Background and senescent component of adult mortality and its connection to mortality shifting

Klára Hulíková Tesárková

Department of Demography and Geodemography, Faculty of Science, Charles University in Prague, Czech Republic
Klara.Tesarkova@gmail.com

Rapid and deep changes in the mortality development during the past decades motivated demographers to analyze the trends more deeply and to develop specific methods which could be useful not only for the description but also for forecasting of the adult mortality. Because of the already very low level of mortality at lower ages, the mortality analysis started to be focused mainly on higher ages and the population group of the "oldest-old". For precise demographic forecasts of these age groups the analysis of mortality development at higher ages have become a key factor.

Within the analysis of the force of mortality (usually expressed in the form of some mortality law, i.e. parametric function) the decomposition of the total mortality into two different components is started to be applied (among other methods). Then both these components could be studied separately. The latest studies dealing with this topic (Bongaarts 2005, 2009; Gavrilova, Gavrilov, 2011; Gavrilov, Gavrilova, 1979; Gavrilov, Gavrilova, 1991) presented the distinguishing to the senescent (the term proposed by Bongaarts 2005) and background mortality (Gavrilov, Gavrilova 1979 used the term "base-line mortality"). Bongaarts based his analysis on the application of the logistic model while Gavrilov and Gavrilova traditionally use the Gompertz-Makeham formula. Both tried to apply this type of analysis to the data from developed and mostly European countries. Bongaarts (2005) concentrated mostly on the latest decades of the 20th century (after the World War II), Gavrilova and Gavrilov (2011) focused on longer time interval – almost the whole 20th century – in Sweden and the USA.

This paper follows the issue of senescent and background mortality as was stated by the authors mentioned above and extend the analysis to wider range of countries data, also on the post-communist countries. These two approaches (the decomposition applied to logistic as well as the Gompertz-Makeham model) are introduced briefly and applied to the data from not only developed Western European countries but also from the Eastern European countries. Moreover, where possible, longer time interval is considered in comparison with previously published works. In the second part of the paper the shifting mortality hypothesis is used for the analysis. This hypothesis is closely related to the previously mentioned decomposition of the total mortality and describes the shifts of the mortality curve as a whole or separately of the senescent mortality curve only. Special approach within the shifting mortality concept is the study of the movements (shifts) of the life table functions.

The main goals of this paper were stated as:

1) To find out whether there are some differences between the results for developed and developing (non-post-communist and post-communist) countries, and whether the considered approach to the decomposition of the mortality to the senescent and background components reveals some more universal pattern of mortality development in both defined groups of countries. The paper focuses more on the Eastern European countries and their comparison

with Western and Northern Europe. The analysis was done according to sex, time and age differences. For the parameters estimation of the logistic or Gomperz-Makeham formula a slightly different method (weighted non-linear least squares) was used instead of the one used in previous papers (Bongaarts 2005, Gavrilovs 2011)

2) To apply the concept of the shifting hypothesis to the results of previously mentioned countries and to analyze the shifts in their history. In this phase of the work the conditions set by Bongaarts (2005) are partly left behind and the shifting process isn`t analyzed under the condition of a parallel shift of the whole hazard (or survival) curve. So there is proposed a simple method of the estimation of the "age-specific shifts".

Then the research questions considered and solved in the paper can be summarized as:

1) Are the results of Gavrilov, Gavrilova (1979, 1991, 2011) and Bongaarts (2005) valid also while using slightly different method of parameters estimation of the models (weighted non-linear least squares)?

2) Could it be proven that the development is similar also in other countries considered in the analysis, not only Sweden, the USA and other mostly Western European countries?

3) What are the differences between Western and Eastern European Countries or rather what are the differences between the post-communist and the other developed countries?

4) What are the differences according to sex?

5) What are the differences of the development of the senescent mortality component according to age?

6) Is there really a parallel shift of the mortality curve or the shifts are significantly different according to age?

Questions 1 to 4 are solved in the first part of this paper, where the decomposition of mortality into two basic components is used and its results presented. Questions 5 and 6 are related to the second part of the paper dealing with the shifting mortality process and its identification in the data.

Analyses in this paper ale based mostly on the usage of the data from the Human Mortality Database (www.mortality.org)[1]. For the analysis almost all the countries where data were available were used[2].

The most important references:

BONGAARTS, J. 2005: Long-range trends in adult mortality: Models and projection methods. Demography, Vol. 42, No. 1, pp. 23-49

BONGAARTS, J. 2009: Trends in senescent life expectancy. Population Studies, Vol. 63, No. 3, pp. 203-213

---

[1] The only exception is the Czech Republic, where the time series used in this paper is longer than the time series available in the Human Mortality database. The data series for the Czech Republic used here starts at 1920 (but data are not available for years 1938–1944). The source is the Czech Statistical Office.

[2] Analyses were made for Australia, Austria, Belgium, Bulgaria, Belarus, Canada, the Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France (the total population), United Kingdom (the total population), Hungary, Switzerland, Chile, Ireland, Iceland, Israel, Italy, Japan, Lithuania, Luxembourg, Latvia, Netherlands, Norway, Poland, Portugal, Russia, Slovakia, Slovenia, Sweden, Ukraine, and the USA.

GAVRILOV, L. A., GAVRILOVA, N. S. 1979: Historical perspective on kinetics of human mortality. Proc. Acad. Sci. USSR [Doklady Akademii Nauk SSSR], 245(4): 1017-1020. English translation by Plenum Publ Corp: pp.776-778.

GAVRILOV, L. A., GAVRILOVA, N. S. 1991: Biology of Life Span: A Quantitative Approach. CRC Press; Rev Upd edition (March 7, 1991), ISBN 978-3718649839

GAVRILOVA N. S., GAVRILOV L. A. 2011: Aging and Longevity: Mortality laws and mortality forecasts for aging populations / Stárnutí a dlouhověkost: Zákony a prognózy úmrtnosti pro stárnoucí populace. *Demografie*, Vol. 53, No. 2. 2011. ISSN 0011-8265.