ON LONG-TERM MORTALITY TRENDS IN THE UNITED STATES, 1850–1968

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Abstract—This study of United States life tables analyzes the process of mortality transition during 1850–1968. Special features of the study are (1) a phase-specific, rather than an age-specific, analysis of mortality and (2) use of measures based on person-years of life \((nL_x)\) in phase-intervals, rather than survival rates \((n p_x)\) or expectation of life at given ages \((e_x)\). The analysis suggests that the historical transition of mortality in the United States can be described as a three-stage process: an initial stage of slow improvement in life expectancy during 1850–1900, a second stage of rapid improvement during 1900–1950, and a third stage of slower improvement since 1950. Quantitative measures of rapidity of mortality decline in the several phases indicate that they are not identical for all phases and in all stages. The analysis also suggests that there have been rapid changes in the components of overall mortality differentials by sex and race in the United States. The paper draws attention to the need for studies of factors in variations of mortality at ages beyond 50 in the United States population subgroups.

INTRODUCTION

This research note brings into focus a few major themes concerning long-term mortality trends in the United States. For this purpose, the measures used are based on person-years of life for selected age intervals in life tables. It is well established that some causes of death are more prevalent in certain age groups than in others (United Nations, 1963, pp. 69–112; World Health Organization, 1970). Furthermore, as Omran (1971) has recently pointed out, a distinctive trend is distinguishable in cause of death by broad age groups in countries undergoing the mortality transition, and often the broad age groups experiencing relatively more homogeneous patterns of cause of death parallel the biological phases of life. Age variations in mortality are analyzed in this paper by grouping the data to correspond approximately to the several phases of the life cycle: infancy and childhood (0–4), late childhood (5–14), adulthood (15–49), late adulthood (50–69), and old age (70 and over).

The study uses the person-year index and components of life expectancy, as discussed below, to help clarify the process of mortality transition in the United States during the last one hundred and twenty years. Specifically, the objectives of the analysis are to establish (1) trends in and rates of decline of mortality specific to the several phases of the life cycle, (2) trends in mortality differentials by sex and race and their phase-specific components, and (3) interrelations between mortality of adjacent phases.

The United States has been chosen as
the case study because data are available for both the white and nonwhite segments of the population. Attention to white-nonwhite differentials in the United States is justified by the fact that timing and rapidity of overall mortality declines have been different for the two segments of the population. (For instance, see Dublin, Lotka and Spiegelman, 1949, pp. 53-55.) If recency and rapidity of mortality declines are related, then the experiences of these two segments can provide two different benchmarks of comparison with contemporary mortality transitions occurring in the less-developed regions of the world.

Excellent studies of mortality trends in both crude and age-specific terms have already been undertaken for the United States (see Bogue, 1959, pp. 168-211; Moriyama, 1961; Spiegelman, 1962; Stricker, 1933; U. S. National Office of Vital Statistics, 1954), and the works of Dublin, Lotka, and Spiegelman provide a comprehensive study of the United States life tables (Dublin and Lotka, 1945; Dublin, Lotka, and Spiegelman, 1949; Spiegelman, 1962). More recently, an exhaustive analysis of age- and cause-specific mortality was conducted by Moriyama (1964). The present investigation is an extension of these earlier works from a slightly different perspective, incorporating somewhat more recent data.

**Methodology**

Broadly speaking, this paper deals with the analysis of life tables. But, instead of using \( nP_x \), the probability of surviving from an exact age \( x \) to an exact age \( x + n \), or \( e_x^o \), the expectation of life at age \( x \), the following person-year indices are used.

Person-year in any interval \( (nL_x) \) is easily converted into the actuarial index \( (nE_x) \), the temporary complete expectation of life for \( n \) years. (For its definition, see Spurgeon, 1922, p. 207; for its recent applications in mortality studies, refer to Arretex and Pujol, 1970; Arriaga, 1970; Rao, 1970.) The conversion is made as follows:

\[
\eta_x = \frac{nL_x}{l_x}.
\]

Further, these temporary expectations of life are divided by the number of years in the interval to make them comparable for intervals of different lengths. Thus,

\[
\eta_x = \frac{1}{n} \eta_x = \frac{1}{n} \frac{nL_x}{l_x}.
\]

Also, one can usefully consider expectation of life at birth as a sum of person-years lived in various age intervals. For instance,

\[
e^o = T_o = \frac{1}{l_o} \cdot 3L_o + \frac{1}{l_o} \cdot 10L_{10} + \frac{1}{l_o} \cdot 35L_{15} + \cdots + \frac{1}{l_o} \cdot 70L_{70}.
\]

For convenience these age-specific person-years are called in this study the components of life expectancy at birth. It is possible to resolve the differences in overall life expectancy between two populations into components contributed by various age intervals.

**Data**

The analysis is based on eleven published life tables for the United States covering the period 1850 to 1968. The first of these tables, representing mortality for 1850, refers to the combined population of Maryland and Massachusetts (Jacobson, 1957). The 1890 (Glover, 1921) and 1893–1897 (Whipple, 1917) life tables both relate to the state of Massachusetts. The remainder refer to more extensive geographic areas, reflecting the expanding vital registration area in the United States (U. S. Department of Health, Education and Welfare, 1970). For example, the 1900–1902 and 1909–1911 data cover ten states and the District of Columbia; for 1919–1921, they encompass 34 states and the