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Mortality in Old Age. The Epidemiological Transition among Elderly in Sweden 1911-2010

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Introduction

The increase in survival in populations during the last centuries represents one of the most fundamental changes in the history of mankind. The main lines of the process has been well described and is known, and our understanding of it has increased even if the question of how it was accomplished is still partly unresolved. Analysing the change from a long-term perspective is important for our understanding of the present-day situation as well as for the future. Can we expect further increases in life expectancy or are the most succesful countries close to reaching an upper limit in how old we can get? This intriguing question attracts attention both from researchers as well as politicians and the general public. In recent years increasing focus have been on health, disease and mortality of the elderly. A strong motive for the changing focus is that a larger proportion of the population are now reaching the third and fourth ages with obvious implications on health care, living conditions and pension systems. The implications are not completely clear and require thorough analysis. Furthermore, in present-day Sweden mortality in young age is very low and further increases cannot add much to higher life expectancy. Still, the transition towards even higher life expectancy have continued contrary to what some have assumed. Health improvements in old age has now become the driving factor for increased survival.

In this paper we explore the Swedish epidemiological transition for the period, 1911-2010. We analyse changes in causes of death of persons 60 years and older. Making such an analysis is however not a straight-forward undertaking and faces the researcher with several challenges related to quality of the available data. The study thus involves an examination on how causes of death were recorded and categorized and what that implies on how old age has been considered in history. Our main research questions are:

Do we find an epidemiological transition among the elderly?
What causes have contributed most to the decline in old age mortality?
Can we identify a delay in the ageing process over time through the recorded causes of death and have they become less dispersed in age?

Transition models of population development

The population dynamics and the rapid changes in demographic patterns during the last centuries have been described by different transition models, the most fundamental one being the demographic transition. The components of the demographic transition model have been described in separate models, for example the mortality transition. Studies of the mortality transition focus on the contribution to the transition from different age groups, when it started and what caused the decline. A model closely related to the mortality transition is Omran's epidemiologic transition model, presented in the early 1970's. The basis for the theory is an analysis of the dominant causes of death and to identify determinants for the transition. Omran finds that mortality has developed through three distinct phases characterised by different cause of death groups. During the "age of pestilence and famine" mortality was mainly caused by infectious diseases. This is followed by the "age of receding pandemics", a transitional phase where the impact of the old type of diseases successively diminish. The third phase is "the age of degenerative and man-made diseases" where mortality is low, infectious diseases play a minor role and diseases such as cancers and cardiovascular diseases dominate. The model implies that mortality will eventually stabilize (p 517) at a level where "… the net gain in life expectancy is small" (Omran 1982, p 173).

The main outline of the model is widely accepted. Many observed however that we are not close to an assumed endpoint. A tremendous further prolongation of life expectancy has occurred. Nothing indicated that the expected life span had stabilised at a certain level but the increase was no longer led by improved survival in younger ages. In an attempt for revision Olshansky and Ault (1986) found that further increase in the American context was brought about by a marked decline in cardiovascular diseases starting in the 1960's. Olshansky and Ault doubt however that further increases will be possible in the future when life expectancy reaches a biological limit. The authors suggests a fourth stage, "the age of delayed degenerative diseases" when diseases are the same as in the third stage but appear later in life. Several of the presuppositions in Omran's and Olshansky's model have been questioned. The assumption by Olshansky that there is a biological limit to the life span and that we are on our way of reaching such a limit is not as obvious as we may believe (Vaupel; Wilmoth). The development in the last decades have shown that the pace of increasing life expectancy do not slow down, and that survival in old age improves rapidly. The limit of the life span assumed by Olshansky and others was soon reached.

Robine's (2001) reformulation of the transition theory is based on an analysis of changes in the dispersion of life spans. The first stage was characterised by large disparities in life spans. As in Omran's model it is followed by "the age of receding pandemics" that ended in the 1950's in the most advanced countries. The transition led to a large reduction in disparities of life span. The third stage, having more similarities with Olshansky's and Ault's fourth stage than Omran's third, is labelled the "Age of the Conquest of the Extent of Life" when the mortality declines takes place in old age and when increases in life expectancy no longer is connected to reduced dispersion of life spans (Robine 2001, p 191f).

Vallin and Mezlé (2004) believes that the observed changes in mortality patterns during the second half of the 19th century calls not only for adding new stages but also for a revised theory. One of the main new aspects of the recent development is the decisive role of individual behaviour, something that Omran's model did not incorporate, but is emphasized in the health transition model (Frenk et al 1991). Vallin's and Meslé's suggest to combine the health transition model with the epidemiologic transition framework. Furthermore, they argue that the stages in the health transition process are characterised by periods when mortality in different places or in different groups were diverging where new opportunities could be transferred to better survival while others lagged behind. After a while, the improvements started among the laggards leading to a convergence.

The epidemiologic transition among elderly – what do we know?

The analysis of the relation between all-cause mortality and cause of death composition dates back to some works in the 1960's and 70's, for example by Thomas McKeown in his analysis of the great mortality decline and Preston (1976) who made a thorough statistical analysis of changes in causes of death for different countries. The studies of McKeown and Preston did not focus specifically on the cause-of-death patterns of the elderly.

Salomon and Murray (2002) find in their analysis of the epidemiologic transition in 58 countries 1950-1998 little evidence of an epidemiologic transition among elderly, thus confirming the findings of both Vaupel (1997) and Olshansky & Ault (1986). They divided causes of death in three groups, infectious, non-communicative and finally injuries. Causes of death among the elderly was heavily dominated by noncommunicative diseases during the complete period and there were only minor changes in the cause composition.

An essential prerequisite in several of the transition models has been an assumed biological limit in the life span and a rectangularisation of life expectancy in populations. When mortality is delayed and life expectancy approaches the biological limit, then dispersion of age at death diminishes and becomes concentrated to a shorter age interval (Fries 1980, 1984 as well as others). The survival curve takes a rectangular form (Wilmoth and Horiuchi 1999). When looking at all ages, it is apparent that the age range of deaths have become more concentrated. It is however not obvious how to measure changes in the dispersion of age at death and several measures have been developed for this purpose (Kannisto; Robine 2001). Engelman et al (2010) found that dispersion in old age has increased during the last decades and that "… survivors to older ages have become increasingly heterogeneous." (p 512) Declining mortality in younger ages may change the selection of frail people in the ageing population, thus increasing the variability in mortality among elderly (p 534).

To conclude this section, studies of the epidemiological transition of the elderly are still few and we have no clear picture of the longterm development of the changing cause of death pattern in the highest age groups. The basic assumption is that we do not find any epidemiologic transition according to the Omran model for this age.

Sweden's demographic transition

Sweden is an excellent illustration of the demographic transition model. Both fertility and mortality was high in the 18th century. A clear break can be seen in the mortality curves in the early 19th century – the mortality transition started. Birth rates remained high during most of the 19th century, leading to a rapid population increase. Not until the last decades of the century did fertility start to decline. When the decline started, it fell however in a rapid pace, and in the 1930's fertility had fallen below replacement level. Sweden was very early in the mortality decline and had next to Norway and Denmark the lowest mortality in the world in the 19th century. Fertility below replacement level was also early in Sweden.

The majority of deaths took place in the youngest age groups during the 19th century was high in the youngest age groups. Life expectancy was low and very few people reached what we now consider as high ages. Deaths were mainly caused by infectious diseases, but the diseases that dominated changed over time. In the early 20th century, life expectancy had increased to about 55 years. The decline was mainly accomplished by improvements in the survival of infants and children, while life expectancy for those 65 years and older had not improved much. Nevertheless, it was not until after the Second World War that infectious diseases became less important when it comes to mortality. Life expectancy continued to increase, reaching 70 for men and 74 for women in the 1950's. At present-day, life expectancy for men is close to 80 and 83,5 for women.

Sources

Sweden has a long tradition of recording causes of death. Inspired by a mercantilistic ideology, the Swedish government started to collect national population statistics in 1749 with the aim at improve the knowledge about population issues in order to stimulate population increase. The complete recording ended in 1830 but was taken up again for towns and cities in 1860 where physicians should diagnose every death and to present death certificates. It was however not until 1911 that the recording of death causes became compulsory again for the whole country. Nevertheless, physicians were few, in particular in the rural parts of the country. Diagnosing the deaths were thus often in the hands of parish ministers after

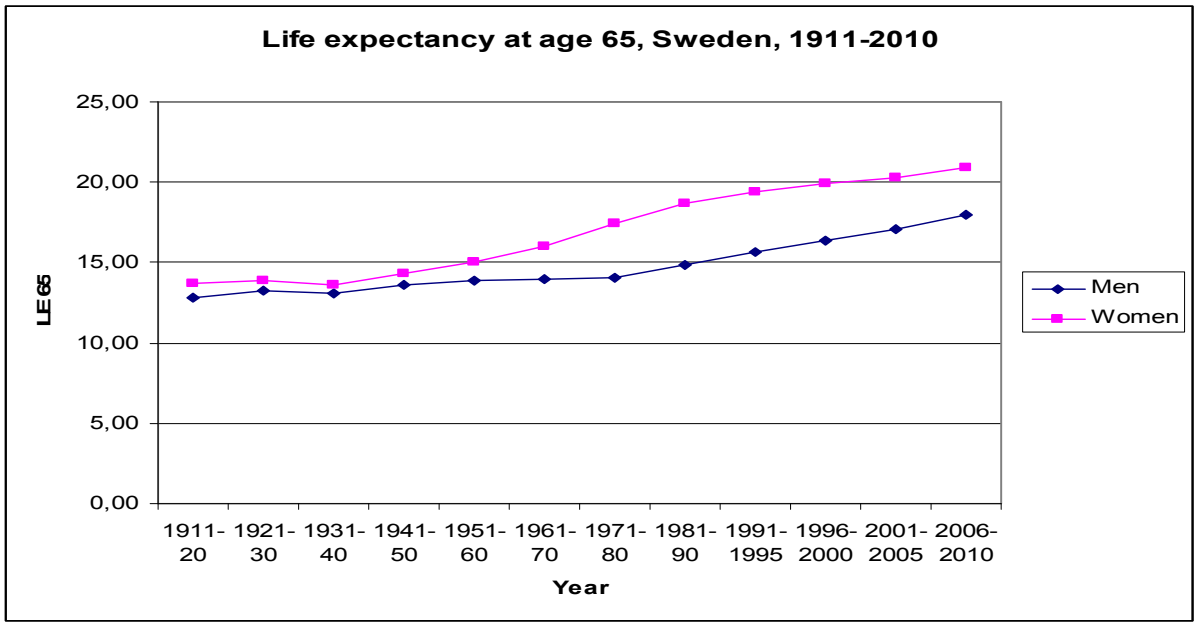
consulting relatives, leading to uncertainties or in many cases missing information. Excerpts from the death registers were regularly sent to the district medical officer for evaluation, marking the diagnoses either as proven or probable. The registration improved successively, and from 1971 death certificates signed by physicians were compulsory. Yet, death certificates were however presented in almost all cases already in the 1960's. Sweden did not adopt the nomenclature of Bertillon in 1911, instead a nomenclature of its own was developed but to a large extent based on previous Swedish nomenclatures. This was kept until 1931 when a new version was introduced. From 1951 Sweden adhered to ICD 6 and from that time the different versions of ICD have been implemented and used.

There are some obvious problems when preparing a time serie of death cause for the studied period. One related to changes in nomenclature. Our evaluation of the changes is however that this is not a great obstacle. We reach a similar conclusion regarding the partly unclear and changing definitions on what cause to be registered in case of multiple causes. In the early version, the terms main and contributing causes of death were used. In connection with adopting ICD, causes of death were recorded in chronological order, starting with underlying cause of death. A larger problem is the quality of the information. During the first centuries, many deaths causes are unknown and vague diagnoses such as "old age" were often used. Furthermore, the medical knowledge about diseases has changed and the use of autopsies have been more or less frequent during our studied period. In our analysis we consider the possible effects of these restrictions. The printed statistics on the basic categories until 1950 have been entered in a database by the department of epidemiology at Umeå University. The database contains yearly causes of death in major groups, divided in sex and age and with separate figures for urban and rural environments. For the following period we have access to data from National Board of Health and Welfare.

First results

In this abstract, we only present a couple of results on the general development and the full results will be presented later.As in other countries, the elderly live get more and more years to their lives. Figure 1 presents the expected remaining years for Swedes 65 years and older from 1911 to 2010. During the early 20th century the levels were quite stable and there was only a slight increase in years lived or less than a one year increase from the 1910's to the 1940's. After the Second World War we find a completely new pattern. Life expectancy of the elderly increased rapidly but with different timing depending on gender. The increase first took place among elderly women, leaving men in a more disadvantaged position. The gap has however narrowed during the last decades. The timing of the increase in survival fits in well with the cardiovascular revolution discussed in the different transition models both in regard of the improvements from the 1960's onwards and the divergent pattern between the sexes where male mortality from these diseases continued to increase until the 1980's.

Figure 1. Life expectancy at age 65, Sweden 1911-2010.



Source: Statistics Sweden.

Another way of illustrating the implications of the declining mortality among elderly is by estimating the relative contribution of this age group to the total gain in life expectancy during the last century (see Figure 2). In the early 20th century the contribution was marginal. During the 1930's and 40's improvements of the elderly had some impact, but it was mainly in the time period after the Second World War that the shift took place. Old age mortality has become more central to the development of survival. From the 1960's, improved old age mortality contributed to half of the increased years and in the last period the contribution was about 80%. Elderly females contributed stronlgy already in the 1950's, while the males lagged behind.

Figure 2. Contribution to increased life expectancy at birth from elderly, 65+. Sweden 1911-2010.