she had two children, Richard and Karl, both of whom have pursued careers in demography.

Apart from three years of teaching at Mt. Holyoke College and a brief stint in Washington where, with the eminent demographer Frank Lorimer she edited *Population Literature* for the Population Association of America, most of Irene Taeuber's career was spent at the Office of Population Research at Princeton University which she joined shortly after its founding. There, from 1937 when the first volume appeared, for the rest of her life she co-edited *Population Index,* an annotated bibliography of the world's population research literature, carrying the main responsibilities for the journal during its first 17 years and writing most of the journal's opening "Current Items." Her reputation as a demographer, however, is based primarily on her research contributions, contained in some 200 published items—books, monographs, articles, book chapters, and reviews. The geography of her demographic interests was wide-ranging, covering all continents. Her best-known book, a 462 page volume entitled *The Population of Japan,* appeared in 1958 and was later translated and published in Japan. In the same year she also co-authored with her husband the massive volume *The Changing Population of the United States.* Although primarily a specialist on the populations of Asia—China, Pakistan, India, and the Philippines as well as Japan —Taeuber also wrote on Europe and the United States and on different parts of sub-Saharan Africa. Measurement issues in demography captured her attention too, as did the science of demography itself. Her contributions to the population field can be characterized as demographic description and analysis at its best, with a truly international purview. A full bibliography of her writings appears as an appendix to a 1975 memorial note in *Population Index* by Frank Notestein.

Professional appreciation of Taeuber's research contributions was signaled by the many academic honors she received during her lifetime. She was president of the Population Association of America from 1953 to 1954 (the first woman to serve in that capacity) and vice-president of the International Union for the Scientific Study of Population from 1961 to 1965. In Princeton, her formal rank was initially Research Associate at the Office of Population Research and, from 1961 until her retirement in 1973, Senior Research Demographer. At that time, Princeton employed very few women as faculty; under later circumstances she would probably have had a "regular" professorial career. After her death the Population Association of America established the biennial Irene B. Taeuber Award to honor her memory.

See also: *Demography, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY IRENE B. TAEUBER.

Taeuber, Conrad, and Irene B. Taeuber. 1958. *The Changing Population of the United States.* U. S. Bureau of the Census and the Social Science Research Council, Census Monograph Series. New York: John Wiley.

Taeuber, Irene B. 1958. *The Population of Japan.* Princeton: Princeton University Press. Published in Japanese as *Nihyon Jinko* (Tokyo: Mainichi Press, 1965).

———. 1962. "Japan's Population: Miracle, Model, or Case Study?" *Foreign Affairs* 40 (July): 595–604.

———. 1964. "Population and Society." In *Handbook of Modern Sociology,* ed. Robert E. L. Faris. Chicago: Rand McNally.

———. 1969. "Population Growth in Less Developed Countries." In *The Population Dilemma,* 2nd edition, ed. Philip M. Hauser. Englewood Cliffs, NJ: Prentice-Hall.

———. 1972. "Chinese Population in Transition: The City-States." *Population Index* 38 (January–March): 3–34.

———. 1972. "Growth of the Population of the United States in the Twentieth Century." In *U.S. Commission on Population Growth and the American Future, Research Reports,* Vol. 1: *Demographic and Social Aspects of Population Growth,* ed. Charles F. Westoff and Robert Parke, Jr. Washington, D.C.: Government Printing Office.

———. 1973. "The Data and the Dynamics of the Chinese Populations" *Population Index* 39 (April): 137–170.

Taeuber, Irene B., and Conrad Taeuber. 1971. *People of the United States in the Twentieth Century.* U.S. Bureau of the Census and the Social Science Research Council, Census Monograph Series. Washington, D.C.: Government Printing Office.

Charles F. Westoff

TECHNOLOGICAL CHANGE AND POPULATION GROWTH

The relationship between population growth and technological change has been debated since the end of the eighteenth century—a debate whose main configuration has proved remarkably persistent. During the ensuing 200 years, historically unprecedented rates of change have been observed in both variables: in industrial, commercial, and communications revolutions spreading out from Europe, North America, and Japan; in parallel (though spatially and temporally uneven) revolutions in the technological base of agricultural production; and in a demographic transition—in which mortality decreased and fertility first increased, then decreased—that is still underway in many developing countries. Interconnections there must be, yet the attribution of primacy and direction of causation among these variables, not to mention the nature of the mechanisms involved and means of influencing outcomes in the interest of meeting social goals, remain controversial. Meanwhile, a new awareness of the emergence of complex social-environmental systems, whether at local or global levels, has extended the debate beyond the discipline of economics, and broadened its emphasis from the welfare of the human race to that of the planet.

Malthus: Limits and Closed Systems

Two grand theories dominate the macro-demographic debate, differing on whether technological change is regarded as originating from within (endogenous) or outside (exogenous) the system in question. Proponents of "neo-Malthusian" views, following T. R. Malthus's *Second Essay* of 1803 and its subsequent revisions, emphasize the biophysical limits to resources (whether renewable or non-renewable), in a system that is essentially closed. Technological advances, which are introduced to the system by autonomous invention, can increase productivity, thus buying time for growing populations, but they serve to stimulate further growth. Continued growth entails eventual diminishing returns to labor or capital and scarcities in food or other commodities. As the prevailing technology determines the "carrying capacity" of natural resources, in Malthus's own time it seemed natural to point to the famous "checks" which, by increasing mortality, brought the population back into equilibrium. In the world of the early twenty-first century, the environmental agenda interposes scenarios of the destruction or degradation of natural resources between predicted population growth and an eventual Malthusian outcome. Indeed, the threat of mass mortality has receded in a post-Cold War world in which boundless confidence in the potential of induced technological change, and a capacity to ship food and other necessities in large quantities from surplus to deficit regions, have shifted the geographical reference from local or national to global.

Technological change holds out the promise of rising global income levels, following the example of the developed world. Yet it also brings potential threats—two in particular. On the one hand, it is seen as having facilitated population growth in poor societies to ultimately insupportable levels (as in Ireland in the mid-nineteenth century), and on the other, it has generated demands, especially in richer societies, for an unsustainable exploitation of nature, with effects that may be global (e.g., atmospheric warming). It is far from obvious that the economic benefits of urban-industrialism can eventually be extended to the world's poor. Led by writers such as Paul and Anne Ehrlich and Lester Brown, a powerful constituency emerged in support of population limitation in countries with high fertility. To reflect the multivariate nature of the environmental threat, Ehrlich and Holdren in 1974 invented the *I=PAT* formulation (Impact of an economic system on the environment = Population × Affluence × Technology). However, although its simplicity has recommended it to many researchers and policy makers, the complex interdependencies and dynamics among *P, A,* and *T* render it unsuitable as a model of complex systems.

Boserup: Technological Change and Agricultural Growth

A view of technological change as endogenous is often associated with the economist Ester Boserup (1910–1999), who explored the implications of this assumption for agricultural growth. Such views see necessity as the mother of invention and the uptake of technology as a process driven by changing factor proportions, in particular (in the agricultural case) those between labor and land. As scarcity drives up the value of land, and of agricultural and other outputs, investments in higher productivity become possible, first as additional labor per hectare (by increasing the frequency of cultivation or the intensity of weeding and fertilizing) and then, as increasing population densities generate markets and urban concentration, in the form of investments in land improvements. At low population densities, labor-saving investments best respond to poor farmers' factor ratios; but as densities increase, land-saving investments become necessary. Adoption of known technologies (whether indigenous or imported) is the key process, though Boserup acknowledged that demographically-driven demand can also play a role in spurring new inventions. An analysis of the technological history of agriculture and its relations with the growth of dense and secure populations, cities, and commerce, suggests "a quantitative relationship between an area's population density and its predominating food supply system" (Boserup 1981, p. 15). However, a growing density is a necessary, but not a sufficient, condition for labor-intensive agricultural growth. This is reflected in the technological diversity among contemporary farming systems in developing countries.

The economist Julian Simon (1932–1998) took this argument further. National data from many countries—rich and poor, North and South—suggested a correlation between indicators of population size and growth on the one hand and technical innovation and cultural creativity on the other. Inventive potential is considered to be randomly distributed in a population (equity, education, interaction, and other variables being equal). "Hence the net result of an additional person is an increase in the total number of new ideas" (Simon 1986, p. 377). Taking a strong stance on the potential of technology to extend the effective size of resource inventories, to enable recycling, and if necessary to substitute for scarce resources, Simon argued against the advocates of population limitation. "Population growth spurs the adoption of existing technology as well as the invention of new technology" (Simon 1996, p. 376).

There is indeed an accumulation of knowledge about historical achievements in food and agriculture that calls into question models and scenarios predicting imminent scarcity or ecological collapse such as those found in *The Limits to Growth* (Meadows et al., 1972). FAO data show that in the 1990s, developing countries were increasing cereal output by 1.5 to 2.2 percent yearly on a cultivated area-per-person that had declined from 0.18 ha in 1960 to 0.10 ha in 1995. However, investing in technology requires economic incentives, as shown by the history of the green revolution in Asia or improved corn yields in Africa. An urban-industrial sector may be essential to motivate surplus production and offer a stream of new technologies, which in turn provide a route to high-productivity agriculture and promote the structural transformation needed in countries having abundant rural labor.

African Case Studies

A case study from Kenya illuminates these relationships. In the Machakos and Makueni Districts of Kenya, decades of rapid population growth, massive losses of natural capital through soil erosion and deforestation, and high food insecurity appeared to justify a Malthusian perspective—which was in fact embraced by the government and its advisers. However, closer investigation reveals a revolution in land conservation and economic productivity since the 1930s, favoring instead a broadly Boserupian process of change. In the 1930s wealth was channeled into livestock as the most readily marketable commodity the farming families in these districts could produce. Between 1930 and 1990, against a background of a sixfold increase in population and a massive transfer of land from common grazing land and woodland to permanent, privately owned farmland, the value of agricultural output per head increased nearly fourfold and its value per hectare more than elevenfold. Keys to this achievement were changes in the profitability, sources, and technological priorities of private investment. Aggressive (even coercive) promotion of soil conservation measures by the government during the 1940s and 1950s produced a minor "Machakos miracle" of landscape transformation, which did not survive for long after independence (1962). The real "miracle" occurred later, beginning in the 1970s, when farmers in the long-settled and very densely populated hills recognized that conservation terraces improved crop yields (through their beneficial effects on soil moisture) and embarked energetically on private investment in terracing.

Further incentives for investment derived from improved access to markets (especially the coffee market, previously restricted to European producers), a loosening of restrictions on selling corn outside the district, and above all the rapid growth of urban demand for fruit and horticultural crops, which progressively opened up new agricultural options. Farmers could draw on a growing bank of technological knowledge from both government and private sources. The agrarian transformation extended even to the driest areas, although the inhabitants of those areas were acutely aware of their constrained farming opportunities (due to drought, risks to animal health, and high cost of access to markets) and were more dependent on diversifying their incomes through education and migration. The social distribution of the benefits of this transformation were far from equitable and farmers continued to face significant economic and ecological risks. However, in broad terms a Boserupian framework appears to offer a valid explanation of the outcomes of long-term interaction between the growth of population and of technology.

The Boserupian model originally reflected Asian rather than African experience. The vigor of debate on the African cases (of which there are many; see Turner et al., 1993) reflects both the rapidity of economic and ecological change under rapid rates of population growth (fertility has only recently begun to decline in Africa) and the severity of environmental degradation as perceived by some international agencies. As the African drylands have a low agroecological potential, high risk of drought, and high rates of population growth, they pose the sharpest challenges to adaptive technology. Yet the possibility of a transition from more extensive (land-using) technologies, which are unsustainable under conditions of population growth, to more intensive (labor-using)—and sustainable—ones, even where the supply of capital is severely constrained by poverty, is suggested by a variety of African evidence. In Kano in Nigeria, on-farm population densities of over 220/km^2 have evolved on a time-scale of centuries, supported by a system of fertilized annual cultivation, and in symbiosis with major urban product and labor markets. In Maradi in Niger a build-up of population through rapid in-migration, with extensive deforestation for farming, collided with the drought cycles of the 1970s and 1980s to threaten a collapse in productivity in a classic Malthusian crisis. But subsequently, there is evidence that a mix of market forces, project interventions, and indigenous investments have halted and in places begun to reverse this trajectory. Grain production per head has been maintained, in part through additional labor and investment.

A Synthesis

An opposition between a view of population (Malthus) or technology (Boserup) as the dependent variable has not discouraged some analysts—including Pryor and Maurer (1982), Lee (1986), and

Simon (1992)—from suggesting that a theoretical synthesis is possible. Simon proposed a single integrative model of technological change in which Malthusian "innovation-pull" and Boserupian "population-push" hypotheses coexist. The real world has also moved on: just as no closed Malthusian systems exist at the local or national level in the early twenty-first century, so Boserup's open system is finally closed at the global scale.

At its core, Malthusian theory posits an equilibrium between population and resources. Many environmentalists seek to control or reverse what they see as maladaptive departures from that equilibrium. However, some ecologists challenge this view of nature, seeing in many ecosystems evidence of variability, irreversibility, crisis, and surprise. A Boserupian frame of reference appears better suited to a dynamic and nonlinear view of social-environmental systems as it contains implicit provision for such concepts as thresholds, transitions, creative changes between states, and resilience under stress. Analysis of the complex interactions among populations, technologies, and environments should not be constrained in advance by modeling assumptions.

See also: *Boserup, Ester; Carrying Capacity; Energy and Population; Limits to Growth; Natural Resources and Population; Simon, Julian L.; Sustainable Development.*

BIBLIOGRAPHY

Boserup, Ester. 1965. *The Conditions of Agricultural Growth.* London: Allen and Unwin.

———. 1981. *Population and Technology.* Chicago: University of Chicago Press.

Ehrlich, Paul R., and Anne H. Ehrlich. 1970. *Population, Resources and Environment: Issues in Human Ecology.* New York: W. H. Freeman.

Ehrlich, Paul R., and J. Holdren. 1974. "The Impact of Population Growth." *Science* 171: 1212–1217.

Gunderson, L. H., C. S. Holling, and S. S. Light. 1995. *Barriers and Bridges to the Renewal of Ecosystems and Institutions.* New York: Columbia University Press.

Kasperson, J. X., R. E. Kasperson, and B. L. Turner II, eds. 1995. *Regions at Risk: Comparison of Threatened Environments.* Tokyo: United Nations University Press.

Lee, Ronald D. 1986. "Malthus and Boserup: A Dynamic Synthesis." In *The State of Population Theory: Forward from Malthus,* eds. D. Coleman, and R. Schofield. Oxford: Basil Blackwell.

Meadows, Donella et al. 1972. *The Limits to Growth: A Report for the Club of Rome.* New York: Picador.

Mortimore, Michael. 1998. *Roots in the African Dust: Sustaining the Sub-Saharan Drylands.* Cambridge, Eng.: Cambridge University Press.

Rosenberg, Nathan, and L. E. Birdzell Jr. 1987. *How the West Grew Rich: The Economic Transformation of the Industrial World.* New York: Perseus Books.

Simon, Julian L. 1986. *Theory of Population and Economic Growth.* New York: Blackwell.

———. 1992. *Population and Development in Poor Countries.* New Haven, CT: Princeton University Press.

———. 1996. *The Ultimate Resource 2.* Princeton, NJ: Princeton University Press.

Tiffen, M., and Michael Mortimore. 1994. "Malthus Controverted." *World Development* 22: 997–1,010.

Tiffen, M., Michael Mortimore, and F. Gichuki. 1994. *More People, Less Erosion: Environmental Recovery in Kenya.* Chichester, Eng.: John Wiley.

Tomich, T. P., P. Kilby, and B. F. Johnson. 1995. *Transforming Agrarian Economies: Opportunties Seized, Opportunities Missed.* Ithaca, NY: Cornell University Press.

Turner, B. L. II, G. Hyden, and R. W. Kates. 1993. *Population Growth and Agricultural Change in Africa.* Gainesville: University Press of Florida.

MICHAEL MORTIMORE

TEMPORARY MIGRATION

A temporary worker generally enters a country for a fixed-time period for a particular occupation or employer, must leave when the period expires, and in most cases is not entitled to family reunification or adjustment to permanent residence. Temporary worker programs cover both unskilled and highly skilled labor. A typical program range was categorized by Heinz Werner (1996) as follows:

1. One-year work permits for experts and executives;
2. Border crossing permits allowing residents of neighboring countries or territories to enter the host country daily or weekly to work;
3. Seasonal work permits;
4. Project-tied contract labor authorizing entry for completion of a specific project; and
5. Trainee permits allowing individuals to work in the country for a defined period of time to gain certain occupational or language skills.

Many countries simultaneously operate multiple programs.

The majority of temporary work is defined as contract labor, which includes both project-tied labor and seasonal labor. Often an employer or recruiter organizes workers for a specific project or for an agricultural season. Project-tied labor involves giving a contract to a foreign company, which can then bring in its own labor for the duration of the project. The International Labor Organization (ILO) has attempted to create standards applying to temporary workers that cover their employment conditions (e.g., hours worked, paid holidays, ability to unionize, access to social security, written contract), provision of equal opportunity, rights to family visitation, and the right to have their grievances investigated fairly.

Contract labor frequently is part of a bilateral agreement between two countries as one component of an economic development plan. Countries also use temporary worker programs to regularize the flow of labor, reduce undocumented migration, and improve bilateral relations more generally. Contracts under bilateral agreements, particularly for seasonal workers, often specify duration of stay, wages, employer, workers' rights (if any), and employer coverage of travel and housing.

Seasonal programs generally require certification of the unavailability of domestic labor prior to employers being allowed to recruit foreign workers. The duration of stay varies in length: three months in Germany, six months in France, nine months in Switzerland, and up to one year in the United States. The size of the programs varies from country to country as well: Germany admitted between 125,000 and 225,000 workers annually in the 1990s (and allowed for up to 20,000 information technology professionals); Canada admitted approximately 17,000 under its seasonal agricultural programs; and the United States permitted entry to approximately 75,000 unskilled temporary workers annually during that same time frame, as well as another 100,000 or so high-skilled workers.

Frontier programs have been used primarily in Germany (with Polish and Czech workers) and in Switzerland (with French, Italian, German, and Austrian workers). While there is no quota or required labor market test, employers must pay prevailing wages. Trainee program participants generally range from a few hundred to a few thousand per country, are not normally subject to a labor market test, and have limited opportunities for adjustment to a permanent status.

Certain nationalities tend to comprise the majority of the world's temporary workers; the Philippines, for example, is the world's largest exporter of labor. Filipino and Sri Lankan workers go to the Gulf States; Bangladeshi workers go to Singapore; Mexicans (in the lower-skilled tier) and Indians (in the higher-skilled tier) are prominent in the U.S. programs; Thai and Romanian workers can be found in Israel; Ukrainian and Turkish workers drift to Russia; Moroccan workers predominate in Spain; and Polish workers fill many of Germany's programs.

Similarly, only particular sectors and occupations have turned to foreign labor, historically and currently, to remedy micro-level shortages. Temporary workers played a vital role in driving twentieth century economic growth, including during European industrialization, during the United States's wartime labor shortages, during the Gulf States's oil boom, and during Asia's rapid economic growth in the 1980s. Specific occupations include physically demanding or dangerous jobs such as construction, agriculture, mining, domestic services, and tourism, as well as newer occupations such as computer programming and other highly skilled information technology jobs.

Common Issues

Regardless of country, all entities designing or managing temporary worker programs face similar challenges. Among the issues they must consider are: (1) the extent of government involvement; (2) the impact on the domestic labor force; (3) unintended, but predictable consequences; and (4) internal program consistency. The first issue was discussed above in terms of whether sending and receiving governments choose to engage in bilateral agreements, but it also includes considerations such as whether the program is administered by a government agency or the private sector, and whether the sending country is actively engaged in worker screening and in protecting the rights of its workers abroad.

The second issue is the challenge to design a program that avoids any adverse impact on the existing native-born work force or any financial advantage to employers in hiring foreign workers. Countries address this through a variety of means, including highly regulated recruitment requirements, worker quotas, required certification of labor shortages, provision of rights and benefits to foreign workers equal to those of domestic workers, access to social security credits, and taxes on employers who import foreign labor. Imposition of a tax for each worker aims to prevent employer dependence on foreign labor; often it is earmarked for a fund to train and recruit domestic workers.

Third, a review of previous temporary worker programs indicates that, in many cases, the creation of such programs stimulates additional migration by creating new migration chains that continue long after the program's termination. Governments, then, must be careful in designing new programs and in considering the potential consequences of existing initiatives that attract new pools of migrants. Research also has demonstrated that a small percentage of workers will likely remain in the receiving country after expiration of the program. Some receiving governments discourage this by allowing only short stays, providing workers with few protections, engaging in repatriation programs, placing responsibility on employers for workers' departures, and even seizing workers' travel documents. Some sending governments encourage workers to return by withholding a percentage of their pay until their return or by offering higher interest rates for the foreign currency brought home. Broader efforts include joint development programs with receiving governments that provide housing and job training for the workers upon their return home, as well as the ability of workers to earn social security credits for their work abroad.

Finally, many countries face the challenge of developing and maintaining internal consistency in their programs. Mixed policy messages, such as devising strict admissions regulations but allowing adjustment after a certain period of time, or issuing long-duration but still "temporary" visas, tend to undermine program success. Moreover, programs that have process-intensive, but ineffective, labor market tests and programs that have stringent but poorly enforced rules pose great challenges to the effectiveness of temporary worker programs.

See also: *Internal Migration; Labor Migration, International.*

BIBLIOGRAPHY

Böhning, W. R. 1984. *Studies in International Labor Migration.* New York: Macmillan.

Cohen, Robin, ed. 1995. *The Cambridge Survey of World Migration.* Cambridge, Eng.: Cambridge University Press.

Congressional Research Service (CRS). 1989. *Temporary Worker Programs: Background and Issues* (1980). Washington, D.C.: U.S. Government Printing Office.

International Organization for Migration (IOM). 2000. *World Migration Report 2000.* New York: International Organization for Migration and United Nations.

Martin, Philip L. 1998. "Germany: Reluctant Land of Immigration." *German Issues,* Vol. 21. Washington, D.C.: American Institute for Contemporary German Studies, Johns Hopkins University.

Miller, Mark J., and Philip L. Martin. 1982. *Administering Foreign-Worker Programs.* Lexington, MA: D.C. Heath.

Organisation for Economic Co-operation and Development. 2001. *Trends in International Migration. Annual Report.* Paris: OECD.

Stalker, Peter. 1994. *The Work of Strangers: A Survey of International Labour Migration.* Geneva, Switzerland: International Labor Organization.

Werner, Heinz. 1996. "Temporary Migration of Foreign Workers." In *Temporary Migration for Employment and Training Purposes.* Strasbourg: Council of Europe.

Deborah Waller Meyers

THOMAS, DOROTHY SWAINE

(1899–1977)

Dorothy Swaine Thomas was born in Baltimore, Maryland, and educated at Barnard College (B.A. 1922) and the London School of Economics (Ph.D. 1924). Her principal mentors were the sociologist William F. Ogburn, the economist Wesley C. Mitchell, the statistician Arthur L. Bowley, and one of the founders of American sociology, W. I. [William Isaac] Thomas, whom she married in 1936.

Between 1924 and 1948 Thomas received research or academic appointments at the Federal Reserve Bank of New York, the Social Science Research Council, Columbia University Teachers College, Yale University, the Social Science Institute at the University of Stockholm, and the University of California at Berkeley. In 1948 she became the first woman professor in the Wharton School of the University of Pennsylvania, where she was a research professor of sociology. At the Wharton School she initiated an interdisciplinary doctoral training program in demography and helped found and direct the Population Studies Center.

After her retirement from the Wharton School in 1970, Thomas taught at Georgetown University for four years. She served on numerous occasions as a technical consultant to the United Nations and to U.S. government agencies. She was the first woman elected president of the American Sociological Association (1952), was president of the Population Association of America (1958–1959), and received an honorary doctorate from the University of Pennsylvania in 1970 for her work in demography.

In her demographic career two features are evident in Thomas's work: the importance of careful measurement and sensitivity to the interplay between demographic change and economic change. In Thomas's demographic work her concern with measurement centered primarily on internal migration, the subject that eventually became the focus of her research. As chair of the Social Science Research Council's Committee on Migration Differentials, she authored a 1938 study that set the research agenda of the field for the next several decades. Subsequently she codirected with the economist Simon Kuznets the University of Pennsylvania project on population redistribution and economic growth (Thomas, 1957, 1960, 1964). Among its other findings, this project produced definitive estimates of internal migration in the United States by sex, age, race, nativity, and state of origin and destination by decade, covering the period 1870–1950; the study was authored by Everett S. Lee. As chair of the Committee on Internal Migration of the International Union for the Scientific Study of Population Thomas collaborated in producing United Nations Manual VI, *Methods of Measuring Internal Migration,* in 1970.

Thomas's attention to economic–demographic relationships dates from her 1925 doctoral dissertation, *Social Aspects of the Business Cycle,* which documented statistically the relationship of vital rates and other social phenomena to short-term business cycles. In her 1941 study *Social and Economic Aspects of Swedish Population Movements*, the focus shifted to economic–demographic relationships over the long term, again with statistical time series as the basis of analysis. Her 1964 collaborative project on U.S. population redistribution and economic growth demonstrated that decade-to-decade swings in internal migration were linked to the level of economic activity.

Thomas's most famous work, which is not cited frequently by demographers, is her coauthored two-volume 1946 and 1952 study of the forced evacuation, detention, and resettlement of West Coast Japanese Americans during World War II. This work was pieced together under difficult circumstances with the aid of graduate student assistants, and—according to Thomas's 1977 obituary in the American Sociological Association's *Footnotes*—its scientific objectivity "was vindicated when the Supreme Court accepted her books as unbiased evidence of our crimes against our fellow Americans" (quoted in Roscoe 1991, p. 406).

Thomas was a gifted scholar capable of making fundamental contributions to many areas in demography and sociology. At a time when professional academic careers were virtually closed to women, she made a lasting mark and can be considered one of the founders of American demography.

See also: *Demography, History of; Kuznets, Simon.*

BIBLIOGRAPHY

SELECTED WORKS BY DOROTHY SWAINE THOMAS.

Thomas, Dorothy S. 1925. *Social Aspects of the Business Cycle.* London: Routledge and Kegan Paul.

(New York: Knopf, 1928.) Reprinted, New York: Gordon and Breach, 1968.

———. 1938. *Research Memorandum on Migration Differentials.* New York: Social Science Research Council.

———. 1941. *Social and Economic Aspects of Swedish Population Movements, 1750–1933.* New York: Macmillan.

———. 1952. "Experiences in Interdisciplinary Research." *American Sociological Review* 17: 663–669.

———. 1964. "Temporal and Spatial Interrelations between Migration and Economic Opportunities." In *Population Redistribution and Economic Growth, United States 1870–1950,* Vol. III: *Demographic Analyses and Interrelations,* ed. Hope T. Eldridge and Dorothy Swaine Thomas. Philadelphia: American Philosophical Society.

Thomas, Dorothy S., Charles Kikuchi, and James Sakoda. 1952. *Japanese American Evacuation and Resettlement: The Salvage.* Berkeley: University of California Press.

Thomas, Dorothy S., ed., with Simon Kuznets. 1957, 1960, 1964. *Population Redistribution and Economic Growth, United States, 1870–1950.* Philadelphia: American Philosophical Society. Vol. I: *Methodological Considerations and Reference Tables,* 1957; Vol. II: *Analysis of Economic Change,* 1960; Vol. III: *Demographic Analyses and Interrelations,* 1964. Memoirs of the American Philosophical Society, 45, 51, 61.

Thomas, Dorothy S., and Richard S. Nishimoto. 1946. *Japanese American Evacuation and Resettlement: The Spoilage.* Berkeley: University of California Press.

SELECTED WORKS ABOUT DOROTHY SWAINE THOMAS.

Bannister, Robert C. 1998. "Dorothy Swaine Thomas: The Hard Way in the Profession." Originally published as "Dorothy Swaine Thomas: Soziologischer Objectivismus: Der harte Weg in die Profession." In *Frauen in der Soziologie,* ed. Claudia Honeggerund und Teresa Wobbe. Munich: Oscar Beck.

Goldenstein, Sidney. 1977. "Dorothy Swaine Thomas, 1899–1977." *Population Index* 43: 447–450.

Lee, Everett S. 1979. "Thomas, Dorothy Swaine." In *International Encyclopedia of the Social Sciences,* Vol. 18: *Biographical Supplement,* ed. David L. Sills. New York: Free Press.

Roscoe, Janice. 1991. "Dorothy Swaine Thomas (1899–1977)." In *Women in Sociology: A Bio-Bibliographical Sourcebook,* ed. Mary Jo Deegan. New York: Greenwood Press.

United Nations. 1970. *Methods of Measuring Internal Migration,* Manual VI, Department of International Economic and Social Affairs. New York: United Nations.

INTERNET RESOURCE.

University Archives and Records Center, University of Pennsylvania. "Guide to Dorothy Swaine Thomas Papers, 1929–1977." <http://www.archives.upenn.edu/faids/upt/upt50/thomasdot.html>.

Richard A. Easterlin

THOMPSON, WARREN S.

(1887–1973)

Warren Simpson Thompson received his Ph.D. in sociology from Columbia University in 1915. As a student of the sociologists Alvan A. Tenney and Franklin Giddings, and the statistician Robert E. Chaddock, he developed an early interest in international population trends and in problems associated with rapid population growth. In his dissertation, *Population: A Study in Malthusianism* (1915), he argued that U.S. population growth rates directly responded to changes in the food supply. In the early 1920s, Edward W. Scripps, the newspaper publisher, grew concerned about population and sought out Thompson on the basis of his dissertation. After a tour of Asia aboard Scripps's yacht, Thompson agreed to head the first foundation exclusively focused on the study of population. The Scripps Foundation for Research in Population Problems, located at Miami University in Oxford, Ohio, in Scripps's home county of Butler, was established in 1922. Pascal Kidder Whelpton (1893–1964), an agricultural economist from Cornell University, joined Thompson as assistant director in 1924. After Scripps's death in 1926, finances for the foundation were fixed at a modest level, preventing its further expansion. As director of this foundation, Thompson engaged in studies of both international and domestic demographic trends for 30 years.

In 1929, Thompson published two notable works on international population dynamics: a book, *Danger Spots in World Population* and an article "Population" in the *American Journal of Sociology*. In the latter, Thompson elaborated an early version of demographic transition theory. He placed all countries into three groups based on trends in their rates of natural increase. He assumed that countries would progress from Group C (high birth and death rates) to Group B (high birthrates but declining death rates) to Group A (low birth and death rates) as they became increasingly industrialized. In *Danger Spots in World Population,* Thompson used this framework to identify regions experiencing population problems and to derive policy recommendations. In a controversial analysis, he concluded that Japan, then in a period of rapid population expansion, had only one policy alternative: "to expand by the acquisition of more territory" (Thompson, p. 43). This theory that seemed to support Japanese imperialism generated little interest among Western policymakers during the interwar period.

Thompson's *Population Problems,* first published in 1930, was the major textbook in population studies until the 1960s. *Population Trends in the United States* (1933), written with Whelpton, established him as a leading forecaster of U.S. population trends. (His and Whelpton's set of projections for the United States, published in 1943, gave 2000 totals under variant assumptions ranging from 129 million to 198 million.) In 1944, Thompson again turned his attention to international population trends in *Plenty of People,* which contained an updated version of his 1929 transition framework. In the period from 1944 to 1946, Thompson, sociologist Dudley Kirk (1913–2000), economist Frank Notestein (1902–1983), and sociologist Kingsley Davis (1908–1997) all generalized the Western demographic experience in similar ways. Together, their work constitutes the classic theory of the demographic transition.

In *Population and Peace in the Pacific* (1946), Thompson outlined the major population problem of the post-World War II period: rapid population growth in colonial areas. Internal order, improved transportation systems, and public health innovations were lowering mortality, yet mother countries were not fostering the industrialization and urbanization that would work to lower fertility. Thompson predicted that this "Malthusian dilemma" would bring about the end of colonialism. In the immediate post-World War II period, Thompson went to Japan as an advisor to General Douglas MacArthur leader of the Occupation forces. Japan's birth rate experienced a sharp increase from 1946 through 1949, and Thompson predicted severe overpopulation. He called on the Japanese government to take "positive measures" to reduce the birth rate. Japan did, in fact, make abortion and contraception readily available and its total fertility rate fell by 50 percent over the next decade, a decline that Thompson had thought impossible. In 1953, Thompson stepped down as director of the Scripps Foundation and was succeeded by Whelpton.

See also: *Demography, History of; Demographic Transition; Population Thought, Contemporary; Whelpton, P. K.*

BIBLIOGRAPHY

SELECTED WORKS BY WARREN S. THOMPSON.

Thompson, Warren S. 1929. *Danger Spots in World Population.* New York: Alfred A. Knopf.

———. 1929. "Population." *American Journal of Sociology* 34(6): 959–975.

———. 1930. *Population Problems* (5th edition, 1965) New York: McGraw Hill.

———. 1946. *Population and Peace in the Pacific.* Chicago: University of Chicago Press.

———. 1948. *Plenty of People: The World's Population Pressures, Problems and Policies and How They Concern Us,* Rev. edition. New York: Ronald Press.

———. 1959. *Population and Progress in the Far East.* Chicago: University of Chicago Press.

Thompson, Warren S., and P. K. Whelpton. 1943. *Estimates of Future Population of the United States, 1940–2000.* Washington, D.C.: National Resources Planning Board.

———. [1933] 1969. *Population Trends in the United States.* New York: Gordon and Breach Science Publishers.

DENNIS HODGSON

TOBACCO-RELATED MORTALITY

Of all the risks to human health, perhaps none has been studied as extensively as tobacco use. Claims about the hazards of smoking tobacco had been voiced for centuries prior to the first scientific studies on the extent of the risk in the early 1950s. Beginning with the pioneering work carried out in the United Kingdom by epidemiologists Richard Doll and Austin Bradford-Hill, cigarette smoking was first identified as a cause of lung cancer and, later, as a cause of numerous other cancers, as well as major respiratory and vascular diseases.

The evidence on causality for tobacco use as a cause of disease and death has become irrefutable. It has been firmly established in numerous case-control, as well as cohort, studies in several developed countries including the United Kingdom, the United States, Sweden, and Japan. Studies in China and India confirm that tobacco use in parts of the developing world is becoming an increasing health hazard in these populations.

In populations where smoking has been prevalent for decades, tobacco causes about 90 percent to 95 percent of lung cancer deaths, about two-thirds of upper aero-digestive tract cancers (and 40% to 50% of all cancer deaths), three-quarters of chronic bronchitis and emphysema deaths, and about one-fifth of all deaths from ischemic heart disease and stroke. Smokers typically have a 20- to 25-fold higher risk of lung cancer than non-smokers, and about a 3-fold higher risk of suffering a heart attack or stroke, compared with lifelong non-smokers. In younger smokers (less than 50 years of age), the risk of coronary heart disease or stroke is typically five to six times higher than in non-smokers. Overall, death rates for smokers are about 2.5 to three times higher than for non-smokers at all ages above 35 years.

The epidemiology of tobacco often leads to a serious misunderstanding of the full health effects of tobacco use. Most of the excess risk of diseases caused by tobacco only occurs several decades after persistent smoking has become widespread. This long delay between the uptake of tobacco use in a population and its full health effects can be misinterpreted to mean that tobacco is not a major cause of death. In developed countries, males began smoking in large numbers in the early decades of the twentieth century (a 60–70% prevalence of smokers among male adults was not uncommon), and by the early 1960s, cigarette consumption had peaked among men in these countries. However, mortality from tobacco use only began to rise beginning in the 1950s, increasing from an estimated annual death toll of about 300,000 in 1950 (20% of all deaths) to 1.45 million (28%) in 1995.

Women in developed countries began smoking much later than men, the practice being adopted first by women in Britain, the United States, Australia, Canada, and New Zealand in the 1930s and thereafter, and, since 1950, increasingly by women in Europe. Prevalence among women has become similar to that of men in these countries, but because they have been smoking for much shorter periods the full health effects are not yet evident. From causing virtually no deaths in 1950, tobacco in the early twenty-first century causes around 500,000 deaths annually among women in developed countries, half of these in the United States alone. This toll is expected to increase dramatically over the first and second decades of the twenty-first century as the impact of past consumption among women becomes apparent.

Overall, cigarette consumption in developed countries peaked in the 1980s and has been steadily declining at the rate of about 1.0 percent per year since then. Much of this decline can be attributed to the success of tobacco control measures taken by these countries, including bans or restrictions on advertising, restricting smoking in public places, increased taxation on cigarettes, banning vending machines for cigarettes, the inclusion of warning labels on cigarette packets, and public information campaigns. As a result, the annual toll of about 2 million deaths from tobacco use in these countries may not rise much higher. The effect of declining mortality among men will progressively outweigh the expected increases in female tobacco-caused deaths over the first two or three decades of the twenty-first century.

In developing countries, cigarette consumption has been relatively low, especially among women. However, smoking of either manufactured or home-made cigarettes has now become increasingly common in most developing countries: about half of all men are regular smokers, and about 10 percent of women. Hence, tobacco-related mortality, still comparatively low, can be expected to increase steeply. In China, where cigarette consumption has quadrupled since 1975, tobacco already causes about 1 million deaths annually. A comparable number (1 to 1.5

million) of deaths occur in the remainder of the developing world. If current trends continue, and cigarette consumption proves as hazardous in developing countries as elsewhere, tobacco use is projected to cause 10 million deaths per year by 2030, 7–8 million of which will be in developing countries. This would make tobacco use by far the greatest contributor to the burden of disease world-wide.

The reduction of cigarette smoking and other forms of tobacco use, particularly in developing countries, has become a global priority for public health action. The dramatic reductions in prevalence and consumption observed over several decades in many industrialized countries, most notably the United Kingdom, demonstrate that success is possible. Specific measures to curtail tobacco use such as advertising bans and price increases are likely to be much more effective in the context of strong political commitment to reducing consumption.

See also: *Alcohol, Health Effects of; Cancer; Cardiovascular Disease; Disease, Burden of; Diseases, Chronic and Degenerative; Mortality Differentials, by Sex.*

BIBLIOGRAPHY

Doll Richard, and Austin Bradford Hill. 1950. "Smoking and Carcinoma of the Lung: Preliminary Report." *British Medical Journal* ii: 739–748.

Liu, B. Q., R. Peto, Z. M. Chen, et al. 1998. "Emerging Tobacco Hazards in China: 1. Retrospective Proportional Mortality Study of One Million Deaths." *British Medical Journal* 317: 1411–1422.

Pampel, Fred C. 2002. "Cigarette Use and the Narrowing Sex Differential in Mortality." *Population and Development Review* 28: 77–104.

Peto, Richard, et al. 1994. *Mortality from Smoking in Developed Countries, 1950–2000.* Oxford: Oxford University Press.

Peto, Richard, and Alan D. Lopez. 2001. "Future World-wide Health Effects of Current Smoking Patterns." In *Critical Issues in Global Health,* ed. C. Everett Koop, C. E. Pearson, and M. Roy Schwarz. San Francisco: Wiley.

ALAN D. LOPEZ

TRANS-ATLANTIC MIGRATION

Numerically the greatest and probably the most consequential population movement in modern history has been the transatlantic migration from Europe to the Western Hemisphere. It is estimated that more than 60 million Europeans emigrated to the Americas from the beginning of the period of colonization (approximately 1500) to 1940. Subsequent to 1940, about 5.8 million persons left Europe for the United States as immigrants, much of this before 1960. Canada received over 2 million migrants from Europe between 1945 and 1981. Latin America was the destination of about 600,000–700,000 Europeans between 1945 and 1960.

Most of this migration was to North America (the United States and Canada), but significant numbers of migrants went to Argentina, Brazil, Chile, Cuba, Mexico, Uruguay, and other areas of Latin America and the Caribbean. In addition, there was a large coerced migration of black Africans as slaves, almost entirely before 1820, when Britain began to use its naval power to suppress the slave trade. It is estimated that about 9.4 million slaves were taken to the Western Hemisphere, but only about 400,000 to British North America. The largest single recipient was Brazil (3.6 million). The mortality rate of slaves outside North America was very high, so that by about 1825 North America had 36 percent of the slaves in the Western Hemisphere even though it had received only 4.2 percent of the imported slaves.

Early Migration

Information on migration for the colonial and early national periods in British North America and the United States is scarce because regular collection of immigration statistics began only in 1819 at major ports in the United States. Estimates of European emigration to British North America and the United States for the period 1700–1820 range between 765,000 and 1.3 million. Most of the migrants originated in Britain (England, Scotland, and Wales) and Ireland, but some came from the Rhineland area of Germany and the Netherlands, and a number of Huguenots (French Protestants) sought refuge in British North America. Although there was a gross flow of about 25,000 migrants from France to the Saint Lawrence Valley and other areas of New France in the seventeenth and eighteenth centuries, most of

TABLE 1

Intercontinental Emigration (all Western Hemisphere destinations), Europe, 1851–1924

Country	1851–1860	1861–1870	1871–1880	1881–1890	1891–1900	1901–1910	1913	1921–1924
			Average Annual Emigration Rates per 100,000 Population					
Austria-Hungary	—	—	29	106	161	476	611	105
Belgium	—	—	—	86	35	61	102	28
British Isles[1]	580	518	504	702	438	653	1,035	607
Denmark	—	—	206	394	223	282	321	178
France	11	12	15	31	13	14	15	4
Germany	—	—	147	287	101	45	40	97
Ireland[2]	—	—	661	1,417	885	698	679	298
Netherlands	50	59	46	123	50	51	40	52
Norway	242	576	473	952	449	833	419	357
Sweden	46	305	235	701	412	420	312	211
Switzerland	—	—	130	320	141	139	165	161
Finland	—	—	—	132	232	545	644	210
Italy	—	—	105	336	502	1,077	1,630	433
Portugal	—	190	289	380	508	569	1,296	321
Spain[1]	—	—	—	362	438	566	1,051	461
			Average Annual Number of Emigrants in Thousands					
Austria-Hungary	—	—	11.1	43.6	72.4	234,218	313.6	57.2
Belgium	—	—	—	5.0	2.2	4,321	7.6	2.1
British Isles:								
Passengers	164.1	157.1	167.9	255.9	174.3	284.1	469.6	287.5
Emigrants Proper							389.4	204.4
Denmark	—	—	3.9	8.2	5.2	7.3	8.8	5.8
France	3.9	4.6	5.7	12.0	5.1	5.3	5.7	1.6
Germany	—	—	62.6	134.2	52.7	27.4	25.8	58.1
Ireland[2]	—	—	35.0	70.0	40.6	30.9	29.8	13.2
Netherlands	1.6	2.0	1.7	5.2	2.4	2.8	2.3	3.6
Norway	3.6	9.8	8.5	18.7	9.5	19.1	9.9	9.5
Sweden	1.7	12.2	10.3	32.8	20.5	22.4	17.2	12.5
Switzerland	—	—	3.6	9.2	4.4	4.9	6.2	6.3
Finland	—	—	—	2.9	5.9	15.9	20.1	7.1
Italy	—	—	28.9	99.1	158.0	361.5	565.0	167.9
Portugal	—	7.8	13.1	18.5	26.6	32.4	77.3	19.4
Spain:								
Passengers	—	—	—	63.6	79.1	109.1	209.7	98.3
Emigrants Proper							151.0	76.7
Malta	—	—	—	—	—	—	1.6	1.7

Note:
[1]Passengers.
[2]For the period 1921–1924, Irish Free State for 1921–23.
—: Not available

SOURCE: Ferenczi and Willcox (1929).

the population growth in that region after about 1680 (from about 9,400 to about 70,000 in 1770) came from natural increase. Spain and Portugal did not encourage immigration into their Western Hemisphere colonies, and so the migration from Europe to those areas was relatively low. Most of the relatively small numbers of French, British, and Dutch persons who went to West Indian colonies migrated to work in the civil administration or military or to seek wealth from sugar cultivation. Many of them died there; some returned to Europe.

In the period after 1820 increasingly large numbers of migrants began to move from Europe to North America. Table 1 shows the overall flows and emigration rates from various European countries, and Table 2 gives the flows and immigration rates to Canada, the United States, Cuba, Argentina, and Brazil in the nineteenth and early twentieth centuries. Table 2 indicates that North America received about three-quarters of the migrants recorded for those five countries for the period 1821–1924. Even for the decade 1901–1910 North America was still

TABLE 2

Immigration to the Western Hemisphere, 1821–1924

Country	1821–1830	1831–1840	1841–1850	1851–1860	1861–1870	1871–1880	1881–1890	1891–1900	1901–1910	1913	1921–1924
Average Annual Rates of Immigration per 100,000 Population											
Canada	—	—	—	992	832	548	784	488	1,676	3,840	941
United States	121	377	829	928	649	546	858	530	1,020	1,215	331
Cuba	—	—	—	—	—	—	—	—	1,184	1,541	1,358
Argentina	—	—	—	385	991	1,170	2,217	1,639	2,918	3,831	1,525
Brazil	—	—	—	—	—	204	411	723	338	771	197
Average Annual Number of Immigrants (in Thousands)											
Canada	—	—	—	27.8	28.3	22.0	35.9	24.9	105.4	276.7	82.7
United States	13.6	56.5	166.8	253.6	227.2	242.4	485.2	368.4	856.7	1,117.7	349.6
Cuba	—	—	—	—	—	—	—	—	24.3	33.1	39.2
Argentina	—	—	—	5.0	16.0	26.1	84.1	64.8	176.4	302.0	145.6
Brazil	—	—	—	—	—	21.9	53.1	114.4	68.9	189.8	60.3

Note: — not available

SOURCE: Ferenczi and Willcox (1929).

the destination of over three-quarters (78%) of those migrants.

In the century 1820–1920, when the United States had relatively few restrictions on immigration, about 33.7 million persons were recorded as having entered the country, of whom 29.8 million (over 88%) were from Europe; this does not include some migrants who entered as first-class passengers, through minor ports, or across land borders (mostly from Canada earlier in the century). This is a gross flow because immigrant returns were not recorded until 1908. Even allowing for substantial return migration, these are huge numbers. In that period net immigration represented about a quarter of American population growth, up to a third in some decades (1850–1860 and 1900–1910).

During that century a dramatic shift took place in the composition of migrants by area of origin within Europe. In the first half (1820–1890) 82 percent of all migrants and 91 percent of European migrants came from Northern and Western Europe (Britain, Ireland, Scandinavia, France, the Low Countries, and Germany). However, a major change began in the 1880s. In the period 1891–1920 only 25 percent of all migrants (and 28% of European migrants) originated in northwestern Europe, whereas about 64 percent of all migrants (and some 72% of European migrants) were from regions in southern, central, and eastern Europe (Italy, Spain, Portugal, Austria-Hungary, and Russia and regions in the Balkans). The course of these changes is shown in Table 3, which provides decade-by-decade numbers of migrants entering the United States by region of origin.

Migration in the Twentieth Century

This was the first great shift in migration to the United States, while the second was in and after the 1960s. Earlier in the twentieth century migration was restricted by the passage of the Literacy Test Act (1917), the Emergency Immigration Act (1921), and the Immigration and National Origins Act (1924), which established annual quotas of 2 percent of the share of a nationality group in the census of 1890. In 1929 the basis for the quotas was changed to the census of 1920, but the total number of immigrants was set not to exceed 150,000 per year, in contrast to the levels in excess of a million per year in the years just before World War I.

These quotas remained more or less the rule until 1965, when the passage of immigration reform legislation included liberal rules on family reunification and modified quotas for areas outside Europe. The Immigration Reform and Control Act of 1986 further modified the rules. Whereas total gross immigration to the United States was 8 million over the period from 1921 to 1960, of which 58 percent was from Europe, the inflow over the years 1961–1997 was 22 million, of which only 17 percent was from Europe. Flows from Asia, Africa, and especially Latin

TABLE 3

United States: Number of Immigrants by Region of Origin, 1821–1997; Canada: Total Number Immigrants, 1851–1990 (in Thousands)

	United States								Canada
Year	All Countries	Total Europe	North-western Europe	Central Europe	Eastern Europe	Southern Europe	Total Africa	All Other & Unknown	All Countries
1821–31	143.4	98.8	88.9	6.8	0.1	3.1	0.0	44.6	—
1831–40	599.1	495.7	337.3	152.8	0.3	5.3	0.0	103.4	—
1841–50	1,713.3	1,597.5	1,157.4	434.7	0.6	4.7	0.0	115.7	—
1851–60	2,598.2	2,452.7	1,479.7	952.8	0.5	19.6	0.2	145.3	243.7
1861–70	2,314.8	2,065.3	1,244.2	797.3	2.6	21.2	0.3	249.2	174.8
1871–80	2,812.2	2,272.3	1,352.2	804.1	39.6	76.3	0.4	539.6	343.1
1881–90	5,246.6	4,737.0	2,325.7	1,858.5	221.2	331.7	0.9	508.7	886.2
1891–19	3,687.6	3,559.0	1,138.3	1,194.6	521.8	704.2	0.4	128.2	339.1
1901–10	8,795.5	8,136.0	1,568.5	2,486.8	1,769.6	2,311.1	7.4	652.1	1,644.1
1911–20	5,735.8	4,376.6	853.5	1,050.4	1,012.5	1,460.2	8.4	1,350.8	1,712.3
1921–30	4,107.2	2,477.9	871.8	854.7	177.6	573.7	6.3	1,623.1	1,230.2
1931–40	528.4	348.3	83.9	162.7	14.5	87.1	1.8	178.4	158.6
1941–50	1,035.0	621.7	261.7	272.4	5.8	81.9	7.4	406.0	491.3
1951–60	2,515.5	1,328.3	445.4	600.6	10.1	272.2	14.2	1,172.9	1,574.8
1961–70	3,321.7	1,129.0	392.1	294.0	14.4	428.5	29.1	2,163.6	1,409.6
1971–80	4,493.3	800.4	214.2	164.2	56.3	365.6	80.8	3,612.2	1,440.0
1981–90	7,338.1	761.6	273.0	226.0	92.6	169.9	176.9	6,399.6	1,328.7
1991–97	6,944.6	1,039.1	239.7	269.6	355.2	112.0	242.7	5,725.4	—

Note: — not available

SOURCE: United States: U.S. Bureau of the Census, (1975). *Historical Statistics of the United States: Colonial Times to 1970.* Washington, DC: Government Printing Office, Series C89-119, and various INS reports. Canada: F. H. Leacy, ed., (1983). *Historical Statistics of Canada,* 2nd ed. Ottawa: Statistics Canada; and United Nations, (1991). *Demographic Yearbook 1989,* New York: United Nations.

America came to dominate migration into the United States.

Canada

The situation for Canada was somewhat different. Canada had experienced immigration rates comparable to or even higher than those for the United States from the middle of the nineteenth century to the 1920s (see Table 2). Regular and consistent data are not available before the 1850s. Although the gross flows were substantial, many of the migrants went on to the United States. For the four decades between 1861 and 1901 net immigration to Canada was actually negative as outflows to the United States outpaced gross inflows. Since that time the net inflow has been positive with the exception of the 1930s, which was also a decade of net outflow from the United States.

Since 1901 net migration has contributed between a quarter and a third of Canada's population growth. Regular statistics on migrants' countries of origin were not reported until 1956. Before that year, however, census data on population by country of birth reveal that most of the foreign born originated in the British Isles: 60 percent in 1871, 55 percent in 1921, and 48 percent in 1951. The remainder came mostly from other European countries: 48 percent in 1871, 42 percent in 1921, and 49 percent in 1951. More recently, however, immigration in Canada shifted away from persons of European origin. In 1989, for example, only 31 percent of migrants were from Europe, the former Soviet Union, the United States, Australia, and New Zealand. Overall, about 13 million persons migrated into Canada between 1852 and 1990.

Among the sending countries, Table 1 indicates that the highest emigration rates out of Europe were in Ireland, Norway, Sweden, and Britain until about 1900, when Italy began to emerge as a major country of origin. In 1913 the highest emigration rates were from Italy, Portugal, Spain, Britain, and Ireland.

Motivation for and Composition of Migration

Most migrants were motivated by expectations of better wages and greater lifetime economic opportunities. Also, over the nineteenth century transportation costs fell with the advent of the railroad, better canal and river transportation, and iron- and steel-hulled propeller-driven steamships. In general cycles in migration over time to the United States were more closely attuned to economic conditions in the United States (a "pull") rather than to poor conditions in Europe (a "push"). Exceptions were the late 1840s with the potato famines and serious political unrest and the two world wars of the twentieth century.

In the nineteenth and early twentieth centuries migration tended to be selective for young single men. For example, the sex ratio of the foreign-born population in the United States was 124 males per 100 females in 1850 in contrast to 103 for the native white population; the corresponding sex ratios in 1910 were 129 and 103. Migration from Europe between 1820 and 1920 also tended to be weighted more toward unskilled and semiskilled workers.

There has been a substantial return migration back to Europe, especially after trans-atlantic travel became less costly. For example, in the 1908–1912 period it is estimated that the return rate was about 50 percent. Nonetheless, the effect of transatlantic migration on the population growth and ethnic composition of the United States and Canada has remained strong. In answering the ancestry question in the 1990 U.S. census, 73.1 percent of the population responding claimed European ancestry and another 8.2 percent claimed African-American ancestry.

See also: *African-American Population History; Famine in Ireland; Immigration Trends; Peopling of the Continents; Slavery, Demography of.*

BIBLIOGRAPHY

Ferenczi, Imre, and Walter F. Willcox. 1929. *International Migrations.* Vol. 1: *Statistics.* New York: National Bureau of Economic Research.

———. 1931. *International Migrations.* Vol. 2: *Interpretations.* New York: National Bureau of Economic Research.

Gemery, Henry A. 1984. "European Emigration to North America, 1700–1820: Numbers and Quasi-Numbers." *Perspectives in American History* (New Series) 1: 283–342.

Haines, Michael R., and Richard H. Steckel, eds. 2000. *A Population History of North America.* New York: Cambridge University Press.

Hatton, Timothy J., and Jeffrey G. Williamson. 1998. *The Age of Mass Migration: Causes and Economic Impact.* New York: Oxford University Press.

Jones, Maldwyn Allen. 1992. *American Immigration.* Chicago: University of Chicago Press.

Nugent, Walter. 1992. *The Great Transatlantic Migrations, 1870–1914.* Bloomington: Indiana University Press.

Michael R. Haines

TUBERCULOSIS

Tuberculosis (TB) is a disease that played a major role in mortality decline in developed countries, and it remains a major cause of morbidity (illness) and mortality in developing countries. Tuberculosis is caused by infection with the bacterium *Mycobacterium tuberculosis,* discovered in 1882 by the German scientist Robert Koch (1843–1910). The related germ *Mycobacterium africanum* also causes TB in sub-Saharan Africa, but even in this region *Mycobacterium tuberculosis* predominates. The bovine form of TB, caused by *Mycobacterium bovis,* can also be transmitted to humans, but pasteurization of milk has reduced the chances of this. In historical texts, TB is sometimes referred to as consumption or pthisis. A notable aspect of TB is that it is an infectious disease of adults, not primarily of youth or the elderly.

Both historically and at present, tuberculosis of the lungs, called pulmonary tuberculosis, accounts for the major portion of TB morbidity and mortality. But tuberculosis can assume many forms, including tuberculosis meningitis, Pott's disease (TB of the vertebral column), and infection of any internal organ. Tuberculosis is a notable example of the difference between infection and disease. Those infected with TB (i.e., harboring the bacilli in their bodies) may develop clinical signs of the disease either immediately or sometimes many years after the first infection. Person-to-person spread occurs when someone with active tuberculosis coughs, producing droplets containing bacilli, which can infect someone nearby. Not all active cases are contagious (i.e., produce bacilli when coughing), however.

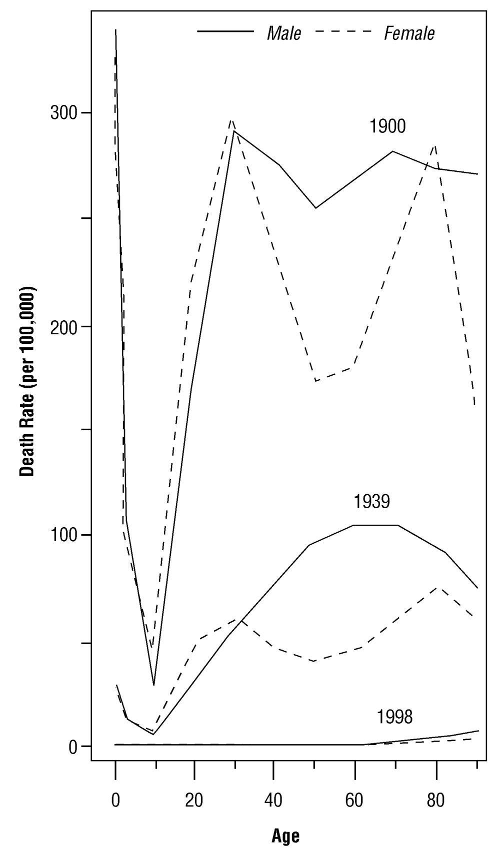
A tuberculosis vaccine, BCG (bacille Calmette-Guerin), exists, but its protective efficacy against TB in adults is variable; it is more effective in protecting children. In some populations, vaccination with BCG also protects against leprosy, which is caused by *Mycobacterium leprae,* a cousin of the TB-causing bacterium. The first antibiotic against TB was streptomycin, first used widely in 1947. Before the introduction of antibiotics, TB patients were treated in specialized sanatoriums, reflecting the belief that fresh air was curative. While this is not true, the sanatoriums did diminish the chances of TB transmission by removing the infected from the general population.

Figure 1 shows age-specific death rates, by sex, for TB (all forms), for the United States. Death rates are shown for 1900, when TB as a cause of death was of overwhelming importance; for 1939, by which time TB mortality had declined markedly but was still fairly high; and for 1998, after a half-century of antibiotic use. The figure depicts four key facets of the demography of TB. First, the data highlight the radical decline of tuberculosis mortality during the twentieth century, with most of the drop occurring before the introduction of antibiotics. Second, they show that TB is as much a disease of middle age as it is of the young and the elderly. This is in contrast to most other infectious diseases of similar importance: Diseases such as measles or pertussis are concentrated in childhood; other diseases such as influenza cause morbidity at all ages, but mortality is typically concentrated at the youngest and oldest ages. Third, death rates for males and females exhibit distinctly different patterns, with males having on average significantly higher TB mortality rates, yet at some ages female mortality is higher. Finally, when TB death rates decline, they do not fall evenly at all ages; both the shape and the level of the age-mortality curves change. The figure is broadly representative of the decline of TB in other developed countries.

Worldwide, there is great variability across nations in TB death rates. In 2002, the following nations had the highest TB death rates in their respective world regions (deaths per 100,000 population): Zambia, 290; Djibouti, 164; Haiti, 137; Cambodia, 90; Indonesia, 68; Russia, 17. Estimates for other nations include: South Africa, 166; India, 46; China, 21; Mexico, 6; Portugal, 5; United Kingdom, 2; United States, 1. These are crude death rates, not adjusted for population age composition, but they do correctly reflect overall tuberculosis disease burden in terms of deaths per capita. Compare these data to the following sample of historical estimates of pulmonary TB death rates (listed by country, year, and death rate per 100,000 population), in chronological order: England and Wales in 1861, 258; Japan in 1899, 127; United States in 1900, 168; Chile in 1904, 270; Australia in 1911, 67; Portugal in 1920, 125; England and Wales in 1921, 89; France in 1926, 143; and South Africa (nonwhite population) in 1951, 300.

FIGURE 1

Death Rates by Age and Sex for Tuberculosis (All Forms), United Sates, 1900, 1939, 1998



SOURCE: U.S. Center for Health Statistics.

Tuberculosis is central to the story of what was one of the great debates in population studies. The British epidemiologist Thomas McKeown (1911–1988) maintained that the standard of living in general, and improved nutrition in particular, played a more important role than did medicine and public-health measures in the historical decline of mortality. He used the case of TB in support of the thesis, noting, among other things, that much of the decline in TB mortality occurred before the introduction of antibiotics. While improved nutrition was certainly a factor in the decline of TB, a number of objections have been raised against McKeown's general argument. His analysis rested mainly on data from England and Wales, in which the decline of TB in the nineteenth century played an idiosyncratically large role in the decline of mortality overall, thus exaggerating the importance of the decline of TB. And the use of sanitariums to reduce TB transmission is best viewed as a public-health measure, not a factor reflecting improved living standards.

In the 1990s TB strains resistant to multiple antibiotics became a significant problem in several countries, most notably in the former Soviet Union—a worrisome development. In any region where such strains become prevalent, reversal of progress against TB cannot be ruled out. This is of particular concern in developing countries, where TB prevalence, transmission, and mortality are still relatively high and where historical declines have been much less rapid than in the advanced industrialized countries. Infection with human immunodeficiency virus (HIV) is a major risk factor for developing active TB disease, with initial HIV-positive status followed by TB exposure being more severe in most cases than the reverse order of infection. In regions where prevalence of TB and HIV/AIDS are both high, most notably in sub-Saharan Africa, HIV-TB coinfection is a strong contributing factor to the lack of progress in reducing tuberculosis morbidity and mortality.

See also: *AIDS; Diseases: Infectious; Health Transition; Mortality Decline; Mortality Reversals.*

BIBLIOGRAPHY

Dormandy, Thomas. 1999. *The White Death: A History of Tuberculosis.* London: Hambledon Press; New York: New York University Press.

Dye, Christopher, Suzanne Scheele, Paul Dolin, Vikram Pathania, and Mario C. Raviglione. 1999. "Global Burden of Tuberculosis: Estimated Incidence, Prevalence, and Mortality by Country." *Journal of the American Medical Association* 282: 677–686.

Espinal, Marcos A., Adalbert Laszlo, Lone Simonsen, Fadila Boulahbal, Sang Jae Kim, Ana Reniero, Sven Hoffner, Hans L. Rieder, Nancy Binkin, Christopher Dye, Rosamund Williams, and Mario C. Raviglione. 2001. "Global Trends in Resistance to Antituberculosis Drugs." *New England Journal of Medicine* 344: 1,294–1,303.

McKeown, Thomas. 1976. *The Modern Rise of Population.* London: Edward Arnold; New York: Academic Press.

Preston, Samuel H. 1990. "Sources of Variation in Vital Rates: An Overview." In *Convergent Issues in Genetics and Demography,* ed. Julian Adams, David A. Lam, Albert I. Hermalin, and Peter E. Smouse. New York: Oxford University Press.

Andrew Noymer

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UNITED NATIONS, POPULATION ACTIVITIES OF

See *Population Organizations: United Nations System*

UNWANTED FERTILITY

The concept of unwanted births that is now so familiar in population studies has been in use for more than half a century. It plays an important role in the design and analysis of population policy. Early criticism of the concept—on both methodological and measurement grounds—has abated but not disappeared.

The origin of the concept is unclear, but its first systematic quantifiable use seems to have been by Pascal K. Whelpton and Clyde V. Kiser in the 1940s in the Indianapolis Study, formally known as *Social and Psychological Factors Affecting Fertility*. A classification of fertility planning status was developed in which the category termed "excess fertility" became the prototype for the later designation of unwanted fertility. This measure was further refined and applied in two subsequent U.S. fertility surveys.

Definition and Measurement

The basic idea is deceptively simple: Some births are wanted and some are not. The current professional usage of the concept is more complicated. The term *unwanted* means that no additional birth as recalled at the time of conception was wanted. In theory, this means that if preferences had prevailed, the birth would never had occurred, a "non-event" of considerable importance for rates of fertility and population growth as well as for the individuals involved. A distinction is drawn between an unwanted and a mistimed birth—the latter being a birth that occurred earlier than preferred but that was nonetheless wanted, although at a later time. Both mistimed and unwanted births are frequently designated collectively as *unintended births* in contrast to births that were wanted and that occurred approximately at the desired time.

Reports on the planning status of births are based typically on interviews with women in sample surveys and involve memories about events in the past and about feelings that may be complex and highly ambivalent—and affected too by the typically uninvestigated preferences and power of the male partner. Hence there are inevitable questions about the meaning of responses and about the reliability of recall. In recent practice, the question is usually focused on births in the preceding five years but it is still subject to recall problems, especially the understandable tendency to rationalize an unwanted event as wanted. The typical question in the surveys is: "At the time you became pregnant with [name] did you want to become pregnant then, did you want to wait until later, or did you want no more children at all?" Recent evidence, based on reinterviews with women who were asked the same questions about the same births some time later indicates considerable inconsistency in responses—increasing with the duration of recall and biased in the (expected) direction of rationalizing unwanted as wanted births. Thus, it seems reasonable to assume that the level of unwanted fertility in a population based on this approach is underestimated. The magnitude of this underesti-

TABLE 1

Total Fertility Rate (TFR), Wanted Total Fertility Rate (WTFR), and Percent Unwanted: Selected Developing Countries, Late 1990s

	TFR	WTFR	Percent Unwanted
Bangladesh	2.3	2.2	4
India	2.8	2.1	25
Indonesia	2.8	2.4	14
Vietnam	2.3	1.9	17
Egypt	3.5	2.9	17
Turkey	2.6	1.9	27
Bolivia	4.2	2.5	40
Brazil	2.5	1.8	28
Haiti	4.7	2.7	42
Peru	2.8	1.8	36
Ghana	4.4	3.6	18
Nigeria	5.2	4.8	8
Ethiopia	5.9	4.9	17
Kenya	4.7	3.5	25
South Africa	2.9	2.3	21
Uganda	6.8	5.3	22
Zimbabwe	4.0	3.4	15

Note: Rates are based on the three years prior to each survey.

SOURCE: Demographic and Health Surveys conducted between 1997 and 2000.

mate is unknown but is certainly greater when the births are further back in time.

Wanted Fertility Rate

Another approach to the assessment of unwanted fertility is based on comparing the number of children desired with the number actually born. The now standard question to determine the desired number is: "If you could go back to the time you did not have any children and choose exactly the number of children to have in your whole life, how many would that be?" In order to preserve the current status of the measure, this approach estimates a synthetic Total Wanted Fertility Rate (TWFR) analogous to the familiar standard Total Fertility Rate (TFR) by subtracting from each age-specific component those births occurring in the recent past (usually three or five years) that exceed the total number wanted by the woman. The resulting TWFR is interpreted as the number of births women would have by the end of their childbearing years if at each age they experienced only the number of births wanted in the recent time period. The difference between the TWFR and the TFR is the component representing unwanted births. In Table 1 the results of such calculations for a sample of developing countries are illustrated. The estimates of unwanted fertility based on this procedure tend to be somewhat higher than those based on the first approach of asking about the wanted status directly but the ranking of countries is very similar for the two measures.

The estimates in the table show an average of about 20 percent of births to be unwanted. This provides some sense of the possible future fertility levels as birth control becomes more common and more effective.

Unwanted fertility presumably begins at a very low level in traditional societies, then increases as the small family norm develops, frequently outpacing the availability of contraception, and eventually diminishes as effective means to control fertility become widespread.

See also: *Contraceptive Prevalence; Family Planning Programs; Family Size Intentions.*

BIBLIOGRAPHY

Bankole, Akinrinola, and Charles F. Westoff. 1988. "The Consistency and Validity of Reproductive Attitudes: Evidence from Morocco." *Journal of Biosocial Science* 30: 439–455.

Bongaarts, John. 1997. "Trends in Unwanted Childbearing in the Developing World." *Studies in Family Planning* 28(4): 267–277.

Freedman, Ronald, Pascal K. Whelpton, and Arthur A. Campbell. 1959. *Family Planning, Sterility and Population Growth.* New York: McGraw-Hill.

Lightbourne, Robert E. 1985. "Individual Preferences and Fertility Behavior." In *Reproductive Change in Developing Countries: Insights from the World Fertility Survey,* eds. John Cleland and John Hobcraft. London: Oxford University Press.

Lightbourne, Robert E., and Alphonse MacDonald. 1982. "Family Size Preferences." In *WFS Comparative Studies.* Voorburg, The Netherlands: International Statistical Institute.

Osborn, Frederick. 1963. "Excess and Unwanted Fertility." *Eugenics Quarterly* 10(2): 59–72.

Westoff, Charles F., Robert G. Potter, Philip C. Sagi, and Elliot G. Mishler. 1961. *Family Growth in Metropolitan America.* Princeton, NJ: Princeton University Press.

Westoff, Charles F., and Norman B. Ryder. 1977. "Wanted and Unwanted Fertility in the United States." In *The Contraceptive Revolution.* Princeton, NJ: Princeton University Press.

Whelpton, Pascal K., and Clyde V. Kiser. 1950. "The Planning of Fertility." In *Social and Psychological Factors Affecting Fertility.* New York: Milbank Memorial Fund.

Charles F. Westoff

URBANIZATION

Urbanization is the process by which an increasing proportion of the population lives in urban areas. The level of urbanization is the proportion of population living in urban areas. Urbanization must be distinguished from urbanism, a term referring to the style of life usually found in large urban centers. A prior issue in studies of urbanization is to determine what constitutes an urban area. In medieval Europe or China, it may have been easy to distinguish between towns—generally tight-knit settlements, often fortified by walls to enable them to be protected from attack—and rural areas. This is no longer the case, either in the developed or the developing world, largely because transportation improvements have made it possible for people to reside a considerable distance from their place of work.

Defining Urbanization

Studies of urbanization are mostly forced to rely on the definitions of urban areas adopted in each country. These vary considerably, thus complicating inter-country comparisons. For example, some countries count all localities with 2,000 inhabitants or more as urban; others designate certain categories of administrative area as urban; still others use criteria such as population density and presence of certain urban facilities. Moreover, many areas, particularly those on the outskirts of large cities, are no longer easy to classify in terms of a rural-urban dichotomy. There is great diversity among areas defined as urban, and likewise among those defined as rural. It has been argued that a more complex breakdown of localities according to degree of urbanness or ruralness is needed.

Historical Trends

In 1950 only 30 percent of the world's population was living in urban areas. By 2000 nearly half the population—some 47 percent—was urban. The second half of the twentieth century was therefore a highly significant period in the history of world urbanization.

Some Western countries had already reached a 50 percent level of urbanization in the second half of the nineteenth century. The United Kingdom led the way, reaching this level in 1851. Australia reached it shortly after 1901, Germany in about 1910, and the United States in about 1918. Such countries therefore have a long history of predominantly urban populations. Japan, some Gulf states, and some Latin American countries have been predominantly urban since the middle of the twentieth century, but most of the Asian and African countries that are predominantly urban at the beginning of the twenty-first century reached that status only in the last two or three decades of the twentieth century.

This does not mean that there is no tradition of urbanization in Asia and Africa. In Egypt and China, for example, urban traditions go back to antiquity. In Southeast Asia, cities were substantial in precolonial times and at least one fifth of the population of the Malay Peninsula was urban in the sixteenth century. Even in sub-Saharan Africa, generally thought of as lacking in urbanization before colonization by Europeans, the Yoruba towns in Nigeria were already substantial in the nineteenth century.

Nevertheless, by the middle of the twentieth century, there were sharp differences in levels of urbanization between, on the one hand, the entire continents of Europe and North America and countries of European settlement such as Argentina, Chile, Uruguay, Australia, and New Zealand, and, on the other hand, Asia, Africa, and the rest of Latin America. In Asia, only Japan and a few city-states and oil producers had reached 50 percent urbanization; in Africa, only some countries of the western Sahara. The general situation by continent is shown in Table 1.

Over the second half of the twentieth century, Latin America experienced an exceptionally rapid pace of urbanization, reaching European and North American levels by 2000. Eastern Europe, which had lagged behind the rest of Europe at mid-century, similarly caught up. In both of these regions, the

TABLE 1

Proportion of the Population Living in Urban Areas and Rate of Urbanization by Major Area, Estimates and Projections, 1950–2030

	Proportion Urban (percent)				Annual Rate of Urbanization (percent)		
	1950	1975	2000	2030	1950-75	1975–2000	2000–30
Africa	14.7	25.2	37.9	54.5	2.18	1.65	1.21
Asia	17.4	24.7	36.7	53.4	1.41	1.60	1.25
Europe	52.4	67.3	74.8	82.6	1.01	0.42	0.33
Latin America*	41.4	61.2	75.3	83.2	1.58	0.83	0.33
North America	63.9	73.8	77.2	84.4	0.58	0.18	0.30
Oceania	61.6	71.8	70.2	74.4	0.61	-0.09	0.19
World	29.7	37.9	47.0	60.3	0.98	0.87	0.83

*Including the Caribbean
Note: The rate of urbanization is calculated as the rate of growth in the urban proportion of the population. Figures for 2030 are UN projections.

SOURCE: United Nations (2001).

level of urbanization increased by more than 30 percent over this period. The pool of rural population from which rural-urban migrants can be drawn has been declining since 1950 in Europe and North America; in Latin America the rural population leveled off around 1985. Many urban centers in countries such as the United Kingdom, Ukraine, Spain, and Italy are actually declining in population. Japan and the Republic of Korea are also reaching this point.

But urbanization was a universal phenomenon in the late twentieth century. Throughout Africa and Asia there was a marked increase in urban proportions, and an even larger increase in the growth of the urban population, since urbanization was occurring in a period of historically unprecedented rates of overall population growth. So far, Africa and Asia have only reached the levels of urbanization attained in Latin America in the 1940s. Whether they will follow the very rapid urbanization that Latin America experienced over the 1950s and 1960s will depend on many factors, particularly the pace and style of economic development.

Percentage of Population Living in Urban Agglomerations

The proportion of the total population residing in truly large cities differs greatly across countries, but in general has been rising over time. Table 2 presents information for selected countries on trends in proportions residing in urban agglomerations of 750,000 or more in 1995. Differing definitions of the term urban raise problems of comparability for percentages of populations in urban areas, but this is less of a problem with data on urban agglomerations.

Over the period from 1950 to 1975, the proportion of population living in large cities increased in all the countries shown except the United Kingdom. However, in the period from 1975 to 2000, Italy, Australia, and Argentina also registered a fall in the proportion of the population living in large cities. This appears to reflect the phenomenon of counterurbanization—the tendency in recent decades for population to be redistributed down the urban hierarchy, either through the absolute decline of the largest cities or through the faster growth of smaller urban places. Many Asian and African countries have much lower proportions of their population living in urban agglomerations (many of them below 20%), but this proportion has almost everywhere been rising over time.

In some countries, the largest city dominates the urban hierarchy, in many cases containing more than half of the total urban population. Many medium size and small countries demonstrate such "urban primacy." In the most populous countries such as China, India, the United States, or Brazil, however, one city is never dominant.

What Causes Urbanization?

The underlying explanation for urbanization involves changing employment opportunities as structural change takes place in the economy. The industrial and service sectors greatly increase their share of output during the course of economic development. Changes in employment structure also reflect increasing productivity in agriculture, which releases agricultural labor. Primary industry's share of employment thus can fall from as high as 70 percent to well below 10 percent. Since employment in secondary and tertiary industries is more heavily concentrated in urban than in rural areas, these structural changes are associated with urbanization.

Factors Contributing to City Growth and Overall Urban Growth

In accounting terms, there are three sources of population growth in urban areas: natural increase of the population living in urban areas, net migration from rural to urban areas, and reclassification of areas formerly defined as rural to urban. Though these three sources are neatly differentiated if calculated over short periods of time (perhaps up to one year), there is in fact considerable interaction between them over the medium to long term. Migrants increase the stock of urban dwellers whose balance of births and deaths makes up the natural increase of the urban population. The natural increase of the rural population increases the "pool" from which rural-urban migrants are drawn. Finally, reclassification is normally based on changes in the characteristics of localities, and increase in population density resulting from natural increase and net migration is frequently a major factor in modifying the characteristics of particular localities toward a more "urban" nature.

Studies by Samuel H. Preston (1979) and Martin Brockerhoff (1999) have examined the factors contributing to city growth over the period from 1960 to 1970, and in developing countries between 1970 and 1990, respectively. In the earlier period, there was an almost perfect association between national population growth rates and city growth rates, suggesting that the same forces fuel population growth in cities and in the countries where they are located. In the more recent period, however, a 1 percent increase in total population growth raises the size of the city population by a lesser percentage, suggesting (in light of continuing increases in urbanization) that smaller urban centers not included in the analysis have been growing more rapidly. In both periods, faster growth of national GDP per capita raised city growth rates, presumably through stimulation of demand for labor in urban industries.

TABLE 2

Proportion of Total Population Living in Urban Agglomerations with 1995 Populations of 750,000 or More, Selected Countries, 1950, 1975, and 2000 (percent)

	1950	1975	2000
United States	33.6	40.0	42.0
United Kingdom	33.4	28.8	26.3
Italy	22.1	28.5	22.5
Germany	38.4	42.2	44.6
Australia	51.2	58.3	57.3
Argentina	36.4	43.9	43.8
Brazil	15.3	29.8	34.9
Peru	12.8	24.1	29.0
Japan	17.7	33.6	39.3
China	11.9	14.2	16.3
Philippines	7.9	12.8	15.9
India	6.0	8.2	11.7
Nigeria	2.3	7.3	13.6
Kenya	1.4	4.9	7.7
Egypt	16.0	22.3	22.9
Senegal	8.9	16.0	21.9

SOURCE: United Nations (2001), Table A.16.

Future Prospects

Virtually all of the world's population growth between 2000 and 2030 is expected to take place in urban areas. During that period the urban population is expected to increase by 2 billion (from 2.9 billion to 4.9 billion), the same number that will be added to the population of the world. The growth rate of the urban population will average 1.8 percent per annum, a rate sufficient to cause a doubling in 38 years. Globally, the population of rural areas will remain roughly constant, reflecting a decline in rural populations of the developed countries offset by a continuing (though slowing) rural growth in developing countries. From 2020 to 2025, the rural population of developing countries will begin a steady decline, repeating the experience of the developed countries since 1950.

The level of urbanization is expected to continue increasing, even in the highly urbanized developed countries, where the urban population is expected to reach 84 percent in 2030. But the rise is likely to be much more rapid in Africa and Asia, which will both pass the 50 percent urban mark before 2025. Between 2000 and 2030, the urban population in Africa is expected to increase from 38 percent to 55 percent, and in Asia from 37 percent to 53 percent. Given that population growth rates are higher in Africa than in any other continent, the substantial rise in urbanization expected over the period implies very rapid increases in Africa's urban population over this period—over 3.5 percent per annum from 2000 to 2010, 2.6 percent from 2025 to 2030.

Very large cities—those with populations over 10 million—will continue to increase their share of the world's population, but only to a level of about 5 percent by 2015. United Nations demographers in the past have tended to overestimate the growth of large cities, and in recent years have made substantial downward adjustments to the population projections for many of them. On the other hand, the populations living in the "mega-urban regions" surrounding these cities are both larger and growing more rapidly than the populations in the official urban agglomerations, because the most rapid growth tends to be in areas outside the agglomeration limits.

See also: *Cities, Demographic History of; Cities, Systems of; Internal Migration; Rural-Urban Balance; Suburbanization; World Population Growth.*

BIBLIOGRAPHY

Brockerhoff, Martin. 1999. "Urban Growth in Developing Countries: A Review of Projections and Predictions." *Population and Development Review* 25(4): 757–778.

Champion, Anthony. 2001. "Urbanization, Suburbanization, Counterurbanization and Reurbanization." In *Handbook of Urban Studies,* ed. Ronan Paddison. London: Sage.

Jones, Gavin W., and Pravin Visaria, eds. 1997. *Urbanization in Large Developing Countries.* Oxford: Clarendon Press.

Kelley, Allen C., and Jeffrey G. Williamson. 1984. *What Drives Third World City Growth? A Dynamic General Equilibrium Approach.* Princeton, NJ: Princeton University Press.

Preston, Samuel H. 1979. "Urban Growth in Developing Countries: A Demographic Reappraisal." *Population and Development Review* 5(2): 195–215.

Reid, Anthony. 1993. *Southeast Asia in the Age of Commerce 1450–1680. Volume Two: Expansion and Crisis.* New Haven: Yale University Press.

Skinner, G. William, ed. 1977. *The City in Late Imperial China.* Stanford, CA: Stanford University Press.

Tarver, James D. 1994. *Urbanization of Africa: A Handbook.* Westport, CT: Greenwood Press.

United Nations. 1980. *Patterns of Urban and Rural Population Growth.* New York: United Nations.

United Nations, Department of Economic and Social Affairs, Population Division. 2001. *World Urbanization Prospects: The 1999 Revision.* New York: United Nations.

Weber, Adna. 1963 [1899]. *The Growth of Cities in the Nineteenth Century.* Ithaca, NY: Cornell University Press.

Gavin W. Jones

V

VALUE OF LIFE, ECONOMIC

Many public sector investment and regulatory decisions have significant effects—typically, but not invariably, beneficial—on the safety of human life. It therefore follows that if a society's scarce resources are to be allocated efficiently and to greatest advantage, then that society requires some means of associating explicit monetary values with safety, and costs with risk. This allows safety effects to be weighed against the other costs and benefits of the investment or regulation, or against other expenditures affecting public welfare.

Plainly, if such explicit monetary values of safety and costs of risk are not applied, it is virtually inevitable that there will be a degree of randomness in the way in which scarce resources are utilized. A measured, strategic approach to safety and risk is optimal.

Defining Monetary Values of Safety

Over the years a number of different approaches have been proposed for defining and estimating values of safety and costs of risk. Two of these deserve serious consideration: the so-called *gross output* (or *human capital*) approach and the *willingness-to-pay* approach.

Under the gross output approach, the cost of the premature death of an individual is treated as the sum total of the monetary value of the individual's future output that is extinguished as the result of his or her premature demise. In some cases advocates of the gross output approach recommend the addition of a more or less arbitrary allowance for the pain, grief, and suffering of the victim and his or her surviving dependents and relatives. In turn, the value of preventing premature death is treated as the cost avoided. As an example of the sort of figures that emerge under the gross output approach, the British Department of Transport's most recent gross output-based cost of an average fatality was £180,330 in 1985 prices (roughly $270,000), of which about 28 percent was an allowance for pain, grief, and suffering.

To the extent that it effectively treats human beings as little more than pieces of productive capital equipment, it is not surprising that the gross output approach has been the subject of fairly vigorous criticism. (It was, in fact, abandoned by the Department of Transport in 1988 in favor of the willingness-to-pay approach discussed below.)

It has been argued that most people value safety *not* because of a desire to preserve current and future productive potential, as the gross output approach implies, but rather because of an aversion to the prospect of premature death per se. This suggests that values of safety and costs of risk should be defined in such a way as to reflect people's pure preferences for safety. But to do so requires some means of measuring the extent of a person's preference—and more particularly the strength of that preference—for safety.

A natural measure of a person's strength of preference for a good or service is the maximum amount that he or she would be willing to pay for it. This sum is a clear indication of what the good or service is worth to the person, relative to other potential objects of expenditure. Moreover, since willingness to pay is conditioned by ability to pay (i.e., income), the sum concerned takes account of the resource constraints that society inevitably faces.

Under what has come to be known as the willingness-to-pay (WTP) approach to the valuation of safety, the monetary value of a safety improvement is defined as the aggregate amount that the group of people affected by the improvement would be willing to pay for the (typically very small) reductions in individual risk that result from the improvement. For example, suppose that a group of 100,000 individuals are each afforded a 1 in 100,000 reduction in the risk of premature death during the forthcoming year, thereby preventing one premature death, on average. (This is referred to as the prevention of one "statistical death" during the period concerned.) Suppose, furthermore, that individuals in the affected group would, on average, each be willing to pay a maximum of $10 for the safety improvement. Aggregated over the group of 100,000 individuals, total willingness to pay would be $1 million; this sum is referred to as the *value of preventing one statistical fatality* (VPF) or the *value of statistical life* (VOSL). Correspondingly, costs of risk are defined in terms of the aggregate amount that affected individuals would be willing to accept as compensation for (typically small) increases in the risk.

It is important to appreciate that, defined in this way, the VPF is not the price of life in the sense of a sum that any one individual would accept as compensation for the certainty of his or her own immediate death: For most people, no finite sum would suffice for that purpose.

Estimating Monetary Values of Safety

How are willingness-to-pay-based values of safety to be estimated in practice? Since the early 1970s, an extensive literature has developed on this subject. For a detailed survey see Michael Jones-Lee (1989), Chapter 2, or W. Kip Viscusi (1993). The body of literature broadly divides into two approaches, which can be viewed as complementary rather than competing.

In the first approach, researchers seek to identify situations in which people actually do trade off wealth or income against risk, as in labor markets where riskier occupations can be expected to command clearly identifiable wage premiums, and safer ones carry corresponding discounts. The two main difficulties with this approach are that wage rates depend on many other factors besides job risk, so that it is necessary to control for the effects of these other factors in identifying the pure wealth-risk tradeoff. A second and arguably more fundamental problem is that workers may have only a limited knowledge of the job risks that they actually face.

By contrast the second approach, known as *contingent valuation,* aims to ask a representative sample of the population more or less directly about their willingness to pay for improved safety or willingness to accept compensation for increased risk. While this approach has the advantage of getting directly to the wealth-risk tradeoff, it does rely upon the somewhat debatable assumption that people are able to think rationally about hypothetical situations, and respond in an unbiased manner to relatively unfamiliar questions.

Under the contingent valuation approach, willingness-to-pay-based values for the prevention of a statistical fatality in the British case are in the region of £1–2 million ($1.5–3.0 million). (The Department of Transport's figure as of 2002 is £1.14 million at 2000 prices.) The labor market wage premium-for-risk approach yields values that are not grossly dissimilar but typically larger.

Conclusion

Any attempt to place an explicit monetary value on human life raises a variety of difficult ethical and empirical questions. Some of these are discussed in detail in the works of John Adams (1995) and John Broome (2002). Nonetheless, it is a fact of life that safety improvements resulting in the avoidance of statistical death are rarely costless; careful public sector decisions in this area must confront these issues.

See also: *Disease, Burden of; Risk.*

BIBLIOGRAPHY

Adams, John. 1995. *Risk.* London: UCL Press.

Broome, John. 2002. *Weighing Lives.* Oxford: Oxford University Press.

Jones-Lee, Michael. 1989. *The Economics of Safety and Physical Risk.* Oxford: Blackwell.

Viscusi, W. Kip. 1993. "The Value of Risks to Life and Health." *Journal of Economic Literature* 31: 1,912–1,946.

M.W. Jones-Lee

VALUES AND DEMOGRAPHIC BEHAVIOR

The use of values to explain demographic behavior, or change in behavior, has been controversial among demographers. Some argue that individual behavior is driven by values. This position considers values to be an essential part of the micro-level processes that connect macro forces with individual action. Thus behavior cannot adequately be explained without knowledge of the underlying values that motivate individuals to make particular decisions. Others argue that values are really part of the behavior that needs explanation, so invoking values as an explanation is not useful. For example, it is circular to say that fertility is high in a population because individuals value large families. The underlying disagreement revolves around the question of whether values arise out of economic, political, and social institutions, or whether values, at least to some extent, are autonomous from institutional contexts and thus have an independent effect on behavior.

Defining Values

What are values? A useful discussion of values must begin with a clear understanding of what this term means. There is some confusion, however, because the term is used in various ways by different authors. Sometimes the term is used simply as a synonym for preferences or attitudes. For example, preferences for sons over daughters or negative attitudes toward women working in the labor force are sometimes referred to as values that influence fertility behavior. Sometimes a norm (e.g., women should not choose to be childless) is equated to a value. A more restrictive definition of values states that they are "evaluative concepts that are internal, durable, and general" (Casterline, 1999, p. 358). This approach emphasizes that values are strongly-held general principles that are applicable to a wide range of situations, and that particular values may be linked to form value systems. When values are conceptualized as unobservable, internal principles, researchers face the challenge of how to measure them.

Fertility

There is little agreement among demographers about the role that values play in fertility behavior. This is evident in the essays on the topic assembled in the edited volume, *Dynamics of Values in Fertility Change* (Leete 1999). In the general literature on theories of fertility change, three different positions can be identified.

One argument emphasizes the importance of changes in social and economic institutions as the catalyst for changes in fertility. For example, John Caldwell argues that the rise of compulsory education in the nineteenth century increased the cost of children. More recently, when educational and work organizations instituted policies allowing women to participate on an equal footing with men, opportunity costs of bearing children increased and existing gender roles in the family were challenged. In both the historical and recent contexts, individuals responded to the social changes by having fewer children *and* by shifting values related to children. In other words, the same forces that affect fertility affect values, and so it is more reasonable to view values as a rationalization of behavior than a cause of that behavior.

A second position argues that underlying values are important because they influence how fertility behavior responds to changes in social and economic institutions. Indeed, values may not need to change in order to influence fertility patterns. For example, in some situations it appears that an effort to maintain existing values in the face of social change produces declining fertility. Also, cultural differences in values could explain why similar social changes do not have the same impact on fertility behavior in all societies. In a 2000 study, Peter McDonald suggests that social changes providing women opportunities approximately equal to those of men has led to greater fertility reduction in southern Europe than in northern Europe because of regional differences in preference for traditional, male-dominated family systems. Surprisingly, fertility is lower in countries preserving traditional family values because of the incompatibility this creates between families and other modern institutions.

The third position argues that value changes play a direct and critical role in changing fertility behavior. The way that this is seen to occur is through cultural diffusion. As secular individualism, liberalism, and freedom from religious authority are imported to a society that does not traditionally hold these values, individuals begin to alter their fertility behavior. High fertility cannot be maintained in a society when individuals adopt values that fail to support this behavior.

Mortality

The clearest example of a value that may affect mortality patterns is the cultural value of preferring sons over daughters. In most populations, age-specific mortality rates are higher for males than females at every age. However, in South Asia death rates are higher for girls than for boys. In their 1998 article, for example, Fred Arnold, Minja Kim Choe, and T. K. Roy note that in India in the 1980s and early 1990s, child mortality (ages one to four) was 43 percent higher for girls than boys. The most plausible explanation for this exceptional mortality pattern in South Asia is the strong preference for (or value attributed to) sons over daughters. Studies suggest that under these conditions daughters experience higher death rates than sons because they receive less effort in disease and accident prevention and less medical attention when sick. In addition to mortality, a strong preference for male offspring sometimes leads to sex-selective abortion and/or female infanticide. When this occurs, the sex ratio at birth (normally about 105 males to 100 females) can be greatly distorted. (Rates well exceeding 110 males to 100 females have been reported recently in China and South Korea, and in some states in India).

Migration

As in fertility theories, values enter the migration literature primarily when the focus is on micro-level models of decision-making. The most explicit formulation of a theoretical model of migration focusing on values is the *value-expectancy model,* presented by Gordon F. De Jong and James T. Fawcett in 1981. The underlying assumption of this model is that individuals are motivated by personal goals and values, and that they rationally calculate how best to achieve them. Multiple values may be involved, each requiring a subjective assessment of wellbeing attained through migration or nonmigration. In deciding whether or not to undertake a particular move, an individual will make a "cognitive calculus" involving the expectancy that the move would produce a net gain in valued outcomes. Little empirical migration research has utilized the value-expectancy model, perhaps because of the complexity of operationalizing and measuring all of the relevant values and collecting data on subjective expectations. However, aspects of this approach are included in studies of migration that investigate place preferences of individuals.

Conclusion

Individuals in modern society tend to believe that they have significant freedom to choose their own life course path, and they have no difficulty in invoking values to explain their choices. Social scientists generally have been skeptical of these explanations, arguing that powerful, unrecognized social forces constrain and direct the behavior of individuals. But many social scientists also want to provide a place for human agency in their theories of behavior. Do individuals choose values that that then independently influence their demographic behavior? Or, are values byproducts of the social conditions that shape the behavior? A lively debate regarding the place of values in explaining demographic behavior persists among population researchers.

See also: *Culture and Population; Diffusion in Population Theory; Fertility Transition, Socioeconomic Determinants of; Gender Preferences for Children; Quetelet, Adolphe; Second Demographic Transition.*

BIBLIOGRAPHY

Arnold, Fred, Minja Kim Choe, and T. K. Roy. 1998. "Son Preference, the Family-Building Process and Child Mortality in India." *Population Studies* 52: 301–315.

Caldwell, John C. 1980. "Mass Education as a Determinant of the Timing of Fertility Decline." *Population and Development Review* 6: 225–255.

Casterline, John B. 1999. "Conclusions." In *Dynamics of Values in Fertility Change,* ed. Richard Leete. New York: Oxford University Press.

De Jong, Gordon F., and James T. Fawcett. 1981. "Motivations for Migration: An Assessment and a Value-Expectancy Research Model." In *Migration Decision Making: Multidisciplinary Approaches to Microlevel Studies in Developed and Developing Countries,* ed. Gordon F. De Jong and Robert W. Gardner. New York: Pergamon Press.

Leete, Richard, ed. 1999. *Dynamics of Values in Fertility Change.* New York: Oxford University Press.

Lesthaeghe, Ron. 1995. "The Second Demographic Transition in Western Countries: An Interpretation." In *Gender and Family in Industrialized Countries,* ed. Karen Oppenheim Mason and An-Magritt Jensen. Oxford: Clarendon Press.

McDonald, Peter. 2000. "Gender Equity in Theories of Fertility." *Population and Development Review* 26: 427–439.

PETER UHLENBERG

VERHULST, PIERRE-FRANÇOIS

(1804–1849)

Belgian mathematician and demographer Pierre-François Verhulst, best known for the conceptualization and specification of the logistic curve, was born in Brussels to wealthy parents. Adolphe Quetelet (1796–1874), the Belgian mathematician and demographer, was first Verhulst's mathematics teacher at the Royal Atheneum, then his professor at the University of Ghent, where Verhulst also earned a doctoral degree in mathematics after just three years of study. Verhulst was a highly versatile man who wrote Latin poetry and even drafted a constitution for the Papal States when he was in Italy, a country that eventually expelled him for that reason. Back in Brussels, Verhulst was invited to join the Academie Royale, of which Quetelet was also a member. Verhulst occupied his chair at the academy in 1848, only one year before his death at age 45.

Verhulst's work in demography was essentially completed by 1833. Through Quetelet, he had been invited to present a mathematical formulation of T. R. Malthus's theories. However, Verhulst was convinced that the geometric or exponential growth of population would be curtailed by constraining factors before Malthus's "positive checks" (emigration, excess mortality due to famine or declining living standards) could limit them. That, in itself, was a departure from Malthus's work. Verhulst also believed that the strength of the curtailing factors would increase in a proportional way to the population expansion itself. To elucidate this, Verhulst needed to introduce a hitherto unknown negative function into the overall formula. The result of the work was a demonstration that any population growth rate would essentially follow a bell-shaped curve, starting from zero, steadily increasing to a maximum, and declining once again to zero in a fashion symmetrical to the positive growth phase. The population stock then evolves according to the elongated S-curve, which has a point of inflection at the maximal value of the growth rate, and then levels off at a new but higher plateau, at which point the growth rate declines to zero. Verhulst checked his theory empirically against population data for France, Belgium, Essex, England, and Russia. Quetelet, however, was not convinced by his student since he knew of no counterpart in physics. After the publication of Verhulst's theory, the logistic curve was forgotten until its rediscovery by the American biometrician Raymond Pearl and demographer Lowell J. Reed in 1921, and British statistician G. Udny Yule's 1925 acknowledgment of the significance of Verhulst's finding of almost a century earlier.

From the 1920s onward, many applications for the theory were found in a wide variety of fields. The logistic curve became one of the essential cornerstones of world systems modeling. It also proved to provide good descriptions of certain diffusion processes, especially of those based on the principles of contagion. Diseases, technical novelties, new ideas and rumors would all grow within a virgin population and reach a maximum, but each would eventually encounter resistance and burn out, or be challenged by a better invention or concept. In the field of mathematics, Verhulst's logistic curve was rediscovered in 1975 by two German physicists who determined that it was one of the essential formulas in the mathematics of fractals.

In the early twenty-first century, Quetelet's contributions to demography have largely faded, while those of Verhulst have steadily increased in importance. However, he is still rarely cited by demographers as the inventor of the logistic curve or the contagion model of diffusion.

See also: *Demography, History of; Pearl, Raymond; Quetelet, Adolphe; Diffusion in Population Theory; Projections and Forecasts, Population.*

BIBLIOGRAPHY

SELECTED WORKS BY PIERRE-FRANÇOIS VERHULST.

Verhulst, Pierre-François. 1838. "Notice sur la loi que la population suit dans son accroissement." *Correspondances mathématiques et physiques* 10: 113.

———. 1845. "Recherches mathématique sur la loi d'accroissement de la population." *Mémoires de l'Académie Royale des Sciences et des Lettres de Bruxelles* 18: 1–38.

———. 1847. "Deuxième mémoire sur la loi d'accroissement de la population." *Mémoire de l'Académie Royale des Sciences, des Lettres et des Beaux Arts de Belgique.* 20: 1–38.

SELECTED WORKS ABOUT PIERRE-FRANÇOIS VERHULST.

Kint, Jos. 1990. "Verhulst, Pierre-François: wiskundige en demograaf." *Nationaal Biografisch Woordenboek* 13: 822–827.

Yule, G. Udny. 1925. "Verhulst." *Journal of the Royal Statistical Society* 88: 1.

R. LESTHAEGHE

VITAL STATISTICS

In population studies the term *vital events* generally includes births, deaths, marriages, divorces, fetal deaths (stillbirths), and induced terminations of pregnancy (abortions). In a majority of countries most, if not all, of these events are recorded through the government's civil registration system, which creates a permanent record of each event.

Vital records have two primary uses. First, they are personal legal documents that are needed by citizens to prove the facts surrounding the event (e.g., age, identity). Second, vital statistics—the data derived from these administrative records—constitute one of the most widely used statistical data systems in the world. Vital statistics form the basis of fundamental demographic and epidemiologic measures and are used in planning and operating health programs, commercial enterprises ranging from life insurance to the marketing of products for infants, and a wide range of government activities.

Early Registration of Vital Events

An early form of the registration of vital events in Western countries were baptisms, burials, and weddings typically recorded in church registers. The first systematic parish register system was established in Sweden in 1608, and similar systems were soon established in Quebec (1610), Finland (1628), and Denmark (1646). However, consolidation of records for entire countries was not attempted until the eighteenth century in France and the early nineteenth century in the United Kingdom.

The Massachusetts Bay Colony was the first government derived from the European tradition to establish a secular vital registration system, requiring that the actual events rather than the ceremonies be recorded and that registration be done by government officials rather than by the clergy. In 1804 France, as part of the Napoleonic Code, made the state responsible for recording births, deaths, and marriages and prescribed who should record each event and what the record should include.

The registration of births, marriages, and deaths in the United States began with registration laws enacted by the Grand Assembly of Virginia in 1632 and the General Court of the Massachusetts Bay Colony in 1639. Connecticut, Plymouth, and eventually the other colonies followed suit. Little or no statistical use was made of these records. They were regarded as statements of fact essential to the protection of individual rights, especially rights relating to the ownership and distribution of property.

Modern Use of Vital Records

The impetus for using vital records as the basis of a statistical data system came from the realization that records of births and deaths constituted a source of information about the condition of the human population. The modern origin of vital statistics can be traced to the analysis of the English Bills of Mortality published by the pioneer demographer John Graunt (1620–1674), in 1662. Graunt's work was followed by that of Edmund Halley (1656–1742), mathematician and astronomer, who in 1693 constructed the first scientific life expectancy table. Over time the analysis of mortality data by cause of death became an important source of information that was used in the control of epidemics and to support sanitary reform.

The United States Constitution, adopted in 1787, provided for a decennial census but not a national vital registration system. Thus, legal authority for the registration of vital events was left to the states. The geographic scope of the U.S. registration areas expanded rapidly, but it was not until the 1930s that it included all the states and the District of Columbia. When the U.S. Census Bureau became a permanent agency of the federal government in 1902, the enabling legislation authorized the bureau to obtain annually copies of records filed in the vital statistics offices of states and cities that had adequate death registration systems and to publish data from those records. This marked the beginning of the National Vital Statistics System. Ten states and cities provided death records to the Census Bureau in 1902. In 1915 birth registration was added to the system, and by 1933 all states were registering live births and deaths with acceptable event coverage and providing the required data.

In 1946 responsibility for collecting and publishing national vital statistics in the United States was transferred from the Census Bureau to the Public Health Service, first in the National Office of Vital Statistics and later (1960) in the National Center for Health Statistics (NCHS), which is now part of the Centers for Disease Control and Prevention, Department of Health and Human Services.

International Statistics

Vital statistics are one of the few data systems that are generally available throughout the world. The United Nations and the World Health Organization have led efforts to standardize registration practices, definitions, and statistical measurement. Most industrialized nations have vital statistics systems that in scope and accuracy equal or exceed that of the United States. In addition, most developing countries have at least a rudimentary vital statistics system. Although there are intercountry variations, in general countries adhere to similar registration principles and statistical measures. These data, ideally in combination with census statistics, are widely used to make international comparisons of life expectancy, cause-specific mortality, infant deaths, and the like. Vital statistics also are used to monitor population growth through measures such as total fertility rates. The United Nations publishes many international vital statistics comparisons in its *Demographic Yearbook,* which has been issued annually since 1948.

Sources of Vital Statistics

The best source of vital statistics is a complete civil registration system. In countries in which data from civil registration do not exist or are deficient, other demographic data collection methods may be used to gather information on the incidence of vital events and to estimate vital statistics. These methods include population censuses, demographic sample surveys, and sample registration areas.

A *population census* is a complete enumeration of the population of a defined area with reference to a specified date. If the census includes appropriate questions (e.g., births and deaths in each household during the past year), the data can be used to estimate vital rates in the recent past.

A *sample survey* collects more detailed information than does a census, but from only a portion of the population. Thus, although it provides added depth, rare events may be missed and reliability may be diminished because of sampling errors.

In general population censuses and sample surveys are less desirable sources of vital statistics because they typically do not provide the detail available from a civil registration system. In addition, the methods used to estimate vital statistics rates from these data sources are based on assumptions about and approximations of the relationships between various characteristics of the population. Thus, they may be less useful for the analysis of trends and detailed statistics. Furthermore, data from these sources cannot serve the important legal purposes of administrative records from a civil registration system.

In countries where civil registration is not fully developed *sample registration* may be used to register vital events and estimate vital rates. Events are registered in a specific area of the country on a continuous basis. If it is gradually expanded, a sample registration system can evolve into national civil registration. The main drawback of a sample registration system is that it does not provide vital rates for local areas outside the sample area.

See also: *Census; Demographic Surveillance Systems; Demographic Surveys, History and Methodology of; Farr, William; Graunt, John; Population Registers.*

BIBLIOGRAPHY

Hetzel, Alice M. 1997. *U.S. Vital Statistics System.* Hyattsville, MD: National Center for Health Statistics.

United Nations, Department of Economic and Social Affairs. 2000. *Demographic Yearbook 1998: Fiftieth Issue.* New York: United Nations.

United Nations, Department of Economic and Social Affairs. 2001. *Principles and Recommendations for a Vital Statistics System, Revision 2.* New York: United Nations.

INTERNET RESOURCE.

National Vital Statistics System and Vital Statistics of the United States. 2002. <http://www.cdc.gov/nchs/nvss.htm>.

Mary Anne Freedman
James A. Weed

W

WAR, DEMOGRAPHIC CONSEQUENCES OF

War ranks last on the political economist T. R. Malthus's list of the chief checks to population growth, following "vicious customs with respect to women, great cities, unwholesome manufactures, luxury" and "pestilence" (Malthus 1970, p. 103). Two centuries later, war appears as problematic as the other items on the list. Its demographic effects are hardly susceptible to scientific analysis.

Definition of War

There are obvious problems with definitions. What is war? When military historians and some archaeologists hypothesize that warfare is as old as the human race, they lump together all forms of conflict involving more than a single pair of combatants. Most scholars have abandoned the search for a definition based on social or technological organization, preferring instead to define wars in terms of casualties suffered. Thus political scientist David Wilkinson's 1980 reworking of Lewis Richardson's register of wars since 1820 lists 315 conflicts in which the overall death toll exceeded 300. The mortality cutoff line is 1,000 in successive editions of Peace Studies specialist Ruth Sivard's *World Military and Social Expenditures* that deal with wars since 1900. Using an alternative methodology the historical anthropologist Lawrence Keeley searched cross-cultural indices for evidence of conflict between *bands and tribes.*

A related problem is that ideas about war and records of war before the nineteenth century derive almost entirely from Europe and the Near East. Gilbert and Sullivan's "Modern Major General" was very much the model in his ability to "quote the fights historical, from Marathon to Waterloo in order categorical" (*Pirates of Penzance,* Act I). Wars elsewhere barely figured in scholarly studies. Evidence about warfare and its effects on population in the pre-Columbian Americas, Asia, and Africa is scant and unreliable. A typical example is the claim that a million people perished as the result of wars unleashed by the Zulu king Shaka in the 1820s—a figure cited in the political theorist Hannah Arendt's influential *Origins of Totalitarianism* (1951). The origin of that statistic was a casual remark made by an English hunter-trader in the late 1830s who was hardly in a position to judge. His unsubstantiated estimate probably exceeded the total population of Southeast Africa at that time. Widespread warfare was undoubtedly associated with the growth of the Atlantic slave trade from Africa, but as no statistically-inclined observers were present to document them, the conduct, extent, and effects of the wars waged in the African interior can only be guessed.

It is difficult to generalize even about wars in Europe because their nature changed so much from era to era. The migrations of the Huns, Wends, and Vikings led to wars that were very different from the campaigns of the Roman legions. Apart from the Crusades, medieval warfare involved small numbers of irregular cavalry and ragtag assemblages of archers. The wars of religion that raged for long periods on the European continent during the sixteenth and seventeenth centuries were destructive largely because the armies lived off the land, commanding food from and imposing other levies on hapless civilian populations. Eighteenth and nineteenth century European wars weighed much less heavily on noncombatants. Twentieth-century strategists rediscovered the merits of deliberately targeting large populations with conventional and nuclear bombs.

The demographic effects of war naturally vary with the organization, conduct, and objectives of the conflict. In feudal Europe the objective of most wars was the acquisition of fertile land that was populated by a settled workforce. Any campaign that killed agricultural laborers or frightened them into fleeing the district was counterproductive. Precolonial wars in southern Africa, before the advent of the slave trade, mainly aimed at the capture of cattle, resulting in relatively low levels of human mortality. Naval warfare rarely killed anyone apart from sailors and officers. In wars waged by well-equipped professional armies, deaths in battle are concentrated among young single men. The effects of their removal from the population on the birth rate seem not to have been very significant before the twentieth century. Prior to the nineteenth century in Europe rises in general prosperity were associated with increased fertility. Thus Malthus was not surprised that "the fertile province of Flanders, which has been so often the seat of the most destructive wars, after a respite of a few years, has appeared always as fruitful and as populous as ever. Even the Palatinate lifted up its head again after the execrable ravages of Louis the Fourteenth" (Malthus 1970, p. 107). The huge losses suffered in the major battles of World War I led European élites to speak of a "lost generation" of young men whose sweethearts remained unmarried, but it is difficult to document the assertion. At a time when fertility was declining due to increased use of birth control, the spread of education, and shifts from country to city-living, the effect of the loss of World War I soldiers on overall population is a matter for surmise.

The demographic effects of war are better documented for the twentieth century than for any previous era. Body counts before the nineteenth century cannot be relied on. In the twentieth century deaths among serving military and naval personnel in Europe and North America were painstakingly recorded in archives. So many of the dead were remembered by name on monuments that the *unknown soldier* for the first time became an object of public solicitude. Unquestionably, the high water mark of state-sponsored killing was reached in the first half of the twentieth century. While estimates range widely, plausible sizes of the military and civilian death toll would be around 8.5 million in World War I and 40 million in World War II.

Collateral Effects of War on Demographics

A difficulty facing the analyst seeking to quantify the demographic effects of war is calculating mortality associated with war but not directly caused by losses on the field of battle. War has often created conditions conducive to famine and epidemic disease. Sivard follows the common practice of including all war-related deaths associated with twentieth-century conflicts in the mortality rate. Since war itself is defined as a conflict generating more than a thousand deaths, this statistical practice increases the number of wars. Famines and epidemics associated with the failed Biafran secession from Nigeria, the Sudanese civil war, and India's intervention in Bangladesh are estimated to have cost in total 4.5 million lives. Some scholars class the 1919 influenza pandemic as a consequence of World War I. World War II made it possible for the Nazi regime to target Jews, gypsies, and other populations beyond German borders in a wholesale fashion that would have been impossible in peacetime. Another problem in calculating mortality statistics for the twentieth century is raised by factors such as the holocaust deaths in Germany during World War II. Should losses in campaigns conducted against internal forces be counted as death in war? Civil wars involving organized armies (for example, the United States, Russian, and Spanish civil wars) figure on all lists.

But more problematic are deaths arising from state-sponsored violence against internal enemies, such Stalin's campaigns against the kulaks and Crimean Tartars, Mao's Cultural Revolution, and the killings in Cambodia under Pol Pot. R. J. Rummel (2000) calls such campaigns *democide.* By excluding interstate wars, and adding up the deaths caused principally by totalitarian regimes, he concludes that "nearly 170 million people probably have been murdered by governments in this [twentieth] century; over four-times those killed in combat in all international and domestic wars during the same years." A related issue concerns conflicts that pit unorganized ethnic groups against each other as was the case during the communal violence at the time of British India's partition in 1947 and what is usually called Rwandan genocide of 1994 in which as many as 1 million people are estimated to have died. Typically, statistics for such conflicts are given in suspiciously round numbers.

Peace groups that lament the increasing numbers of civilians who have died in the wars of the late twentieth and early twenty-first centuries arrive at that conclusion by including deaths associated with any conflict even when the numbers of formal combatants were relatively small. The net effect is to annex statistics of mortality which, in previous centuries, would have been counted as losses from famine and pestilence. This practice obscures the most striking aspect of wars since 1945: the sharp decline in military personnel dying in battle. Sivard's estimates of numbers of military persons killed in wars in the twentieth century show a total of some 35 million deaths in the period 1900–1945, but less than one-quarter as many in the period 1946–1995.

War from the Mid-Twentieth Century

Battlefield deaths declined sharply after the end of the Vietnam War in 1975. Since there have been no important naval battles since World War II, deaths at sea have declined to a demographically insignificant figure.

Apart from losses of combatants, the most important impact of war on population in the twentieth century arose from advances in military technology and the practice of deliberately targeting civilians. Whereas previous wars had mainly killed young single men, twentieth century warfare was indiscriminately directed at men, women, and children. This was particularly true after the advent of airborne bombing and deliberate campaigns of extermination (for example, the firebombing of Dresden, the atomic bombs dropped on Japan, the Holocaust, the Pol Pot regime, and the Rwandan genocide). The removal of large numbers of women of childbearing age undoubtedly reduced fertility in certain regions. While the civilian populations of the Americas and Africa escaped such devastating attacks in World War II, some countries were very hard hit. Deaths from all war-related causes in the Soviet Union have been estimated to be as high as 29 million, a figure many times greater than the number of military personnel involved.

If all things were equal, fertility might have been expected to decline drastically. But, as Malthus noted when marveling at the rapid recovery of population in late-eighteenth-century Flanders, all things are never equal. Postwar prosperity was associated with a *baby boom* not just in the United States. Many parts of the world, including war-ravaged East and Central Europe, experienced a relative jump in prosperity compared with the Depression of the 1930s. The rise in optimism about the future and high levels of employment generated by postwar reconstruction led to increased fertility. Where war coincides with large movements of refugees, famine, and disease—as it did in Rwanda, Ethiopia, Sudan, and Somalia in the 1980s and 1990s—it becomes very hard to specify the effects of war on population. Those African countries have also felt the impact of relatively late demographic transitions in fertility and the AIDS pandemic. Despite all its problems Rwanda's population appears to have grown from 7,165,000 in 1991 to nearly 9 million in 2002.

The impact of improved killing technology on population losses due to war is debatable. During the Cold War the United States and the Soviet Union acquired the capability to obliterate each other's cities with nuclear weapons. The number of nations possessing such weapons has grown steadily. But by the end of the twentieth century not one of the nuclear states had dared to employ them against an enemy, or even to openly threaten their use. The standoff between the United States and the USSR was often attributed to a "balance of terror" generated by the knowledge of the probability of "mutually assured destruction." The same could not be said of other nuclear powers. Whether this restraint is due to respect for the opinions of humankind or is attributable to some other reason is not clear.

Paradoxically, the highest rate of killing in late-twentieth-century wars occurred in the worst equipped states. About half the war deaths between 1945 and 2000 occurred in three countries—Sudan, Nigeria, and Bangladesh—which rate near the bottom of any list of military powers. Armies and modern weapons played very minor roles in these contests. In Rwanda, as in Pol Pot's Cambodia, people used agricultural implements to slaughter their neighbors.

In the early twenty-first century it is no easier to generalize about the effects of war on population than it was in Malthus's time. Battlefield losses in the wars of the only remaining superpower, the United States, have been minuscule. On the other hand, both military campaigns and threats to use force have frequently generated tides of refugees. The permeability of borders in an age of globalization has spread those refugees across the globe, with demographic consequences that are as yet impossible to calculate.

See also: *Ethnic Cleansing; Forced Migration; Genocide; Holocaust; National Security and Population; States System, Demographic History of.*

BIBLIOGRAPHY

Addington, Larry H. 1994. *The Patterns of War since the Eighteenth Century,* 2nd edition. Bloomington: Indiana University Press.

Arendt, Hannah. 1951. *Origins of Totalitarianism.* New York: Harcourt, Brace.

Eckhardt, William. 1992. *Civilizations, Empires and Wars: A Quantitative History of War.* London: McFarland & Co.

Elliot, Gil. 1972. *Twentieth Century Book of the Dead.* London: Penguin.

Hayes, Brian. 2002. "Statistics of Deadly Quarrels." *American Scientist* 90: 10–15.

Keeley, Lawrence. 1996. *War Before Civilization: The Myth of the Peaceful Savage.* New York: Oxford University Press.

Malthus, T. R. [1830] 1970. *A Summary View of the Principle of Population.* Harmondsworth: Penguin.

———. [1789] 1970. *An Essay on the Principle of Population.* Harmondsworth: Penguin.

Richardson, Lewis. 1960. *Statistics of Deadly Quarrels,* ed. Quincy Wright and C. C. Lienau. Pittsburgh: Boxwood Press.

Rummel, R. J. 1994. *Death by Government.* New Brunswick, NJ: Transactions Publishers.

Sivard, Ruth L., ed. 1978–1996. *World Military and Social Expenditures.* Leesburg, VA: WSME Publications.

Small, Melvin, and J. David Singer. 1982. *Resort to Arms: International and Civil Wars, 1816–1980* London: Sage.

———. 1972. *The Wages of War, 1816–1965.* New York: John Wiley.

Wilkinson, David O. 1980. *Deadly Quarrels: Lewis F. Richardson and the Statistical Study of War.* Berkeley: University of California Press.

Wright, Quincy. 1965. *A Study of War.* rev. edition. Chicago: University of Chicago Press.

INTERNET RESOURCE.

Rummel, R. J. 2000. *20th Century Democide.* <http://www2.hawaii.edu/~rummel/20TH.HTM>

NORMAN ETHERINGTON

WATER AND POPULATION

Fresh water is essential for human survival and for most human activities. The human body depends on a daily throughflow of drinking water. Unless that water is safe, people get ill; this is a problem of enormous dimensions because an estimated 1.1 billion persons are still without safe water supply and over 2.4 billion do not have safe sanitation. Water also is fundamental for productive activities in society, especially to produce the food people eat. Water precipitating over land is partitioned at the ground: Some evaporates directly; some infiltrates into the soil, is picked up by plant roots, and vaporizes; and the rest recharges rivers and aquifers. In the early twenty-first century an average of some 1,200 cubic meters of water is consumed (evaporated) annually per person, about 50 times the amount an average person uses in the household.

Predicament of Countries with Rapidly Growing Populations

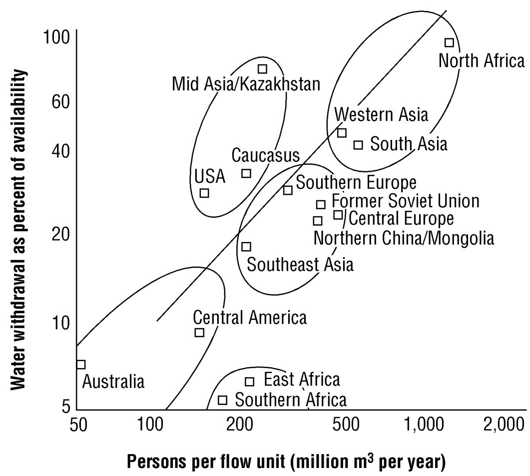
Food production problems tend to be significant in regions that have monsoon climates with a short rainy season and a long dry season, an atmosphere in which rainwater evaporates rapidly, large variability in rainwater both interannually (recurrent drought years) and in the rainy season (large risk of dry spells hurting growing plants), and vulnerable soils that easily degrade into crushed and eroded lands. The difficulties of coping with these complex problems, most of which are unknown in the temperate zone, have left large regions of the world in poverty and with undernutrition. The problems are particularly significant in southern Asia and sub-Saharan Africa. However, it was in regions with such climatic challenges that agrarian civilization emerged.

Using human ingenuity, riverine populations developed intricate irrigation systems to protect growing crops from deficiencies in rainfall. In the contemporary world agricultural development presents the greatest difficulties in regions where rivers are absent, carry water only during heavy rains, or are shared with other countries so that the water supply is contingent on international agreements.

Irrigated areas should be able to produce much more food than most currently do by turning to less wasteful methods of irrigation. However, food production in most countries is heavily dependent on rain-fed agriculture. Large-scale upgrading of rain-fed agriculture is needed to forestall recurrent crop failures and food shortages in those regions as their populations rise. Fortunately, there is enough rainfall for much better yields: Rainfall now wasted through flood flows and evaporation could be caught and put to productive use. The problem thus is not so much lack of rainfall as lack of soil infiltrability and inadequate plant uptake capacity caused by dry spell damage. Better soil conservation methods can raise the level of soil infiltration, and better harvesting of local water runoff can improve the ability of plants to absorb soil water.

FIGURE 1

Population Pressure and Use of Water Resources by Region, Mid 1990s



Note: Logarithmic scale on both axes. Diagonal line shows per capita water withdrawal of 1,000m³ per year, needed for food self sufficiency in semi-arid tropics and subtropics.

SOURCE: Shiklomanov (1997).

Policy Implications

Figure 1 shows current similarities and differences in the water resources predicaments of different clusters of regions. Moving up the vertical scale is equivalent to mobilizing more of the streamflow to make it accessible for withdrawal for household use, productive activities, and irrigation. Because a certain amount has to remain in rivers to protect aquatic ecosystems and fisheries, there is a ceiling beyond which no more water can be put to use except through the reuse of upstream wastewater. Countries and regions find themselves in different situations. As long as it is still possible to mobilize more, increased water demands can be met through supply management, provided expertise, labor power, and financial resources will allow the necessary infrastructures to be built. Countries that are already close to their "water ceilings" have to change their water management policies and promote water-saving approaches (demand management).

The effect of larger population size, and thus indirectly of population growth, can be traced in the figure by moving out along the horizontal scale, which shows the level of "water crowding": the number of persons per flow unit. Higher values of this measure indicate more people polluting every unit of water flow and imply increasing proneness to disputes. In such situations water pollution abatement becomes essential, as does dispute mitigation, supported by legislation, mediation, flexible institutions, and public participation in order to secure social acceptance of the remedial action that is decided on. It is evident that with high levels of water crowding, efforts to curtail population growth are called for because the population-supporting capacity of the existing water resources is being exhausted. Solutions that could support an even larger population include reliance on imported food and nonconventional means of expanding water availability, such as desalination, water importation in tankers (or in towed plastic megabags), and water transfers through pipelines and canals from countries with better water resources.

Shift in Thinking

In the increasingly precarious conditions created by continued population growth in water-short regions political leaders are expected to guide their countries safely toward water security, food security, and environmental security. The task of constructing safe water supply and sanitation systems remains fundamental. In addition, the situation calls for a broadening of perspectives to encompass pollution abatement so that the available water stays usable, food imports to compensate for shortfalls in food self-reliance, income-generating activities to pay for that food, dispute risk minimization in a climate of increasing water crowding, and preparedness for recurrent droughts and floods linked to variability in rainfall.

Among experts on water resources, attention is moving away from seeing current streamflow as a stable resource and toward seeing rainfall as the original resource. This resource is partitioned between evaporation, linked especially to biomass production in forests, grasslands, wetlands, and croplands, and the surplus that is feeding the rivers and aquifers and is used for societal purposes. In tropical regions changes in land use may alter the streamflow considerably. Large-scale deforestation may increase the streamflow and/or raise the water table (causing damage from salination, as it did in Australia); large-scale forest plantations may reduce the streamflow (as in South Africa, where such plantations are considered a streamflow-reducing activity and require special permits). These linkages make land use decisions water management decisions. As a consequence, the currently recommended long-term route is integration of land and water management as part of a catchment-based ecological approach.

See also: *Carrying Capacity; Ecological Perspectives on Population; Food Supply and Population; Limits to Growth; Natural Resources and Population.*

BIBLIOGRAPHY

Chaplin, M. F. 2001. "Water: Its Importance to Life." *Biochemistry and Molecular Biology Education.* 29: 54–59.

Falkenmark, Malin. 1994. "Landscape as Life Support Provider: Water-Related Limitations." In *Population—The Complex Reality,* ed. Sir F. Graham-Smith. London: Royal Society.

———. 1997. "Meeting Water Requirements of an Expanding World Population." *Philosophical Transactions of the Royal Society, Biological Sciences* 352: 929–936.

———. 2001. "The Greatest Water Problem: The Inability to Link Environmental Security, Water Security and Food Security." *Water Resources Development* 17(4): 539–554.

Falkenmark, Malin, and Gun Nar Lindh. 1976. *Water for a Starving World.* Boulder, CO: Westview Press.

Haraddin, M. J. 2001. "Water Scarcity Impacts and Potential Conflicts in the MENA Region." *Water International* 26(4): 460–470.

Lundqvist, Jan, ed. 2000. *New Dimensions in Water Security.* Rome: FAO, AGL/MISC/25/2000.

Shiklomanov, Igor. 1997. *Assessment of Water Resources and Water Availability of the World.* Background report to the Comprehensive Assessment of Freshwater Resources of the World. Stockholm: Stockholm Environment Institute and World Meteorological Organization.

INTERNET RESOURCE.

Rockström, Johan et al. 1999. "Linkages among Water Vapour Flows, Food Production, and Terrestrial Ecosystem Services." *Conservation Ecology* 3(2). <http://www.consecol.org/vol3/iss2/art5/index.html>.

Malin Falkenmark

WELFARE STATE

A welfare state has been defined as a "state which has a policy of collective responsibility for individual well-being" (Clegg 1980, p. 7). For some commentators the term refers to the services produced, provided, and delivered by public agencies; however, for others it also includes benefits and services that are purchased by public resources but may be provided by commercial or voluntary bodies. Others even include welfare services produced and provided by employers (occupational welfare) and the family.

Welfare is difficult to define in light of the fact that both its source and its delivery vary widely. Welfare can be derived from a range of activities, including paid work, private activity such as savings and insurance, and voluntary activity as well as through the state. Benefits can be in cash or in kind; benefits in kind include both free services such as public education and health care and subsidized services such as low-rent housing provided along with employment, community care services, and dental care. A service may be publicly funded, publicly produced, both, or neither.

The objectives of welfare also are varied, ranging from poverty relief or the reduction of inequality to strengthening social inclusion and increasing social cohesion (Barr 2001). Most welfare states act both as a lifetime "piggy bank"—using social insurance to redistribute funds from one point in an individual's life to another—and as a "Robin Hood"—redistributing income and wealth from the rich to the poor to alleviate poverty and reduce social exclusion. The balance between these two roles varies from country to country, depending on the priority assigned to different objectives.

Types of Welfare Regimes

Gøsta Esping-Andersen, in *The Three Worlds of Welfare Capitalism* (1990), constructed "decommodification" indexes to measure the coverage, accessibility, and performance of social security schemes in eighteen Organization for Economic Cooperation and Development (OECD) countries. Using these indexes, he distinguished three ideal-type welfare regimes:

1. Liberal welfare regimes, in which the government provides only a minimum or "residual" level of welfare services and the family or religious and charitable institutions play the major role in providing health and social welfare services. Such regimes assign priority to promoting economic growth and aim to reduce poverty in a way that impinges minimally on that goal. Examples are southern European countries such as Greece, Portugal, and Spain, as well as the United States.
2. Conservative/corporatist regimes, in which the government plays a leading role in both organizing and providing welfare services. Services are highly developed, are of good quality, and are funded by a mixture of private and social insurance schemes. In addition to the state, nongovernment institutions such as churches, employers, and trade unions are important. Corporatist welfare states assign priority to social stability and tend to be conservative in their approach to welfare issues such as the family and the role of women in the labor market. Examples are Germany, Austria, Belgium, and France.
3. Social democratic regimes, in which the government emphasizes social equality as well as the alleviation of poverty. Services tend to be comprehensive and universal. Public spending is usually very high, and welfare benefits tend to be generous. However, there is also an emphasis on the work ethic and supporting people to remain in the labor force, for example, through extensive child-care services. The classic examples are the Scandinavian countries, especially Sweden.

Although they are theoretically useful, these classifications are highly stylized and have been subject to debate and criticism. In particular Robert Goodin and his associates (1999) claim that it is not sufficient to measure the performance of social security systems by using data from only one point in time. They argue that the assessment of welfare regimes needs to take account of their impact on people's lives *over* time. With the increasing availability of longitudinal panel data, this type of assessment is becoming possible.

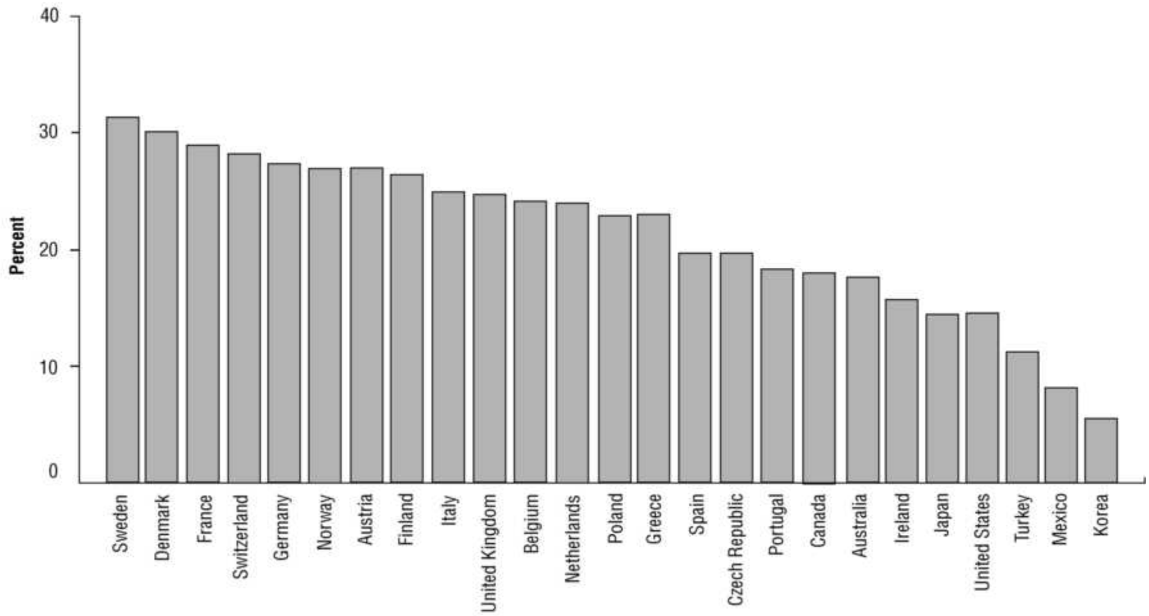
Scale of Public Transfers

The scale of public transfers varies considerably among OECD countries, ranging in 1998 from around 5 percent of gross domestic product (GDP) in Korea to 31 percent in Sweden (Figure 1). It is notable that expenditures on public transfers increased considerably in most countries between 1980 and 1998, doubling from 11 percent in 1980 to 23 percent in 1998 in Greece and rising in that period from 15 percent to 28 percent in Switzerland.

Much of this rise in welfare spending is attributed to changes in the structure of the beneficiary population as a result of population aging. Public spending on old-age cash benefits (pensions and social assistance) has increased steeply, amounting to nearly 13 percent of GDP in Italy in 1998. Older people are also major consumers of health services, and public spending on health care, which by the late 1990s typically was over 5 percent of GDP, generally has risen over time (although some countries have experienced a fall, such as Denmark, Ireland, and Sweden).

FIGURE 1

Public Social Expenditures as Percent of GDP, Selected Countries, 1998



Note: Data are for selected OECD countries. Public transfers on social expenditures include old-age cash benefits, disability cash benefits, benefits for occupational injury and disease, sickness benefits, services for the elderly and disabled people, survivors' family cash benefits, active labor market programs, unemployment, health, and housing benefits, and other contingencies.

SOURCE: OECD Social Expenditure Database (2001).

Responding to an Aging Population

Recent growth in levels of public expenditure and changes in the relative size of different age groups have given rise to the notion of a "demographic time-bomb": It is argued that severe fiscal problems will arise as a result of the relative fall in the number of workers making pension contributions and the relative growth of those drawing pension benefits.

Demographers typically have examined the pressures of population aging by examining the size of the "dependent" population in relation to the size of the population of working age:

$$\frac{(0\text{–}15 \text{ years}) + (65 \text{ and over})}{(16\text{–}64 \text{ years})}$$

This is taken to be a rough index of the number of dependent people per nondependent person.

A dependency ratio defined only by age has, however, come under significant criticism for being simplistic. Economic dependency is complex and multifaceted, and many things in addition to age determine whether a person is dependent. A more sophisticated dependency ratio that is suited to an examination of pressures on public finances:

$$\frac{\text{non-economically active population}}{\text{economically active population}}$$

This ratio takes into account people of working age who are out of the labor market because they are studying, are unemployed (but not seeking work), or have caring responsibilities as well as people of postretirement age who are still working. However, this more refined ratio also can be criticized. Many social gerontologists argue that older people are contributors as well as recipients, particularly if unpaid work outside the formal labor market is taken into account. In the United Kingdom, for example, one-third of the people who provide unpaid care to frail older people are elderly themselves. Many older people are taxpayers as well as beneficiaries.

The key advantage of the refined dependency ratio is that it draws attention to the fact that the fiscal burden is determined by a range of factors beyond purely demographic ones. In particular, the effects of population aging in developed countries have been exacerbated by changes in the length of working life. Since the mid-1970s there has been a sharp fall in the number of years of life men spend in employment and a corresponding increase in the number of years spent in other activities or states, such as school, unemployment, and especially retirement. In a typical OECD country at the start of the twenty-first century a man might spend only half his life in employment (OECD 2000). Women, in contrast, are spending more of their lives in paid employment than was the case in earlier times.

It is increasingly recognized that "the burden of supporting an older population over the coming decades will depend crucially on the extent to which the population of working age in general, and older workers in particular, will participate in the labour market" (OECD 1996, p. 65). Many countries are adopting policies to slow and reverse trends toward early retirement. For example, work incentives in pension schemes are being strengthened. In addition, several countries are considering or implementing an increase in the retirement age (or, more accurately, the age at which state pensions are payable).

Moves toward later retirement may be politically unpopular. When pensions were first introduced, however, the period of expected life after the age of retirement was relatively short. For example, the first old-age pension, introduced in New Zealand in 1898, was payable at age 65; the pension introduced in the United Kingdom in 1908 was payable at age 70. In 1901 expectation of life at birth in the United Kingdom was 56 years for men and 63 years for women; in 2001 it was around 75 years for men and 80 years for women.

Because health-care costs are known to rise with age, it is feared that an aging population will lead to higher health-care expenditures. However, recent studies show that unlike the case with pensions, increased longevity in the population need not translate into increased health costs. Evidence suggests that the greatest proportion of health-care spending among older people is incurred in the final year of an individual's life regardless of the length of that life. In the United Kingdom it is estimated that people consume about a quarter their lifetime consumption of health care during the last year of life. If greater longevity means only that the cost of dying is postponed, the implications for future health spending are limited. If, however, there are additional costs to greater longevity, the implications will be very different. A critical factor will be whether the additional years of life are spent in good or poor health. So far the evidence regarding the compression of morbidity is mixed.

It is important to bear in mind that trends in health-care expenditures are largely determined by factors other than demographic change. For example, three-quarters of the rise in medical spending in the United States between 1960 and 1993 was attributable to technological change in contrast to only 3 percent that was due to demographic change. Thus, there are upward pressures on welfare spending for a whole range of reasons, including aging of the population. The future performance of the economy, and the levels of unemployment and early retirement in particular, will have as great an effect as will demographic change. The question of whether societies can continue to afford the welfare state will be answered as much by ideology as by fiscal concerns.

See also: *Aging of Population; Cost of Children; Family Allowances; Family Policy; Intergenerational Transfers.*

BIBLIOGRAPHY

Barr, Nicholas. 2001. *The Welfare State as Piggy Bank: Information, Risk, Uncertainty and the Role of the State.* Oxford: Oxford University Press.

Clegg, Joan. 1980. *Dictionary of Social Services: Policy and Practice,* 3rd edition. London: Bedford Square Press.

Cutler, David, and Ellen Meara. 1999. "The Concentration of Medical Spending: An Update." Cambridge, MA: National Bureau of Economic Research, Working Paper 7279.

Esping-Andersen, Gøsta. 1990. *The Three Worlds of Welfare Capitalism.* Cambridge, Eng.: Polity Press.

Goodin, Robert et al. 1999. *The Real Worlds of Welfare Capitalism.* New York: Cambridge University Press.

Johnson, Paul, and Jane Falkingham. 1992. *Ageing and Economic Welfare.* London: Sage.

Organization for Economic Cooperation and Development. 1996. *Aging in OECD Countries: A Critical Policy Challenge.* Paris: Organization for Economic Cooperation and Development.

———. 2000. *Reforms for an Ageing Society.* Paris: Organization for Economic Cooperation Development.

Zweifel, Peter, Stefan Felder, and Markus Meier. 1999. "Ageing of the Population and Healthcare Expenditure: A Red Herring?" *Health Economics* 8: 485–496.

Jane Falkingham

WHELPTON, P. K.

(1893–1964)

Pioneer American demographer. Pascal Kidder Whelpton did his undergraduate studies at Cornell University and obtained a graduate degree from the University of Nebraska. His career started with extension work for the Department of Agriculture in agricultural economics and then in a faculty position at Texas A & M University. In 1924 he joined Warren S. Thompson at the Scripps Foundation for Research in Population Problems at Miami University in Oxford, Ohio. His relationship with the Scripps Foundation—he became Associate Director in 1940, Director in 1953—continued until his retirement in 1963. He was president of the Population Association of America in 1941-42 and director of the United Nations Population Division (1950–1953).

Thompson and Whelpton together won national prominence with their 1928 article "Population of the United States 1925–1975," published in the *American Journal of Sociology* and with a series of subsequent publications on U.S. future population trends. They presented population projections using the cohort component method, which had been introduced by English economist Edwin Cannan at the end of the nineteenth century and then used by the statistician Arthur Bowley in the 1920s. The method used a life table to calculate survivors of the initial populations classified by age and sex and added allowances for births and immigration. All three projection inputs—life table, birth rate, and rate of net immigration—required arbitrary assumptions about future demographic conditions; however, the resulting population trajectories seemed to accord with a wholly independent projection method, the logistic curve fitted to observed past population totals in studies by Raymond Pearl and Lowell Reed of Johns Hopkins University. (Both kinds of projection, as it turned out, were large underestimates: U.S. population surged in the baby boom years and with high rates of immigration.).

Whelpton's main contribution to demography lies in his studies of fertility. Notable among these was *Social and Psychological Factors Affecting Fertility,* known as the Indianapolis Study, published in five volumes over 1946–1958. This innovative research project, of which he was a principal investigator (together with Clyde V. Kiser), was based on field interviews and began the rich tradition of survey research on fertility. Whelpton was also closely involved with the Growth of American Families studies carried out in the 1950s and 1960s. He contributed to cohort methods of analyzing fertility, work that culminated in his book *Cohort Fertility* (1954). A selected bibliography of his writings is given in Durand (1964).

Demography has become more sophisticated since Whelpton's time, and some of the methods he used are obsolete, but his role as one of the founders will remain a permanent part of the history of the discipline.

BIBLIOGRAPHY

SELECTED WORKS BY P. K. WHELPTON.

Freedman, Ronald, Pascal K. Whelpton, and Arthur A. Campbell. 1959. *Family Planning, Sterility, and Population Growth.* New York: McGraw-Hill.

Grabill, Wilson H., Clyde V. Kiser, and Pascal K. Whelpton. 1958. *The Fertility of American Women.* New York: Wiley. (Census Monograph Series).

Thompson, Warren S., and P. K. Whelpton. 1933. *Population Trends in the United States.* New York: McGraw-Hill. Reprinted by Gordon and Breach Science Publishers, New York, 1969.

Thompson, Warren S., and P. K. Whelpton. 1943. *Estimates of Future Population of the United*

States, 1940–2000. Washington: National Resources Planning Board.

Whelpton, P. K. 1954. *Cohort Fertility: Native White Women in the United States.* Princeton, NJ: Princeton University Press.

Whelpton, Pascal K., Arthur A. Campbell, and John E. Patterson. 1966. *Fertility and Family Planning in the United States.* Princeton, NJ: Princeton University Press.

Whelpton, P. K., and Clyde V. Kiser. 1953. "Résumé of the Indianapolis Study of Social and Psychological Factors Affecting Fertility." *Population Studies* 7: 95–110.

Whelpton, P. K., and Clyde V. Kiser, eds. 1946–1958. *Social and Psychological Factors Affecting Fertility.* 5 vols. New York: Milbank Memorial Fund.

SELECTED WORKS ABOUT P. K. WHELPTON.

Durand, John D. 1964. "Pascal Kidder Whelpton (1893–1964)." *Population Index* 30: 323–328.

Kiser, Clyde V. 1973. "Contributions of P. K. Whelpton to Demography." *Social Biology* 20: 438–447.

Nathan Keyfitz

WICKSELL, KNUT

(1851–1926)

Swedish economist and prominent exponent of neo-Malthusian ideas, Johan Gustav Knut Wicksell was born in Stockholm and graduated from Uppsala University in mathematics in 1871. After a period living, in Paul Samuelson's words, "a bohemian existence of preoccupation with anti-religion, anti-sexual puritanism, anti-alcoholism, anti-monarchism and anti-militarism" (1987, p. 908). Wicksell turned to the social sciences, studying economics and eventually obtaining a doctorate at Uppsala. In 1904, at age 53, he became professor of economics at Lund University where he remained until his retirement in 1916.

Wicksell's most important scholarly contributions were to price theory and monetary policy (where he was an influence on Keynes), and to the creation of neoclassical theory. He was also one of the first economists to study decision-making within political assemblies, particularly with regard to taxation; this work was a forerunner of public choice theory. Wicksell's prestige as an economist lent intellectual weight to his vigorous propagation of neo-Malthusianism in Sweden. Inspired by the British neo-Malthusian George Drysdale (1825–1904), Wicksell argued in a widely distributed 1880 speech that Sweden was overpopulated and needed to decrease its birth rate. He called for early marriages and the use of contraceptives within marriage as an alternative to celibacy and prostitution. Concerned about resource scarcity and pessimistic about the speed of technological development, in a number of lectures and articles he not only pleaded for reduced natality but for a reduction of the population. He placed Sweden's optimum population at three million, at a time when its actual population was five million.

Wicksell retained his interest in "the population question" and neo-Malthusianism until his death. He was active at European congresses on birth control, and in 1906 he became one of the vice presidents of the English Malthusian League. His views made him a rebel in Sweden's conservative society. Wicksell was an atheist (he was imprisoned for two months in 1910 for blasphemy), a republican, and a strong advocate of women's suffrage. His wife, Anna Wicksell Bugge (1862–1928), was a pioneer in the women's movement in Scandinavia.

See also: *Demography, History of.*

BIBLIOGRAPHY

SELECTED WORKS BY KNUT WICKSELL.

Wicksell, Knut. 1910. *The Theory of Population, Its Composition, and Models of Change.* Stockholm: Bonniers.

———. 1954. *Value, Capital and Rent* (1893). London: Allen & Unwin.

———. 1958. *Selected Papers on Economic Theory,* ed. Erik Lindahl. London: Allen & Unwin.

———. 1977–1978. *Lectures on Political Economy,* 2 vols, trans. E. Classen, ed. Lionel Robbins. Fairfield, NJ: Augustus M. Kelly.

———. 1997–1999. *Selected Essays in Economics,* 2 vols, ed. Bo Sandelin. London and New York: Routledge.

SELECTED WORKS ABOUT KNUT WICKSELL.

Samuelson, Paul A. 1987. "Wicksell and Neoclassical Economics." In *The New Palgrave: A Dictionary of Economics* Vol. 4. London: Macmillan.

Uhr, C. G. 1951. "Knut Wicksell—A Centennial Evaluation." *American Economic Review* 41(5): 829–860.

LARS-GÖRAN TEDEBRAND

WOMEN'S STATUS AND DEMOGRAPHIC BEHAVIOR

Research on many aspects of population change in the contemporary world has highlighted the significance of relationships between women's status and demographic behavior. In particular, knowledge of these relationships has been important in understanding demographic transition, increasing the complexity of the classical depiction in which fertility decline is seen as a natural outcome of mortality decline and economic development. Especially in conditions where economic growth is slow or stagnant, considerations of women's status and autonomy have yielded key insights into trends in health and fertility.

Conceptual and Methodological Issues

Kingsley Davis, an influential theorist of social and demographic change, has argued that in contemporary high-fertility societies the status of women is an important factor influencing demographic change, whereas in Western societies that have experienced demographic transition gender equality might well have been a consequence (although incidental) of low fertility. The principal cultural anchor for persistently high levels of fertility, according to Davis, is a complex of institutional factors with their accompanying attitudes and norms that determine women's status. The most important of these factors are patriarchal, patrilineal, and patrilocal marriage and kinship systems in which the filial bond dominates the marital bond in family organization and kinship and family are the principal bases of social organization; a young age at marriage and higher proportions married, and thus early exposure to intercourse; and taboos on the free mixing of the sexes and consequent poor interspousal communication, particularly with regard to sexual behavior, resulting in relatively little use of contraception.

The most important effect of such institutional patterns is the subordination of women: their seclusion; lack of autonomy in making decisions, including decisions pertaining to their fertility; and the denial to them of opportunities for formal education and economic independence, opportunities that can enhance their ability to interact with the world outside the home, with attendant gains in knowledge and self-confidence.

By and large demographers agree that strongly patriarchal systems in which women have a high degree of economic dependence on men and experience social subordination through patrilocal exogamy are associated with high fertility. They are less agreed on the direction of the underlying cause-effect relationships, if any exist, and how such relationships might vary in different cultural contexts.

Women's status can be seen as being embedded in a gender system—the complex of roles, rights, and statuses that surround being male and female in a particular society or culture. Gender systems embody institutionalized inequality in power, autonomy, and well-being between male and female members, typically to the disadvantage of females. They are reinforced by state, community, family, and kin and perpetuated by socializing new generations into behaving in accordance with the dominant gender norms. In this manner, gender systems affect individual behavior, including behavior bearing on fertility.

Women's Status and Demographic Outcomes

Empirical investigations of the relationship between women's status and demographic outcomes, however, have mostly taken a narrower approach, focusing on a few variables that plausibly are linked to women's status. The most significant of these variables are:

- *the perceived advantages of high fertility* resulting from the denial to women of other sources of cultural and economic worth;
- *son preference*, both as a security measure, reflecting women's concern to protect themselves against the risks inherent in their low status and economic dependence on

husband, and as a religious or social duty toward the husband's lineage;

- *female education*, which confers self-esteem and self-confidence, access to new information, and a greater propensity to adopt innovative behavior;
- *women's autonomy*, indicated by mobility outside the home and participation in decision making in the household;
- *women's economic worth*, indicated by ownership of property and participation in the labor force;
- *women's health-care-seeking behavior* for themselves and their children; and
- *marriage and kinship systems* (age at marriage, social support systems, etc.).

The fertility-related variables generally considered in these studies are age at marriage, use of modern contraception, age at termination of childbearing, attitudes toward birth control, and number of children (and number of sons and daughters separately) desired; an indicator of child health and mortality is female disadvantage in survival.

Social demographic analysis has found strong links between women's status and their demographic behavior. Discrimination against women appears to be the root cause of much of the high fertility and female disadvantage in survival, with regional variations reflecting differences in cultural systems. (Disadvantage in survival is sometimes manifest in higher female than male age-specific mortality rates; more commonly, it is seen in female survival rates that are higher than male survival rates but by less than would be expected in the absence of gender discrimination.)

Conventional demographic survey research on this topic often produces ambiguous results, perhaps because of weaknesses in the proxy variables typically used in the analysis or because gender inequality cannot be adequately captured by a single quantitative indicator. Broad generalizations on cause-effect relationships have also been confounded by the different levels at which influences work: On the one hand, the sphere of individual actions affecting fertility and child mortality, and on the other, the macro level at which cultural configurations of women's status are generally conceptualized. More recent studies have attempted to work with direct indicators of women's autonomy (freedom of movement, participation in household decision-making), their empowerment (sense of self, ability to negotiate with agents outside the domestic sphere), and their control over material resources (economic security, property rights, inheritance rights).

Illustrative Findings

Illustrative findings on this topic frequently come from studies in South Asia, a region characterized by women's low status and moderate or high fertility. The findings point to women's economic activity, education, and mobility/autonomy as factors affecting fertility, although these variables may well behave differently in different circumstances.

The link between female labor force participation and child survival is well established. Women who engage in economic activity tend to provide better chances for the survival of their female offspring than do women with no wage income. The precise reason working women seek as prompt health care for daughters as for sons remains unclear. Possible explanations may lie in the effect of particular agricultural regimes, such as southern Indian and Southeast Asian rice cultivation, in enhancing women's economic worth; women's culturally sanctioned greater economic independence, as in Africa; or their greater mobility and sense of self-worth. Very likely, there is a combination of several factors.

There is no conclusive evidence that gender bias in child survival is lower among poor households. Nevertheless, landless households are believed to show less discrimination against girls.

The relative female disadvantage in infant survival appears to be greater in cultures that value female seclusion, accentuate women's economic and social dependence on men, or place a higher comparative value on sons than on daughters. The disadvantage increases with socioeconomic status as defined by caste, income, and maternal education. Gender discrimination works both through less attention given to health care for girls and, more recently, through resort to sex-selective abortion (practiced in China, South Korea, and Vietnam as well as in South Asia). Improved educational levels help women gain the independence and autonomy needed to ensure better nutrition and medical care for their children, enhancing overall child survival, but do not necessarily narrow the relative female disadvantage in regard to infant survival.

Paradoxically, education (a covariable with class and therefore improved status) may contribute to the intensification of patriarchal norms such as women's seclusion and reduced autonomy in fertility decisions in these cultures. In the long run education is probably the most potent engine of both demographic change and women's overall well-being. In this respect it would be superior to labor force participation, which among poor women entails the double burden of work outside and inside the home to the detriment of their own health. In the short run, however, education may not always be an unmixed blessing. To yield its effects in reducing fertility and lessening gender discrimination education means more than just literacy; it calls for formal schooling up to the secondary level, and for women as well as men.

Other Modernizing Influences

Demographic behavior does not respond only to broad trends in economic development and social stratification: There are other modernizing influences at work. These influences are, most notably, access to newer contraceptive technologies; diffusion of modern ideas through the mass media, especially the electronic media, and the health and educational systems; the wider availability of health services and their public information component; and the forces that lead to family nucleation among urban dwellers. Such factors have the potential to alter aspirations for self and family, in turn affecting both women's status and demographic outcomes.

The alacrity with which contraception is often resorted to, even—sometimes especially—by illiterate women when high-quality family planning services are sensitively offered, suggests that these services might have equivalent effects to female education on fertility and child survival.

The field of women's health, by bringing in other disciplinary perspectives, has contributed new insights into how gender inequalities actually affect women's fertility decisions. Research has highlighted the value of smaller-scale, qualitative methods of investigation in understanding the layers of meaning that fertility and its regulation have for women and the complex strategies that women devise to achieve some measure of control over their own bodies even when constrained by the unequal power structures that operate in both the domestic and public domains.

See also: *Education; Feminist Perspectives on Population Issues; Fertility Transition, Socioeconomic Determinants of; Gender Preferences for Children.*

BIBLIOGRAPHY

Balk, Deborah. 1997. "Defying Gender Norms in Rural Bangladesh: A Social Demographic Analysis." *Population Studies* 51: 153–172.

Basu, Alaka M. 1992. *Culture, the Status of Women and Demographic Behaviour.* Oxford: Clarendon Press.

Caldwell, John C. 1976. "Toward a Restatement of Demographic Transition Theory." *Population and Development Review* 2: 321–366.

———. 1998. "Mass Education and Fertility Decline." In *The Earthscan Reader in Population and Development,* ed. Paul Demeny and Geoffrey McNicoll. London: Earthscan Publications.

Das Gupta, Monica, and P. N. Mari Bhat. 1995. "Intensified Gender Bias in India: A Consequence of Fertility Decline." Working paper No. 95.02. Cambridge, MA: Harvard Center for Population and Development Studies.

Davis, Kingsley. 1984. "Wives and Work: The Sex Role Revolution and Its Consequences." *Population and Development Review* 10(3): 397–417.

Davis, Kingsley, and Judith Blake. 1956. "Social Structure and Fertility: An Analytic Framework." *Economic Development and Cultural Change* 14(2): 211–235.

Dyson, Tim, and Mick Moore. 1983. "On Kinship Structure, Female Autonomy and Demographic Behaviour in India." *Population and Development Review* 9(1): 35–60.

Freedman, Ronald. 1979. "Theories of Fertility Decline: A Reappraisal." *Social Forces* 58: 1–17.

Jejeebhoy, Shireen J. 1996. *Women's Education, Autonomy and Reproductive Behaviour: Assessing What We Have Learnt.* Honolulu: East-West Center.

Malhotra, Anju, Reeve Vanneman, and Sunita Kishor. 1995. "Fertility, Dimensions of Patriarchy, and Development in India." *Population and Development Review* 21(2): 281–305.

Mason, Karen O. 1997. "Gender and Demographic Change: What Do We Know?" In *The Continu-*

ing Demographic Transition, ed. G. W. Jones, R. M. Douglas, J. C. Caldwell, and R. M. D'Sousa Oxford: Clarendon Press.

Murthi, Mamta, Anne-Catherine Guio, and Jean Dreze. 1995. "Mortality, Fertility and Gender Bias in India: A District-Level Analysis." *Population and Development Review* 21(4): 745–782.

Petchesky, Rosalind P. 2000. "Re-Theorising Reproductive Health and Rights in the Light of Feminist Cross-Cultural Research." In *Cultural Perspectives in Reproductive Health,* ed. C. M. Obermeyer. Oxford: Oxford University Press.

Radhika Ramasubban

WORLD FERTILITY SURVEY

The World Fertility Survey (WFS) was one of the most important international undertakings in demographic data collection and analysis of the twentieth century. Between 1973 and 1984, 66 countries carried out comparable surveys of human fertility. Forty four of these were developing countries that received substantial financial and technical assistance channeled through WFS's headquarters. Thus, an impressive geographical coverage was achieved, though some of the largest countries (China, India, Brazil, and the Soviet Union) declined to participate.

The idea for this international program probably originated with Reimert Ravenholt, the forceful head of the Office of Population at the U.S. Agency for International Development, as a means to resolve conflicting assessments of the fertility impact of family planning programs. The United Nations Fund for Population Activities gave its support for the project and these two organizations became the dominant financial sponsors of the WFS.

Coordination of the enterprise was entrusted to the International Statistical Institute, based in the Netherlands, which brought the necessary scientific respectability and political independence. The institute appointed the eminent British statistician Maurice Kendall (1907–1983) to head the program, which, at his insistence, was based in London. Thus this unique program was funded by two U.S.-based organizations, managed in the Netherlands, and executed in the United Kingdom.

Because of its mandate to yield internationally comparable data, the WFS developed core instruments to be used in all developing countries. These consisted of a household schedule or roster, and a more detailed questionnaire to be administered to ever-married women of reproductive age. Single women were also included in some surveys. Only 3 of the 44 surveys also canvassed husbands.

The core questionnaire for women included complete marriage and pregnancy histories, and sections on socioeconomic background, contraception, breastfeeding, and fertility preferences. This content was not linked to any theory of fertility, but proved ideal for demographic description. The survey allowed a degree of flexibility in the form of optional sets of questions that permitted more in-depth analysis of specific topics. Only two such "modules" were commonly used: one on family planning and one that enquired into biological determinants of childbearing other than contraception.

The imperative to maximize quality of information drove the data collection strategy. Questionnaires were carefully translated into all major languages. Female interviewers were specially recruited and intensively trained. They worked in teams under close supervision. Major efforts were put into producing clean, well-documented, standardized data sets, a pioneering emphasis that WFS's successor, the Demographic and Health Surveys project, has maintained.

The WFS developed a formidable analytic capacity to complement its data collection expertise. The survey made significant contributions to analytic methods such as the adaptation of linear models to individual-level measures of fertility and the application of hazard models to event histories. Its contribution to a greater understanding of the determinants of fertility change was less impressive, nor did it provide a conclusive answer to key policy questions concerning the impact of state-sponsored family planning programs. The name of the enterprise notwithstanding, the World Fertility Survey's contribution to an understanding of childhood mortality probably exceeded its contribution to studies of fertility.

See also: *Demographic and Health Surveys; Demographic Surveys, History and Methodology of.*

BIBLIOGRAPHY

Cleland, John, and John Hobcraft. 1985. *Reproductive Change in Developing Countries: Insights from the World Fertility Survey.* Oxford: Oxford University Press.

Cleland, John, and Christopher Scott. 1987. *The World Fertility Survey: An Assessment.* Oxford: Oxford University Press.

Kendall, Sir Maurice. 1979. "The World Fertility Survey: Current Status and Findings." *Johns Hopkins University Population Reports,* Series M(3).

Population Information Program. 1985. "Fertility and Family Planning Surveys: An Update." *Johns Hopkins University Population Reports,* Series M(8).

John Cleland

WORLD POPULATION GROWTH

The human race, even if its destiny appears unique, is part of the general evolution of the animal kingdom. But it is in the vanguard of that evolution since it is able to gain increasing mastery over its environment. Humanity's dominance of the planet and its exploitation of the Earth's resources have been accompanied by major increases in the size of human populations.

Prehistoric Beginnings

Possibly as long as 3 million years ago, *Homo habilis* emerged in East Africa. Its distinguishing characteristics were that it made, and more or less systematically used, tools of wood or flint stone, and that it exhibited a novel, more advanced type of social behavior: It consumed food not where it was obtained but at the group's campsites. The territory occupied by these early humans covered some 4 million square kilometers (about 1.5 millon square miles) of wooded savanna-land between today's Ethiopia and Zimbabwe. According to an estimate by János Nemeskéri, there may have been a population as great as 100,000, already exhibiting subgroups with distinct physical features.

From then onward, human genetic change has been very rapid: Most notably brain size, which at the start was less than 500 grams, increased by more than 1 kilogram in less than 3 million years. In successive stages of evolution, the great selective advantage that resulted gave humans the ability to eliminate their nearest competitors. *Homo habilis* thus yielded its place to *Homo ergaster,* which, having quadrupled the territory it occupied in Africa, spread to Europe and to southern Asia, taking on the closely similar form of *Homo erectus.*

In the twenty-first century, numerous methods are available for making estimates about prehistoric populations. The most commonly used method assigns to a given territory the population density among peoples with similar culture and who are living under similar climatic conditions, observed in some recent period. The resulting estimates indicate small populations, despite technical advances such as the domestication of fire. The extent of the territory occupied and variations in climate thus appear more influential than technical progress. The population size of *Homo erectus* over the entire earth may have varied between 500,000 and 700,000.

Later, three branches of humanity emerged: *Homo sapiens* in Africa and south Asia, *Homo neanderthalensis* (Neanderthal man) in Europe, and Java man in Indonesia. Hypothetically, the maximum population of *Homo sapiens* was about 800,000 in the Afro-Asian territory, while the corresponding numbers for Neanderthal man and Java man may have been 250,000 and 100,000.

From around the onset of the last Ice Age, some 70,000 years ago, *Homo sapiens* were ascendant and in the subsequent millennia spread over continental territories theretofore unoccupied by man: Australia, Siberia, and eventually the Americas. (Up to about 15,000 years ago, large parts of North America and Europe were under ice cover.) The world population may have reached 1.5 million during this period, most of it in Africa and Asia. Technical progress became the main driving force of demographic expansion.

Settlement of North Africa came relatively late. Taking advantage of the narrowness of the straights between Sicily and Tunisia, Europeans crossed over to Africa in two waves—around 20000 B.C.E., and around 12000 B.C.E.—thus peopling the whole of North Africa from the Canary Islands to Egypt.

In Europe, population size may have attained 200,000 persons in the period from 10000 to 8700

B.C.E. Then there was a sudden warming of the climate, coinciding with a brutal end to the flourishing Paleolithic cultures. At the beginning of the Mesolithic period that followed, population size diminished, but subsequently the peopling of Northern Europe, earlier under ice cover, renewed demographic growth. Toward 7000 B.C.E., population size in Europe as a whole may have approached 400,000.

Late Prehistoric Populations

About that time, a small sedentary population, engaged in agriculture and animal husbandry, established the first known Neolithic village, near twenty-first-century Saloniki in Greece. From this region two streams originated, together forming the population of Neolithic Europe: one, a maritime group, occupying the coastal regions all the way to Britain; the other a terrestrial group, occupying the inland. By 4000 B.C.E., almost all Europe was Neolithic, with a population of some 2 million, and growing. That population peaked around 2000 B.C.E. at some 23 million, followed by a sharp drop early in the Bronze Age, which was then beginning.

This Neolithic culture was born in the Near East. Its main constituting elements—the hoe, animal husbandry, pottery, and maritime navigation—make their appearance in the period from 10000 to 8000 B.C.E. The region's population increased over this period from about 200,000 to around 5 million, and reached some 10 million by 2000 B.C.E. From its core, the culture spread to Mesopotamia, Egypt, the Caucasus, the Persian Highland, the Punjab, Nubia, Ethiopia, and Yemen.

The Asian subcontinent—present-day Pakistan, India, Bangladesh, and Sri Lanka—had a larger population: perhaps about 600,000 people by 4000 B.C.E., 3 million by 3000 B.C.E., and a peak of some 20 to 25 million by 2000 B.C.E.

In East Asia, beginning around 8000 B.C.E., a Neolithic culture arose in the lowlands of the Hoang-Ho (Yellow River), covering a region of some 600,000 square kilometers, and spread rapidly to the East and later to the South. The population may have reached 800,000 by 4000 B.C.E., 3 or 4 million by 3000 B.C.E., and 20 million by 2000 B.C.E.

Other Neolithic populations appeared somewhat later in Mexico and the Andean Highlands. Based on the examination of pottery evidence, Neolithic-type cultures also arose in Japan from around 12000 B.C.E. and in the African Sahel from around 8500 B.C.E.

From 6000 B.C.E. to 4000 B.C.E., the world's population may have risen from 6 or 7 million to near 30 million; 2,000 years later, as the plough was replacing the hoe, it may have reached 100 million.

Population Growth Since Antiquity

If chronologically widely-spaced estimates are made, a curve connecting the plotted points of these estimates gives the impression of smooth exponential growth from the distant past to the present. Colin McEvedy and Richard Jones, starting from 400 B.C.E., presented this type of curve with some light fluctuations; but the dominant impression conveyed is virtually uninterrupted exponential growth.

Yet the best known populations since Antiquity—the populations of Europe, China, the Near East, and Japan, which together comprise more than half of all humanity—exhibited marked fluctuations. Compartmentalization of the overall total into broad cultural subgroups reveals these fluctuations (see Table 1). The estimates shown in the table are not precise; even data from twentieth-century census counts from developed countries cannot be claimed to be such. But various checks on the estimates for early dates tend to support the numbers, and as to recent census data, the typical error in census counts has been demonstrated to be about 1 to 2 percent in developed countries and 5 to 30 or even 40 percent in certain developing countries up to the middle of the twentieth century.

Recent studies provide population estimates since Antiquity for various Near Eastern populations—notably for Egypt and Palestine—but interpretation of the underlying data from the ancient, medieval, and Ottoman periods is problematic.

China has a remarkable series of population counts starting at the beginning of the era shown in the table. Use of that data requires great care, but the broad lines of population growth have been established.

For Japan, even if the early estimates are uncertain, the population numbers are well known starting with the early seventeenth century, thanks to the use of temple-registers in which all persons residing in a given village or town district were required to be recorded.

For Europe, documents from Antiquity relating to population are rare. For the medieval period, fis-

TABLE 1

World Population Estimates, by Region, Selected Dates, 400 BC–AD 2000 (millions)

Region	400BC	0	500	1000	1300	1400	1500	1700	1800	1900	2000
China	19	70	32	56	83	70	84	150	330	415	1273
India	30	46	33	40	100	74	95	175	190	290	1320
South-West Asia	42	47	45	33	21	19	23	30	28	38	259
Japan	0.1	0.3	2	7	7	8	8	28	30	44	126
Rest of Asia	3	5	8	19	29	29	33	53	68	115	653
Europe	32	43	41	43	86	65	84	125	195	422	782
North Africa	10	13	12	10	9	8	8	9	9	23	143
Rest of Africa	7	12	20	30	60	60	78	97	92	95	657
North America	1	2	2	2	3	3	3	2	5	90	307
Latin America	7	10	13	16	29	36	39	10	19	75	512
Oceania	1	1	1	1	2	2	3	3	2	6	30
World total	**152**	**250**	**205**	**257**	**429**	**374**	**458**	**682**	**968**	**1613**	**6062**

Note: China includes the Korean Peninsula. India includes Pakistan, Bangladesh, and Sri Lanka. Europe includes the former Soviet Union. Latin America includes the Caribbean.

SOURCE: Biraben (1979) and United Nations (2001).

cal records provide an important basis for estimates. The main difficulty is to correctly interpret the concept of the hearth: The term originally corresponded to the household, but its meaning shifted starting with the late fourteenth century. Later, for the sixteenth and seventeenth centuries (and for the eighteenth century in Eastern Orthodox countries), the use of parish registers allow accurate estimates of population characteristics and population change.

For the Indian subcontinent, the estimates shown follow those by Ajit Das Gupta, starting with the estimate of 150 million for the year 1600. That number is broadly confirmed by Shireen Moosvi who gives an estimate of 145 million for the year 1595. For earlier periods, the interval estimates provided by John Durand are used; these show peaks of 50 to 60 million persons for the three most prosperous periods: those of the Mauryan Empire (321–185 B.C.E.), the Gupta Empire (320–470 C.E.), and during the rule of Harsha (612–627 C.E.).

For the Americas and for Australia, despite occasional claims on the matter, there is no plausible evidence to support any substantial population densities for the early periods.

For Africa, existing records yield population estimates for the northern part of the continent, but very little is known prior to 1800 for Africa south of the Sahara. The slave trade (involving some 10 million persons taken to the Americas and some 4 million or more to Muslim lands) very likely removed the larger part of natural increase over the period it existed, causing long-term stagnation of population size. Censuses from the nineteenth century and for the early part of the twentieth century almost certainly substantially underreported population sizes. The figures in Table 1 take this into account.

Estimates for the world population as a whole can be taken as accurate within plus or minus 5 percent since 1900, within 7 to 8 percent between 1700 and 1900, within about 10 percent between 1500 and 1700, and perhaps within 15 percent before 1500.

Population Surges and Fallbacks

Three major technological revolutions resulted in three great population surges in the course of human history:

- acquisition of clothing and hunting and fishing tools in the Upper Paleolithic period (c. 30000–10000 B.C.E.);
- sedentarization and the introduction of agriculture, animal husbandry, and maritime navigation in the Neolithic period (c. 8000–5000 B.C.E.);
- the industrial revolution, which began in the eighteenth century and will conclude in the twenty-first century, as the post-industrial era takes over.

The amplitude of recurrent falls in population due to climate change in prehistoric times, and due to disease, war, and famines starting with the Neolithic period, may be put at between 10 and 20 percent.

Extrapolations of population size based on historical estimates spanning only a few centuries have been demonstrated to be worthless. Based on the population growth rate of the fourth and third centuries B.C.E., an extrapolation would yield a year 2000 population of more than 20 billion. Extrapolation of the growth rate for the third and fourth centuries C.E. would yield a population in 2000 of only 35 million.

Changing Behaviors

By and large, in prehistoric populations the level of mortality allowed a modest measure of natural growth for several years on end. Typically, a bad year removed that gain in numbers. Starting with the Neolithic era, the level of mortality decreased slightly and the expectation of life at birth reached about 25 years. In Europe, these underlying health conditions persisted until the sixteenth century when a fall in mortality commenced, gathering speed up to and into the twentieth century. In Western Europe, in around 1800, the expectation of life at birth was about 35 years; by 1900 it was about 50 years; and by 2000, 75 years (with a six to eight year difference favoring the female population), while in Eastern Europe it was about 40 years in 1900 and 65 years in 2000. Outside Europe, only the countries of European settlement (North America, Australia, and New Zealand) and Japan had a similar mortality record. Finally, at the middle of the twentieth century, the achievements of modern medicine caused a spectacular rise in life expectancy globally.

It seems that up to the Mesolithic era, the causes of death due to climatic factors (the scarcity of edible plants and wild game) played an important role in the regulation of population. In the Mesolithic era, production and, to a certain degree, storage of harvests and of domestic animals greatly lowered vulnerability to climatic risk, and the population increased rapidly. But above a certain population density, epidemic illnesses, previously rare, multiplied and played an increasingly important role in population regulation. From sixteenth-century Europe, there begins to be some success in the struggle against these epidemics. The plague was almost eliminated in the course of the seventeenth century; smallpox was under attack in the eighteenth century (and nearly eliminated in the nineteenth century); and in the twentieth century, all infectious diseases, which formed the second-most common cause of death up to the middle of the nineteenth century, were attacked and in most cases brought under control.

Fertility, with an average number of children per woman of around 6 or 7, showed little evidence of being voluntarily limited until well into the seventeenth century. Contraceptive practice was largely nonexistent. Voluntary limitation of births among the general populace can be traced back to the early eighteenth century in three French regions—Champagne, Normandy, and Aquitania—commencing even before any decline of mortality began. In France at large, from an average level of 6 children per woman at the beginning of the eighteenth century, fertility fell to 3 children per woman by 1800. From then on, the absolute number of births in France stagnated, while it doubled in all the other countries of Europe. Only Japan had a similar fertility experience. Elsewhere in Western Europe, fertility began falling only in the last quarter of the nineteenth century, and in Eastern Europe in the first decade of the twentieth century, long after mortality had shown a decrease. Among European colonists in America, fertility was very high in the eighteenth century, with an average of about 7 children per woman. In the United States, however, a decline of fertility started in the late eighteenth century and continued up to the second third of the twentieth century. A similar process began in the second half of the twentieth century in much of Latin America, then in East Asia and, more slowly, in India, and finally in most Muslim countries (with the exception of Palestine) in the 1980s and, more hesitantly, also in Africa south of the Sahara.

Structural Changes

The age distribution of the world population remained very young for a long period, reflecting both high fertility and high mortality. Thus, the effects of dramatic demographic shocks were rapidly erased from the age pyramid. Starting around 1800, however, both France and Japan showed an increase in the proportion of older persons. In effect, the decrease of fertility shrinks the proportion of persons who are young and increases the share of the elderly. The decline of mortality, especially when it improves infant survival, also contributes to a rejuvenation of the population age structure.

Once voluntary limitation of fertility appears, changes in the age distribution also become irregular. Twentieth-century age pyramids in Europe show marked perturbations resulting from fluctuations in the annual number of births—with differences between peaks and troughs that may amount to as much as 50 percent.

Populations of European origin in America and Oceania show more regular changes in the number of births, and substantial immigration also contributes to smoothing the jaggedness of the age pyramids.

In the developing world, from about the middle of the twentieth century, medical advances lowered mortality and increased fertility by improving health and extending the number of years spent in the married state. This resulted in exceptionally rapid population growth, further amplified by a rejuvenated age distribution. Coping with such growth without impoverishment requires heavy economic investment, which many of the countries affected were unable to afford and that consequently experienced serious economic difficulties. Economic outcomes also varied with ownership of resources and other assets and with political conditions—with some countries losing their elite class and their wealth through wars and other calamities.

The decline of fertility that began in almost all developing countries between 1970 and 1990 halted the trend toward younger age distributions. But, by 2000, the phenomenon of population aging was still in a very early phase.

Over the first half of the twenty-first century the global population is projected to increase from 6 billion to around 9 billion. But by the end of this period the growth rate is likely to be much diminished. The very youthfulness of the twenty-first century developing world favors rapid generational change, including change of ideas and attitudes. If so, the future pace of decline in fertility may turn out to be more rapid than is now anticipated.

See also: *Archaeogenetics; Climate Change and Population: History; Epidemics; Health Transition; Mortality Decline; Peopling of the Continents; Prehistoric Populations; Projections and Forecasts, Population.*

BIBLIOGRAPHY

Biraben, Jean-Noël. 1979. "Essai sur l'évolution du nombre des hommes." *Population* 34(1): 13–25.

———. 1988. "Préhistoire." In *Histoire de la population française,* Vol. 1, ed. Jacques Dupâquier. Paris: Presses Universitaires de France.

———. 1999. "Le peuplement de l'Europe préhistorique." In *Histoire des populations de l'Europe,* Vol. 1, ed. Jean-Pierre Bardet and Jacques Dupâquier. Paris: Arthème Fayard.

Caldwell, John. C., and Thomas Schindlmayr. 2002. "Historical Population Estimates: Unraveling the Consensus." *Population and Development Review* 28(2): 183–204.

Cartier, Michel. 1973. "Nouvelles données sur la démographie chinoise a l'époque des Ming (1368–1644)." *Annales Economies, Sociétés, Civilisations* 1341–1359.

Cartier, Michel, and Pierre-Etienne Will. 1971. "Démographie et institutions en Chine: contribution à l'analyse des recensements de l'époque impériale (2 ap. J.C.–1750)." *Annales de démographie historiques* pp. 161–245.

Das Gupta, Ajit. 1972. "Study of the Historical Demography of India." In *Population and Social Change,* ed. D. V. Glass and Roger Revelle. London: Arnold.

Durand, John D. 1977. "Historical Estimates of the World Population: An Evaluation," *Population and Development Review* 3(3): 253–296.

McEvedy, Colin, and Richard Jones. 1978. *Atlas of World Population History.* London: Penguin.

Nemeskéri, János. 1974. *Esquisse d'histoire de peuplement humain.* Budapest: Akadémiai Kiadó.

United Nations. 1972-2001. *Demographic Yearbook.* Special Topic (in selected years): Population Census Statistics. New York: United Nations.

United Nations. 1973. *The Determinants and Consequences of Population Trends: New Summary of the Findings on Interaction of Demographic, Economic and Social Factors.* New York: United Nations.

———. 2001. *World Population Prospects: The 2000 Revision,* Vol. 1, *Comprehensive Tables.* New York: United Nations.

Jean-Noël Biraben

POPULATION TABLES

Selected Demographic Indicators and Rankings for Countries with a Population of 10 Million or More in 2000

TABLE 1

Selected Demographic Indicators for Countries with a Population of 10 Million or More in 2000

Country	Population 2000 (millions)	Area (1000 km²)	Population Density 2000 (per km²)	Total Fertility Rate 2000	Expectation of Life at Birth, 2000 (years)	Population Growth Rate 2000 (% per year)	Population 1950 (millions)	Population 2050 (millions)
Afghanistan	21.8	652	33	6.9	42.5	2.64	8.2	72
Algeria	30.3	2,382	13	3.3	68.9	1.82	8.8	51
Angola	13.1	1,247	11	7.2	44.6	2.94	4.1	53
Argentina	37.0	2,780	13	2.6	72.9	1.26	17.2	55
Australia	19.1	7,741	2	1.8	78.7	1.15	8.2	27
Bangladesh	137.4	144	954	3.8	58.1	2.12	41.8	265
Belarus	10.2	208	49	1.3	68.5	−0.28	7.7	8
Belgium	10.2	33	311	1.5	77.9	0.22	8.6	10
Brazil	170.4	8,547	20	2.3	67.2	1.33	54.0	247
Burkina Faso	11.5	274	42	6.9	45.3	2.32	4.0	46
Cambodia	13.1	181	72	5.3	56.5	2.80	4.3	30
Cameroon	14.9	475	31	5.1	50.0	2.28	4.5	32
Canada	30.8	9,971	3	1.6	78.5	0.93	13.7	40
Chile	15.2	757	20	2.4	74.9	1.36	6.1	22
China	1,252.8	9,561	131	1.8	69.7	0.90	547.3	1,437
Colombia	42.1	1,139	37	2.8	70.4	1.77	12.6	71
Congo (Zaire)	50.9	2,345	22	6.7	50.5	2.56	12.2	204
Cuba	11.2	111	101	1.6	75.7	0.42	5.9	11
Czech Republic	10.3	79	130	1.2	74.3	−0.11	8.9	8
Ecuador	12.6	284	45	3.1	69.5	1.97	3.4	21
Egypt	67.9	1,001	68	3.4	66.3	1.82	21.8	114
Ethiopia	62.9	1,104	57	6.8	44.5	2.55	18.4	186
France	59.2	552	107	1.7	78.1	0.37	41.8	62
Germany	82.0	357	230	1.3	77.3	0.09	68.4	71
Ghana	19.3	239	81	4.6	56.3	2.20	4.9	40
Greece	10.6	132	80	1.3	78.0	0.30	7.6	9
Guatemala	11.4	109	104	4.9	64.0	2.64	3.0	27
Hungary	10.0	93	107	1.4	70.7	−0.49	9.3	7
India	1,008.9	3,288	307	3.3	62.3	1.69	357.6	1,572
Indonesia	212.1	1,905	111	2.6	65.1	1.41	79.5	311
Iran	70.3	1,633	43	3.2	68.0	1.69	16.9	121
Iraq	22.9	438	52	5.3	58.7	2.70	5.2	54
Italy	57.5	301	191	1.2	78.2	0.08	47.1	43
Ivory Coast	16.0	322	50	5.1	47.7	2.14	2.8	32
Japan	127.1	378	336	1.4	80.5	0.26	83.6	109
Kazakhstan	16.2	2,717	6	2.1	64.1	−0.54	6.7	15
Kenya	30.7	580	53	4.6	52.2	2.32	6.3	55
Korea, North	22.3	99	225	2.1	63.1	0.82	10.8	28
Korea, South	46.7	99	472	1.5	74.3	0.78	20.4	52
Madagascar	16.0	587	27	6.1	51.6	2.94	4.2	47
Malawi	11.3	118	96	6.8	40.7	2.42	2.9	31
Malaysia	22.2	330	67	3.3	71.9	2.09	6.1	38
Mali	11.4	1,240	9	7.0	50.9	2.68	3.5	42
Mexico	98.9	1,958	50	2.8	72.2	1.63	27.7	147
Morocco	29.9	447	67	3.4	66.6	1.87	9.0	50

[continued]

TABLE 1 [CONTINUED]

Selected Demographic Indicators for Countries with a Population of 10 Million or More in 2000

Country	Population 2000 (millions)	Area (1000 km²)	Population Density 2000 (per km²)	Total Fertility Rate 2000	Expectation of Life at Birth, 2000 (years)	Population Growth Rate 2000 (% per year)	Population 1950 (millions)	Population 2050 (millions)
Mozambique	18.3	802	23	6.3	40.6	2.31	6.2	39
Myanmar (Burma)	47.7	677	71	3.3	55.8	1.48	17.8	69
Nepal	23.0	147	157	4.8	57.3	2.40	8.5	52
Netherlands	15.9	41	387	1.5	77.9	0.52	10.1	16
Niger	10.8	1,267	9	8.0	44.2	3.46	2.5	52
Nigeria	113.9	924	123	5.9	51.3	2.74	29.8	279
Pakistan	141.3	796	177	5.5	59.0	2.66	39.7	344
Peru	25.7	1,285	20	3.0	68.0	1.73	7.6	42
Philippines	75.7	300	252	3.6	68.6	2.03	20.0	128
Poland	38.6	323	120	1.5	72.8	0.01	24.8	33
Portugal	10.0	92	109	1.5	75.2	0.20	8.4	9
Romania	22.4	238	94	1.3	69.8	−0.22	16.3	18
Russian Federation	145.5	17,075	9	1.2	66.1	−0.36	102.7	104
Saudi Arabia	20.3	2,150	9	6.2	70.9	3.49	3.2	60
Serbia and Montenegro	10.6	102	103	1.8	72.2	0.01	7.1	9
South Africa	43.3	1,221	35	3.1	56.7	1.57	13.7	47
Spain	39.9	506	79	1.2	78.1	0.09	28.0	31
Sri Lanka	18.9	66	287	2.1	71.6	0.96	7.5	23
Sudan	31.1	2,506	12	4.9	55.0	2.13	9.2	64
Syria	16.2	185	88	4.0	70.5	2.59	3.5	36
Taiwan	22.3	36	617	1.6	76.5	0.87	7.5	25
Tanzania	35.1	945	37	5.5	51.1	2.58	7.9	83
Thailand	62.8	513	122	2.1	69.6	1.34	19.6	82
Turkey	66.7	775	86	2.7	69.0	1.62	20.8	99
Uganda	23.3	241	97	7.1	41.9	2.95	5.2	102
Ukraine	49.6	604	82	1.3	68.1	−0.78	37.3	30
United Kingdom	59.4	245	243	1.7	77.2	0.27	50.6	59
United States of America	283.2	9,364	30	2.0	76.5	1.05	157.8	397
Uzbekistan	24.9	447	56	2.9	68.3	1.76	6.3	41
Venezuela	24.2	912	27	3.0	72.4	2.02	5.1	42
Vietnam	78.1	332	235	2.5	67.2	1.40	27.4	124
Yemen	18.3	528	35	7.6	59.4	4.17	4.3	102
Zambia	10.4	753	14	6.1	40.5	2.46	2.4	29
Zimbabwe	12.6	391	32	5.0	42.9	1.91	2.7	24
Other countries and territories	357.8	17,845	20				151.0	653
World	**6,056.7**	**133,572**	**46**	**2.8**	**65.0**	**1.35**	**2,519.5**	**9,322**

Notes: Countries with a population of 10 million or more made up 94.1 percent of the total world population in 2000. Estimates shown of fertility, life expectancy, and population growth refer to the 5-year period 1995-2000. Expectations of life are for both sexes combined. Estimates for China exclude Hong Kong, Macao, and Taiwan. Population figures for 2050 are the UN's "medium" projection.

SOURCES: Estimated and projected population characteristics are from United Nations, *World Population Prospects: The 2000 Revision, Volume I: Comprehensive Tables*. New York, 2001. Area statistics are from World Bank, *World Development Report 2000/2001*. New York: Oxford University Press, 2001. Estimates for Taiwan compiled from various sources.

TABLE 2

Countries with a Population of 10 Million or More in 2000 Ranked by Population Size in 1950, 2000, and 2050

Rank	Country	Population 1950 (millions)	Country	Population 2000 (millions)	Country	Population 2050 (millions)
1	China	547.3	China	1,252.8	India	1,572
2	India	357.6	India	1,008.9	China	1,437
3	United States of America	157.8	United States of America	283.2	United States of America	397
4	Russian Federation	102.7	Indonesia	212.1	Pakistan	344
5	Japan	83.6	Brazil	170.4	Indonesia	311
6	Indonesia	79.5	Russian Federation	145.5	Nigeria	279
7	Germany	68.4	Pakistan	141.3	Bangladesh	265
8	Brazil	54.0	Bangladesh	137.4	Brazil	247
9	United Kingdom	50.6	Japan	127.1	Congo (Zaire)	204
10	Italy	47.1	Nigeria	113.9	Ethiopia	186
11	France	41.8	Mexico	98.9	Mexico	147
12	Bangladesh	41.8	Germany	82.0	Philippines	128
13	Pakistan	39.7	Vietnam	78.1	Vietnam	124
14	Ukraine	37.3	Philippines	75.7	Iran	121
15	Nigeria	29.8	Iran	70.3	Egypt	114
16	Spain	28.0	Egypt	67.9	Japan	109
17	Mexico	27.7	Turkey	66.7	Russian Federation	104
18	Vietnam	27.4	Ethiopia	62.9	Yemen	102
19	Poland	24.8	Thailand	62.8	Uganda	102
20	Egypt	21.8	United Kingdom	59.4	Turkey	99
21	Turkey	20.8	France	59.2	Tanzania	83
22	Korea, South	20.4	Italy	57.5	Thailand	82
23	Philippines	20.0	Congo (Zaire)	50.9	Afghanistan	72
24	Thailand	19.6	Ukraine	49.6	Colombia	71
25	Ethiopia	18.4	Myanmar (Burma)	47.7	Germany	71
26	Myanmar (Burma)	17.8	Korea, South	46.7	Myanmar (Burma)	69
27	Argentina	17.2	South Africa	43.3	Sudan	64
28	Iran	16.9	Colombia	42.1	France	62
29	Romania	16.3	Spain	39.9	Saudi Arabia	60
30	Canada	13.7	Poland	38.6	United Kingdom	59
31	South Africa	13.7	Argentina	37.0	Kenya	55
32	Colombia	12.6	Tanzania	35.1	Argentina	55
33	Congo (Zaire)	12.2	Sudan	31.1	Iraq	54
34	Korea, North	10.8	Canada	30.8	Angola	53
35	Netherlands	10.1	Kenya	30.7	Nepal	52
36	Hungary	9.3	Algeria	30.3	Niger	52
37	Sudan	9.2	Morocco	29.9	Korea, South	52
38	Morocco	9.0	Peru	25.7	Algeria	51
39	Czech Republic	8.9	Uzbekistan	24.9	Morocco	50
40	Algeria	8.8	Venezuela	24.2	South Africa	47
41	Belgium	8.6	Uganda	23.3	Madagascar	47
42	Nepal	8.5	Nepal	23.0	Burkina Faso	46
43	Portugal	8.4	Iraq	22.9	Italy	43
44	Australia	8.2	Romania	22.4	Venezuela	42
45	Afghanistan	8.2	Taiwan	22.3	Peru	42

[continued]

TABLE 2 [CONTINUED]

Countries with a Population of 10 Million or More in 2000 Ranked by Population Size in 1950, 2000, and 2050

Rank	Country	Population 1950 (millions)	Country	Population 2000 (millions)	Country	Population 2050 (millions)
46	Tanzania	7.9	Korea, North	22.3	Mali	42
47	Belarus	7.7	Malaysia	22.2	Uzbekistan	41
48	Peru	7.6	Afghanistan	21.8	Canada	40
49	Greece	7.6	Saudi Arabia	20.3	Ghana	40
50	Taiwan	7.5	Ghana	19.3	Mozambique	39
51	Sri Lanka	7.5	Australia	19.1	Malaysia	38
52	Serbia and Montenegro	7.1	Sri Lanka	18.9	Syria	36
53	Kazakhstan	6.7	Yemen	18.3	Poland	33
54	Uzbekistan	6.3	Mozambique	18.3	Cameroon	32
55	Kenya	6.3	Syria	16.2	Ivory Coast	32
56	Mozambique	6.2	Kazakhstan	16.2	Spain	31
57	Malaysia	6.1	Ivory Coast	16.0	Malawi	31
58	Chile	6.1	Madagascar	16.0	Ukraine	30
59	Cuba	5.9	Netherlands	15.9	Cambodia	30
60	Uganda	5.2	Chile	15.2	Zambia	29
61	Iraq	5.2	Cameroon	14.9	Korea, North	28
62	Venezuela	5.1	Angola	13.1	Guatemala	27
63	Ghana	4.9	Cambodia	13.1	Australia	27
64	Cameroon	4.5	Ecuador	12.6	Taiwan	25
65	Cambodia	4.3	Zimbabwe	12.6	Zimbabwe	24
66	Yemen	4.3	Burkina Faso	11.5	Sri Lanka	23
67	Madagascar	4.2	Guatemala	11.4	Chile	22
68	Angola	4.1	Mali	11.4	Ecuador	21
69	Burkina Faso	4.0	Malawi	11.3	Romania	18
70	Mali	3.5	Cuba	11.2	Netherlands	16
71	Syria	3.5	Niger	10.8	Kazakhstan	15
72	Ecuador	3.4	Greece	10.6	Cuba	11
73	Saudi Arabia	3.2	Serbia and Montenegro	10.6	Belgium	10
74	Guatemala	3.0	Zambia	10.4	Serbia and Montenegro	9
75	Malawi	2.9	Czech Republic	10.3	Portugal	9
76	Ivory Coast	2.8	Belgium	10.2	Greece	9
77	Zimbabwe	2.7	Belarus	10.2	Czech Republic	8
78	Niger	2.5	Portugal	10.0	Belarus	8
79	Zambia	2.4	Hungary	10.0	Hungary	7
	Other countries and territories	151.0	Other countries and territories	357.8	Other countries and territories	653
	World	**2,519.5**	**World**	**6,056.7**	**World**	**9,322**

Note: Countries are listed in descending order according to population size in the respective year. Population figures for 2050 are the "medium" projections from the UN's 2000 projection series. Estimates for China exclude Hong Kong, Macao, and Taiwan.

SOURCES: Estimated and projected population totals are from United Nations, *World Population Prospects: The 2000 Revision, Volume I: Comprehensive Tables*. New York, 2001. Estimates for Taiwan compiled from various sources.

TABLE 3

Countries with a Population of 10 Million or More in 2000 Ranked by Total Fertility Rate, Expectation of Life at Birth, and Population Growth Rate

Rank	Country	Total Fertility Rate 2000	Country	Expectation of Life at Birth (years) 2000	Country	Population Growth Rate (% per year) 2000
1	Spain	1.2	Japan	80.5	Ukraine	−0.78
2	Czech Republic	1.2	Australia	78.7	Kazakhstan	−0.54
3	Italy	1.2	Canada	78.5	Hungary	−0.49
4	Russian Federation	1.2	Italy	78.2	Russian Federation	−0.36
5	Ukraine	1.3	Spain	78.1	Belarus	−0.28
6	Belarus	1.3	France	78.1	Romania	−0.22
7	Greece	1.3	Greece	78.0	Czech Republic	−0.11
8	Romania	1.3	Belgium	77.9	Poland	0.01
9	Germany	1.3	Netherlands	77.9	Serbia and Montenegro	0.01
10	Hungary	1.4	Germany	77.3	Italy	0.08
11	Japan	1.4	United Kingdom	77.2	Germany	0.09
12	Poland	1.5	United States of America	76.5	Spain	0.09
13	Portugal	1.5	Taiwan	76.5	Portugal	0.20
14	Korea, South	1.5	Cuba	75.7	Belgium	0.22
15	Netherlands	1.5	Portugal	75.2	Japan	0.26
16	Belgium	1.5	Chile	74.9	United Kingdom	0.27
17	Cuba	1.6	Korea, South	74.3	Greece	0.30
18	Canada	1.6	Czech Republic	74.3	France	0.37
19	Taiwan	1.6	Argentina	72.9	Cuba	0.42
20	United Kingdom	1.7	Poland	72.8	Netherlands	0.52
21	France	1.7	Venezuela	72.4	Korea, South	0.78
22	Serbia and Montenegro	1.8	Serbia and Montenegro	72.2	Korea, North	0.82
23	Australia	1.8	Mexico	72.2	Taiwan	0.87
24	China	1.8	Malaysia	71.9	China	0.90
25	United States of America	2.0	Sri Lanka	71.6	Canada	0.93
26	Korea, North	2.1	Saudi Arabia	70.9	Sri Lanka	0.96
27	Kazakhstan	2.1	Hungary	70.7	United States of America	1.05
28	Sri Lanka	2.1	Syria	70.5	Australia	1.15
29	Thailand	2.1	Colombia	70.4	Argentina	1.26
30	Brazil	2.3	Romania	69.8	Brazil	1.33
31	Chile	2.4	China	69.7	Thailand	1.34
32	Vietnam	2.5	Thailand	69.6	Chile	1.36
33	Indonesia	2.6	Ecuador	69.5	Vietnam	1.40
34	Argentina	2.6	Turkey	69.0	Indonesia	1.41
35	Turkey	2.7	Algeria	68.9	Myanmar (Burma)	1.48
36	Mexico	2.8	Philippines	68.6	South Africa	1.57
37	Colombia	2.8	Belarus	68.5	Turkey	1.62
38	Uzbekistan	2.9	Uzbekistan	68.3	Mexico	1.63
39	Peru	3.0	Ukraine	68.1	Iran	1.69
40	Venezuela	3.0	Peru	68.0	India	1.69

[continued]

TABLE 3 [CONTINUED]

Countries with a Population of 10 Million or More in 2000 Ranked by Total Fertility Rate, Expectation of Life at Birth, and Population Growth Rate

Rank	Country	Total Fertility Rate 2000	Country	Expectation of Life at Birth (years) 2000	Country	Population Growth Rate (% per year) 2000
41	Ecuador	3.1	Iran	68.0	Peru	1.73
42	South Africa	3.1	Vietnam	67.2	Uzbekistan	1.76
43	Iran	3.2	Brazil	67.2	Colombia	1.77
44	Algeria	3.3	Morocco	66.6	Egypt	1.82
45	Malaysia	3.3	Egypt	66.3	Algeria	1.82
46	Myanmar (Burma)	3.3	Russian Federation	66.1	Morocco	1.87
47	India	3.3	Indonesia	65.1	Zimbabwe	1.91
48	Egypt	3.4	Kazakhstan	64.1	Ecuador	1.97
49	Morocco	3.4	Guatemala	64.0	Venezuela	2.02
50	Philippines	3.6	Korea, North	63.1	Philippines	2.03
51	Bangladesh	3.8	India	62.3	Malaysia	2.09
52	Syria	4.0	Yemen	59.4	Bangladesh	2.12
53	Ghana	4.6	Pakistan	59.0	Sudan	2.13
54	Kenya	4.6	Iraq	58.7	Ivory Coast	2.14
55	Nepal	4.8	Bangladesh	58.1	Ghana	2.20
56	Sudan	4.9	Nepal	57.3	Cameroon	2.28
57	Guatemala	4.9	South Africa	56.7	Mozambique	2.31
58	Zimbabwe	5.0	Cambodia	56.5	Kenya	2.32
59	Cameroon	5.1	Ghana	56.3	Burkina Faso	2.32
60	Ivory Coast	5.1	Myanmar (Burma)	55.8	Nepal	2.40
61	Cambodia	5.3	Sudan	55.0	Malawi	2.42
62	Iraq	5.3	Kenya	52.2	Zambia	2.46
63	Pakistan	5.5	Madagascar	51.6	Ethiopia	2.55
64	Tanzania	5.5	Nigeria	51.3	Congo (Zaire)	2.56
65	Nigeria	5.9	Tanzania	51.1	Tanzania	2.58
66	Zambia	6.1	Mali	50.9	Syria	2.59
67	Madagascar	6.1	Congo (Zaire)	50.5	Afghanistan	2.64
68	Saudi Arabia	6.2	Cameroon	50.0	Guatemala	2.64
69	Mozambique	6.3	Ivory Coast	47.7	Pakistan	2.66
70	Congo (Zaire)	6.7	Burkina Faso	45.3	Mali	2.68
71	Ethiopia	6.8	Angola	44.6	Iraq	2.70
72	Malawi	6.8	Ethiopia	44.5	Nigeria	2.74
73	Burkina Faso	6.9	Niger	44.2	Cambodia	2.80
74	Afghanistan	6.9	Zimbabwe	42.9	Madagascar	2.94
75	Mali	7.0	Afghanistan	42.5	Angola	2.94
76	Uganda	7.1	Uganda	41.9	Uganda	2.95
77	Angola	7.2	Malawi	40.7	Niger	3.46
78	Yemen	7.6	Mozambique	40.6	Saudi Arabia	3.49
79	Niger	8.0	Zambia	40.5	Yemen	4.17
	World	**2.8**	**World**	**65.0**	**World**	**1.35**

Note: Countries are listed in ascending order by fertility and population growth rate and in descending order by expectation of life. Estimates refer to the 5-year period 1995-2000. The total fertility rate can be interpreted as the average lifetime births per woman at the prevailing rate of childbearing. Expectations of life are for both sexes combined.

SOURCES: United Nations, *World Population Prospects: The 2000 Revision, Volume I: Comprehensive Tables.* NewYork, 2001. Estimates for Taiwan compiled from various sources.

TABLE 4

Countries with a Population of 10 Million or More in 2000 Ranked by Area and Population Density

Rank	Country	Area (1000 km^2)	Country	Population Density (per km^2)
1	Russian Federation	17,075	Bangladesh	954
2	Canada	9,971	Taiwan	617
3	China	9,561	Korea, South	472
4	United States of America	9,364	Netherlands	387
5	Brazil	8,547	Japan	336
6	Australia	7,741	Belgium	311
7	India	3,288	India	307
8	Argentina	2,780	Sri Lanka	287
9	Kazakhstan	2,717	Philippines	252
10	Sudan	2,506	United Kingdom	243
11	Algeria	2,382	Vietnam	235
12	Congo (Zaire)	2,345	Germany	230
13	Saudi Arabia	2,150	Korea, North	225
14	Mexico	1,958	Italy	191
15	Indonesia	1,905	Pakistan	177
16	Iran	1,633	Nepal	157
17	Peru	1,285	China	131
18	Niger	1,267	Czech Republic	130
19	Angola	1,247	Nigeria	123
20	Mali	1,240	Thailand	122
21	South Africa	1,221	Poland	120
22	Colombia	1,139	Indonesia	111
23	Ethiopia	1,104	Portugal	109
24	Egypt	1,001	France	107
25	Tanzania	945	Hungary	107
26	Nigeria	924	Guatemala	104
27	Venezuela	912	Serbia and Montenegro	103
28	Mozambique	802	Cuba	101
29	Pakistan	796	Uganda	97
30	Turkey	775	Malawi	96
31	Chile	757	Romania	94
32	Zambia	753	Syria	88
33	Myanmar (Burma)	677	Turkey	86
34	Afghanistan	652	Ukraine	82
35	Ukraine	604	Ghana	81
36	Madagascar	587	Greece	80
37	Kenya	580	Spain	79
38	France	552	Cambodia	72
39	Yemen	528	Myanmar (Burma)	71
40	Thailand	513	Egypt	68
41	Spain	506	Malaysia	67
42	Cameroon	475	Morocco	67
43	Uzbekistan	447	Ethiopia	57
44	Morocco	447	Uzbekistan	56
45	Iraq	438	Kenya	53

[continued]

TABLE 4 [CONTINUED]

Countries with a Population of 10 Million or More in 2000 Ranked by Area and Population Density

Rank	Country	Area (1000 km²)	Country	Population Density (per km²)
46	Zimbabwe	391	Iraq	52
47	Japan	378	Mexico	50
48	Germany	357	Ivory Coast	50
49	Vietnam	332	Belarus	49
50	Malaysia	330	Ecuador	45
51	Poland	323	Iran	43
52	Ivory Coast	322	Burkina Faso	42
53	Italy	301	Tanzania	37
54	Philippines	300	Colombia	37
55	Ecuador	284	South Africa	35
56	Burkina Faso	274	Yemen	35
57	United Kingdom	245	Afghanistan	33
58	Uganda	241	Zimbabwe	32
59	Ghana	239	Cameroon	31
60	Romania	238	United States of America	30
61	Belarus	208	Madagascar	27
62	Syria	185	Venezuela	27
63	Cambodia	181	Mozambique	23
64	Nepal	147	Congo (Zaire)	22
65	Bangladesh	144	Chile	20
66	Greece	132	Peru	20
67	Malawi	118	Brazil	20
68	Cuba	111	Zambia	14
69	Guatemala	109	Argentina	13
70	Serbia and Montenegro	102	Algeria	13
71	Korea, South	99	Sudan	12
72	Korea, North	99	Angola	11
73	Hungary	93	Saudi Arabia	9
74	Portugal	92	Mali	9
75	Czech Republic	79	Niger	9
76	Sri Lanka	66	Russian Federation	9
77	Netherlands	41	Kazakhstan	6
78	Taiwan	36	Canada	3
79	Belgium	33	Australia	2
	Other countries and territories	17,845	Other countries and territories	20
	World	**133,572**	**World**	**46**

Note: Population density is for 2000.

SOURCES: World Bank, *World Development Report 2000/2001*. New York: Oxford University Press, 2001. Estimates for Tawain compiled for various sources.

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