

Regularities and Deviations in Mortality Trends of the Developed World

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1 Introduction

By the second half of the 20th century, mortality patterns in various industrialized countries showed a continuous tendency of reduction at all ages, even at the oldest ones (Kannisto et al. 1994). For low-mortality areas, this tendency has been quite general, and has involved both women and men, although a time lag has been often recorded between male and female mortality improvements. However, the pace of mortality decline considerably varies depending on the country (Caselli 1996; Kannisto 1994). Furthermore, in a few cases, stagnation and even an unexpected reversed pattern have been observed in more recent years (Janssen et al. 2003, 2004; Vallin and Mesle 2004).

In this paper an extensive comparative analysis of mortality trends in several developed countries is performed. The aim of the paper is to locate deviations from expected mortality patterns, and to determine the reasons for these deviations. As a first step of the analysis, a new two-dimensional relational model is applied to mortality surfaces of the selected developed countries to disentangle and compare age, time and cohort patterns, and speed of changes of different populations. In the second step, mortality by cause of the countries with particular structural features is analyzed through the surfaces of leading causes of death (Barbi et al. 2004).

2 Data and Methods

The analyses presented here focus on adult and old age mortality (aged 50-99), between 1960 and 1999 in low-mortality countries included in the *Human Mortality Database* (www.mortality.org). Probabilities of dying for single years of age and single calendar year are obtained from this data collection.

Regarding cause specific mortality data, probabilities of dying by groups of causes and by five-years age groups are estimated from data available at the *World Health Organisation Mortality Database* (www.who.int/whosis).

All-cause probabilities of dying are analyzed by means of a new relational model. Relational models of mortality are based on a standard mortality schedule capturing the complexity of age patterns of mortality, and on parameters capturing deviations from the standard. This concept can be generalized so that the standard mortality schedule is defined over time (y) and age (x). If $\mu_0(x,y)$ is the standard mortality surface, the relational model may be written as

$$\mu(x, y) = \mu_0(x, y) \exp[k(y)r(x)],$$

where $k(y)$ captures deviations over time and $r(x)$ describes the relative impact of these deviations at different ages (Lee and Carter 1992; Vaupel 1999). These two functions may be estimated by the maximum likelihood method.

The standard surface has been estimated following the concept of “best practice” (Oeppen and Vaupel 2002). Figure 1 shows the female surface of the lowest probabilities of dying (i.e. the best practice mortality surface), between 1960 and 1999, from birth to age 99, computed accounting for the probabilities of dying of 13 low-mortality countries: Austria, Denmark, Finland, France, West Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, Switzerland, USA.

Cause specific mortality profiles are analyzed exploiting a simple but powerful tool: the surface by age and time of leading causes of death. After locating the predominant cause of death (or the predominant location of a disease category) over age and time, is then possible to focus on this specific disease (or location) for a more in depth investigation.

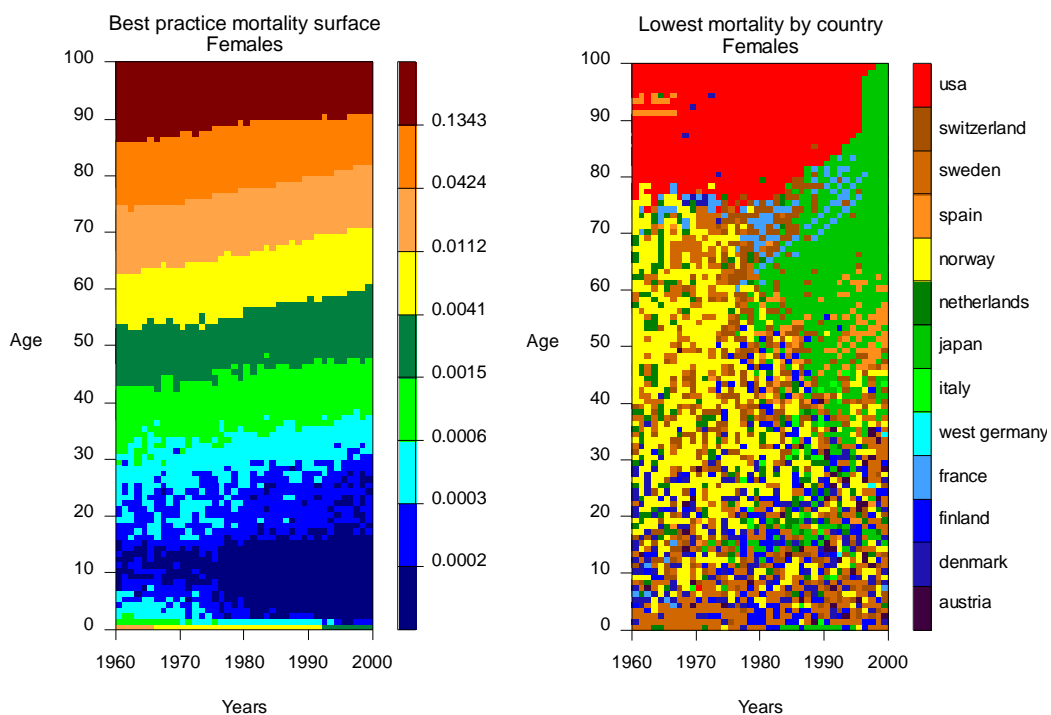


Figure 1. Best practice mortality surface. Females, 1960-1999.

3 Application

To give an example, this session includes preliminary results for Japanese and U.S. women. Figure 2 depicts the evolution of mortality from birth to age 99 for the female population in the two countries. At the beginning of the 1960's, Japan finds itself at a disadvantage with respect to the U.S. However, Japan has caught up at a remarkable pace and today is the country with the highest life expectancy in the world. The U.S., on the contrary, by the mid 1980s, has experienced a period of stagnation that persists to recent years.

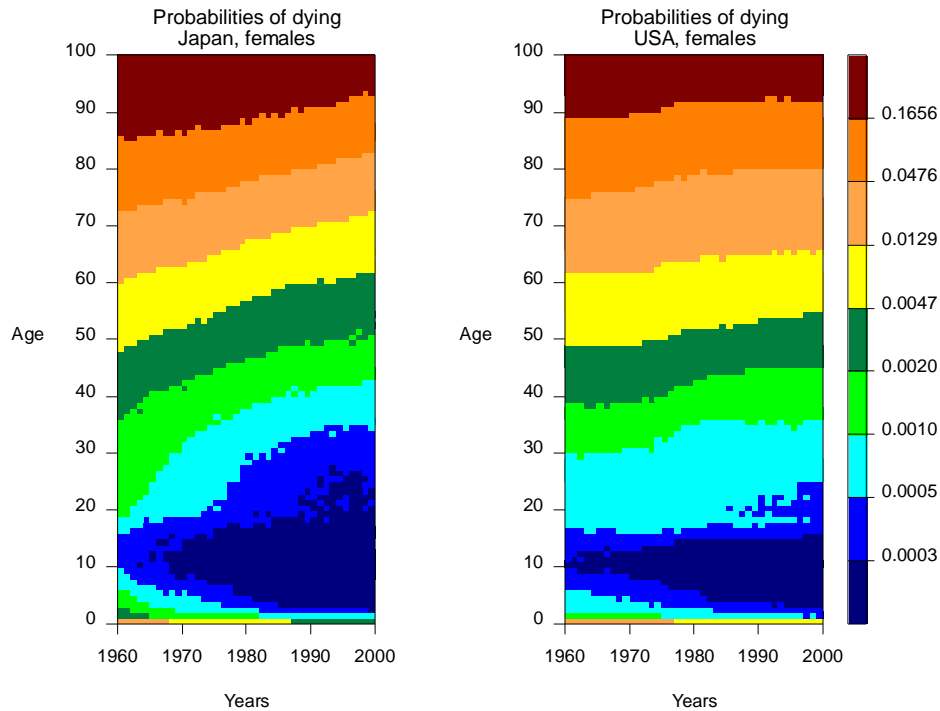


Figure 2. Mortality evolution in Japan and the U.S., from 1960 to 1999.

Figure 3 shows the estimated functions $k(y)$ and $r(x)$ of the relational model fitted to female Japanese and U.S. probabilities of dying, between 1960 and 1999, from age 50 to 99. As Japan and the U.S. largely dominate the best practice mortality surface (i.e. the standard surface in the relational model), results are somehow expected. By the mid 1970s the two countries show an evident diverging trend and a different age pattern of deviation from the standard. While in Japan the deviation is reducing over time and its relative impact is higher at older ages, in the U.S. this is increasing with a greater importance at adult and young-old ages.

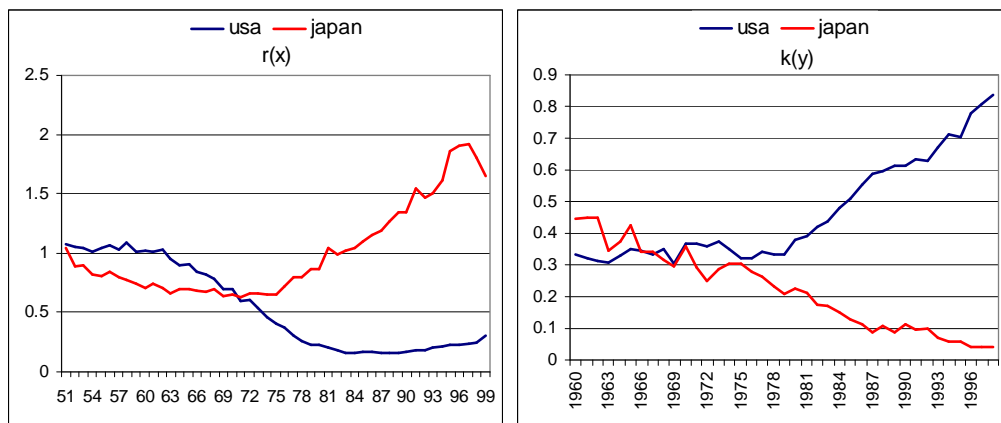


Figure 3. Estimated parameters of the relational model

Let's turn now to cause specific mortality. The analysis here has been limited to the group of diseases of the circulatory system. Figure 4 shows the leading locations of this group of causes in the two countries. In Japan, cerebrovascular diseases are the first location at all ages considered until 1986 when, at older ages, the leading

category becomes other hearth diseases. In the U.S., ischaemic hearth diseases are the most important category at all ages for the entire study period.

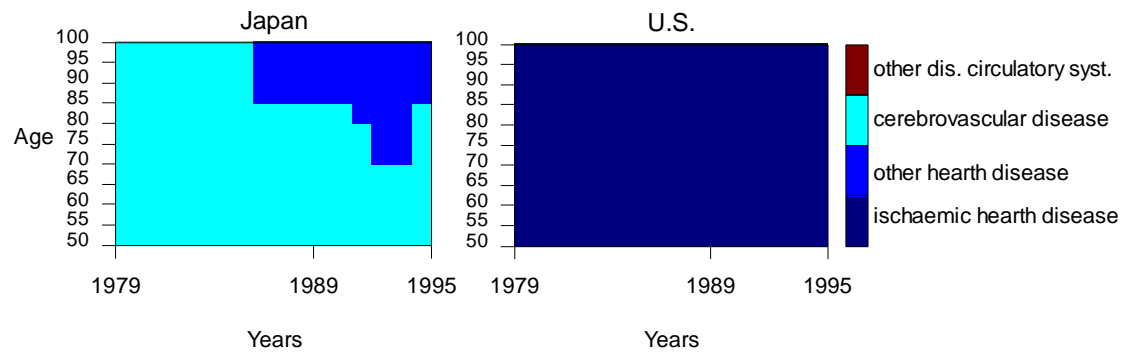


Figure 4. Leading location by age and time among diseases of the circulatory system.

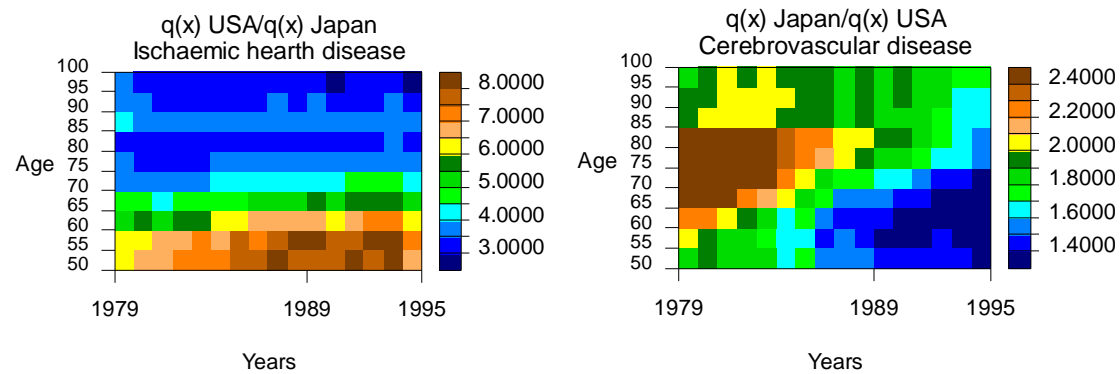


Figure 5. Ratios of Japanese and U.S. probabilities of dying from ischaemic hearth disease and cerebrovascular disease.

Focusing now on these two country-specific predominant locations, cerebrovascular diseases and ischaemic hearth diseases, the analysis reveals completely different age and time patterns (Figure 5). While values of probabilities of dying from cerebrovascular diseases of the two countries tend to converge (due to a faster decline in Japan), the high difference between probabilities from ischaemic hearth diseases of the two countries stays constant and even slightly increases. The highest discrepancy between U.S. and Japanese probabilities of dying from ischaemic hearth diseases is recorded at adult and young-old ages. These findings perfectly match with the age and time patterns of deviation from the “optimal position” estimated by the relational model.

Here the analysis involved only two countries and focused only on one group of causes of death. This study will be extended to other countries of interest and to all causes of death grouped in main categories. The resulting detailed picture may prove useful to explain diverging mortality trends.

References

- Barbi E., Caselli G., Yashin A. (2004), Age and time patterns of mortality by cause in Italy: A mortality surface approach, *Proceedings of the XLII Scientific Meeting of the Italian Society of Statistics*, Bari 9-11 June, 2004.

- Caselli G. (1996), Future longevity among the elderly. In Caselli G. and Lopez A. (eds.), *Health and mortality among elderly populations*, Oxford: Clarendon Press.
- Janssen F. et al. (1993), Stagnation in mortality decline among elders in The Netherlands, *The Gerontologist*, 43(5), 722-734.
- Janssen F., Mackenbach J.P., Kunst A.E. (2004), Trends in old-age mortality in seven European countries, 1950-1999, *Journal of Clinical Epidemiology*, 57, 203-216.
- Kannisto V. (1994), *Development of oldest-old mortality, 1950-1990: Evidence from 28 developed countries*. Odense University Press.
- Kannisto V., Lauritsen J., Thatcher A.R., Vaupel J.W. (1994), Reductions in mortality at advanced ages: several decades of evidence from 27 countries. *Population and Development Review*, 20(4), 793-810.
- Lee R.D. and L.R. Carter (1992), Modeling and forecasting U.S. Mortality. *Journal of the American Statistical Association*. Vol 87, No. 419, 659-671.
- Oeppen J., Vaupel J.W. (2002), Broken limits to life expectancy, *Science*, 30.
- Vallin J., Meslé F. (2004), Convergences and divergences in mortality. A new approach to health transition, *Demographic Research*, special collection 2.
- Vaupel J.W. (1999), The long-term pattern of adult mortality and the highest attained age. Discussion on the paper by A R Thatcher. *Journal of the Royal Statistical Society - Series A: Statistics in Society*. 162: 31-32.