Mortality Trajectories at Extreme Old Ages:

A Comparative Study of Different Data Sources on U.S. Old-Age Mortality

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Abstract

The growing number of individuals living beyond age 80 underscores the need for accurate measurement of mortality at advanced ages. Our earlier published study challenged the common view that the exponential growth of mortality with age (Gompertz law) is followed by a period of deceleration, with slower rates of mortality increase (Gavrilov and Gavrilova 2011). This refutation of mortality deceleration was made using records from the U.S. Social Security Administration's Death Master File (DMF).

Taking into account the significance of this finding for actuarial theory and practice, we tested these earlier observations using additional independent datasets and alternative statistical approaches. In particular, the following data sources for U.S. mortality at advanced ages were analyzed: (1) data from the Human Mortality Database (HMD) on age-specific death rates for 1890–99 U.S. birth cohorts, (2) recent extinct birth cohorts of U.S. men and women based on DMF data, and (3) mortality data for railroad retirees.

In the case of HMD data, the analyses were conducted for 1890–99 birth cohorts in the age range 80–106. Mortality was fitted by the Gompertz and logistic (Kannisto) models using weighted nonlinear regression and Akaike information criterion as the goodness-of-fit measure. All analyses were conducted separately for men and women. It was found that for all studied HMD birth cohorts, the Gompertz model demonstrated better fit of mortality data than the Kannisto model in the studied age interval. Similar results were obtained for U.S. men and women born in 1890–99 and railroad retirees born in 1895–99 using the full DMF file (obtained from the National Technical Information Service, or NTIS). It was also found that mortality estimates obtained from the DMF records are close to estimates obtained using the HMD cohort data.

An alternative approach for studying mortality patterns at advanced ages is based on calculating the age-specific rate of mortality change (life table aging rate, or LAR) after age 80. This approach was applied to age-specific death rates for Canada, France, Sweden and the United States available in HMD. It was found that for all 24 studied single-year birth cohorts, LAR does not change significantly with age in the age interval 80–100, suggesting no mortality deceleration in this interval. Simulation study of LAR demonstrated that the apparent decline of LAR after age 80 found in earlier studies may be related to biased estimates of mortality rates measured in a wide five-year age interval.

Taking into account that there exists several empirical estimates of hazard rate (Nelson-Aalen, actuarial and Sacher), a simulation study was conducted to find out which one is the most accurate and unbiased estimate of hazard rate at advanced ages. Computer simulations demonstrated that some estimates of mortality (Nelson-Aalen and actuarial) as well as kernel smoothing of hazard rates may produce spurious mortality deceleration at extreme ages, while the Sacher estimate turns out to be the most accurate estimate of hazard rate. Possible reasons for finding apparent mortality deceleration in earlier studies are also discussed.

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