The Era of Centenarians – The Mortality of Swedish Oldest-Old

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Background

Recent demographic evidence has shown that record life expectancy has improved almost linearly by about 2.5 years per decade for more than 160 years (Oeppen and Vaupel, 2002, Christensen et al., 2009). This remarkable trend was first fueled by reductions in infant and child mortality, since the 1950s most part of the mortality reductions were observed for older ages. The annual decline of mortality at older ages is continuing for many countries, including Sweden (Rau et al., 2008). Between 1960 and 2000 Swedish life expectancy at age 80 increased by 1.31 years for men and 2.58 years for women (Rau et al., 2008). With the decrease of mortality for the ages below 100, the number of Swedish centenarians has risen almost exponentially in recent years (Vaupel, 2010). The increase was accompanied by a steady increase in the maximum age at death (Wilmoth et al., 2000).

An important question arises from these observations. Did mortality of centenarians also decline? Perhaps mortality started to decrease as it was observed for the 80 and 90 year old due to the ongoing effort to improve health in the elderly. Or perhaps mortality increased because more and more people frail individuals are reaching age 100. Or perhaps mortality has not changed because we were not able to overcome a certain limit with our medical and public health efforts. The answer to this question is a very important demographic issue because it remains to be shown whether aging also at today's most advanced ages can be postponed.

Data and Method

Until recently mortality estimations for people aged 100 and older were difficult to obtain. Two main problems were identified.

The first problem was the poor quality of data on the ages of the very elderly. For our investigation we use individual-level data of all Swedish centenarians. The data is provided by Statistics Sweden (2010). We obtained information on the exact date of birth and exact date of

death for all Swedes who reached age 100 between January 1ˢᵗ 1969 and January 1ˢᵗ 2010. The data was organized by year of birth (cohort). Due to the register system, Swedish mortality data is known to be of exceptional quality with no signs of faulty data after 1861, even at very high ages (Wilmoth and Lundstrom, 1996). Our final data set includes a total of 15,231 centenarians, of whom 13,471 died, 112 emigrated, and 12 are of unknown status. The remaining individuals are censored at January 1ˢᵗ, 2010.

The second problem was the small number of people that reached the age 100. At these ages survival rates were highly erratic, which made it difficult to calculate the annual death rates to construct a life table. Therefore, previous investigations of mortality at the highest ages often relied on mathematical models and extrapolation methods to adjust and correct the data (Caselli et al., 2006). Although these methods tend to fit mortality at higher ages sufficiently well, there is still an ongoing discussion on which model actually fits the data best (???). We would like to avoid the possibility that important trends over time and age are masked by the mathematical model chosen. Therefore we decided to apply basic demographic methods on the raw and unadjusted Swedish individual-level data. The most common measure of the average age at death in Demography is life expectancy derived from a life table. To calculate life expectancy in a life table, death probabilities for each age or year have to be calculated. In a cohort perspective life expectancy can also be interpreted as the mean age of death. Our data allows us to estimate the mean age directly, without having to calculate the annual probabilities first. One of the problematic characteristics of the mean is that it is not resistant to outliers, which means that single cases of extreme ages may influence the estimation of the average age at death. In addition cohort life expectancy can only be calculated after all members of this cohort have died. Estimates for the most recent cohorts are therefore not possible to obtain. (Canudas-Romo, 2010) pointed out that although the median and model age at death is rarely used as measures to study longevity, they are equally important. To estimate the average age at death of centenarians we propose to also use the median age at death. This measure describes the point in time when half of a cohort of centenarians has died. The median age at death is robust against statistical outliers and can already be calculated when half of a cohort has died. Therefore the median can also be estimated for more recent cohorts of centenarians.

First Results

First results for each cohort of centenarians from 1968 until today indicate that the mortality for centenarians of both sexes remained remarkably stable over the whole 40 year period. Figure 1 and 2 give the median age at death in days since the 100ᵗʰ birthday for each cohort of male and female centenarians with fitted trend lines. The trend lines follow a linear regression equation. As expected the mortality pattern was erratic at the beginning of the observation
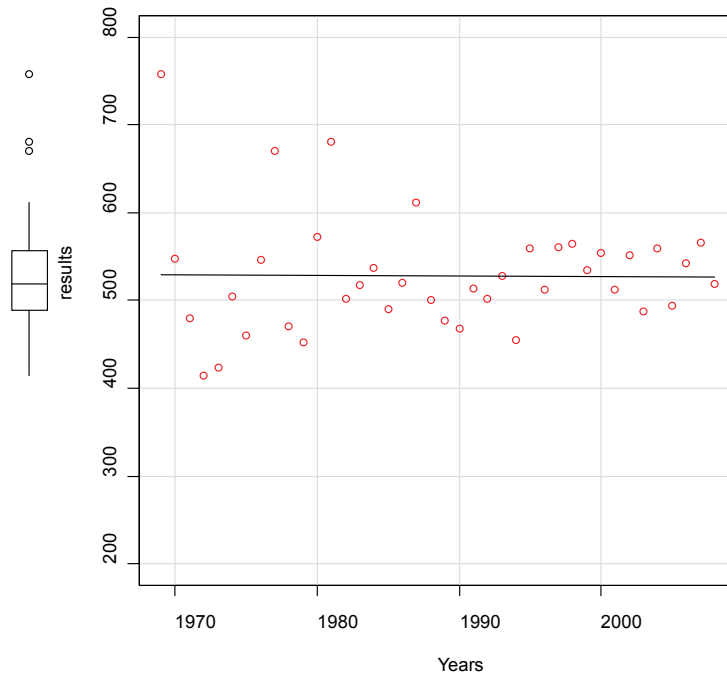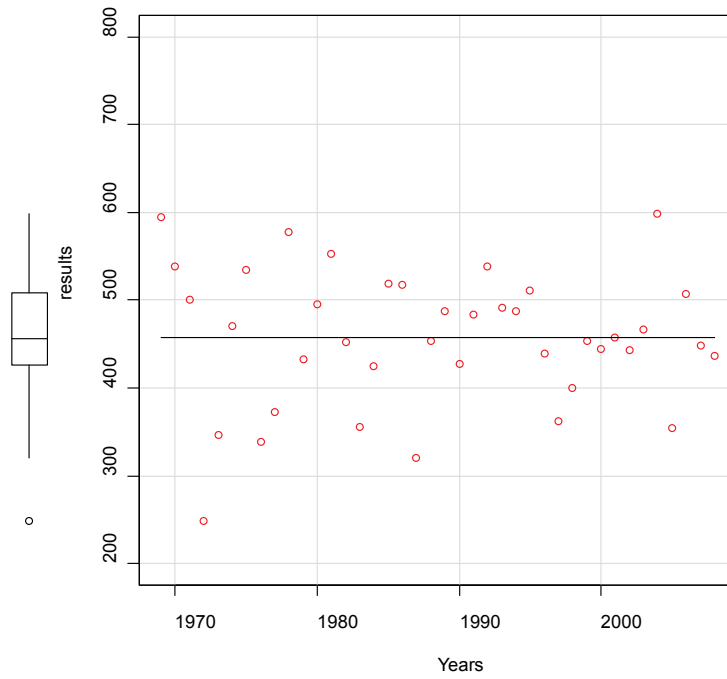
Figure 1 (Women)

Figure 2 (Men)

period but became more stable since the 1980's, especially for women. However, even for the most recent cohort of centenarians we observe an unchanged mortality pattern. A very similar trend was found for the mean age at death. Further results will be available in time for the PAA meeting.

Conclusion

The study aims to use high quality data to estimate a time series on the mortality of Swedish centenarians. This is a very important demographic issue because it is still not sure whether aging also at the most advanced ages can be postponed. Preliminary evidence indicates no change in the mortality pattern of Swedish centenarians. This suggests that future progress in the delay of death to higher ages has to be fueled by a deeper understanding of the aging process.

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