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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 in-

creased cardiovascular mortality, violence, and alcoholism.

See also: *Disease, Burden of; Diseases, Chronic and Degenerative; Diseases, Infectious; Health Transition; Mortality Decline; Mortality Reversals; Oldest Old.*

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JEAN-MARIE ROBINE

ESTIMATION METHODS, DEMOGRAPHIC

Demographic estimation methods have been dev oped to cope with inadequacies frequently found standard demographic data. In settings where pop lation statistics are of good quality, key descripti demographic measures are calculated as occurren exposure rates, with occurrences recorded by a vi statistics system and exposure time obtained fr population estimates, the latter typically censu based. In many developing countries, data fr these sources may simply not be available, or may affected by systematic errors that bias the resulti measures.

An Overview of Estimation

Improvements in demographic data have reduc the need for demographic estimation. For examp the birth histories widely collected in sample surv in developing countries provide adequate measu of fertility and child mortality from occurren exposure data. However, measures for small ar and of other population parameters, such as ad mortality and migration, still often require estin tion. Even when population statistics are genera adequate, estimation methods have proved use for tracing historical trends in demographic paran ters, and are also helpful for estimating some para eters of current population dynamics that are part ularly hard to measure, such as migration.

Demographic estimation methods can broadly categorized into three groups: those that timate rates from *changes in stocks,* those that based on *consistency checks,* and those that are ba on *indirect estimation.* The ideas underlying three groups are illustrated below with examples

Changes in Stocks

Stocks, such as the number of people in a populati over age 50 or the number of children ever born a cohort of women, change as a result of den graphic events. Changes in stocks can therefore used to draw inferences about underlying den graphic rates. In situations where demograp events are not directly recorded, or are recor with unacceptable levels of error, changes in popu tion aggregates between two observations can used as a basis to estimate the number of events tween the two observations. Estimation meth