Lifetime according to health status among the oldest olds in Denmark

HENRIK BRØNNUM-HANSEN, INGE PETERSEN, BERNARD JEUNE, KAARE CHRISTENSEN

1National Institute of Public Health, University of Southern Denmark, Øster Farimagsgade 5 A, DK-1399, Copenhagen, Denmark
2Department of Epidemiology, Institute of Public Health, University of Southern Denmark, J. B. Winsløws Vej 9B, DK-5000, Odense C, Denmark

Address correspondence to: H. Brønnum-Hansen. Tel: (+45) 39 20 77 77; Fax: (+45) 39 20 80 10. Email: hbh@niph.dk


Abstract

Background: policy makers face increasing demands for care of the aged and therefore need more information about the health status of very old people. The purpose of this study was to quantify the average lifetime according to health status among the oldest olds in Denmark.

Methods: the 2,258 participants (63% of all survivors) in the 1905 Danish cohort survey were interviewed in 1998 and re-assessed in 2000, 2003 and 2005. Lifetime according to self-rated health status, physical independence and being cognitively intact was estimated. Physical independence was defined as the ability to get up from a chair or bed, walk around the house and go to the toilet, and being cognitively intact was defined as having a Mini-Mental State Examination score > 22.

Results: the average lifetime between ages 92 and 100 was 2.7 years for men and 3.3 years for women, of which almost half was in self-rated good health. The lifetime in physical independence was 2.0 years for men and 2.4 years for women, and both men and women spent an average of 1.1 years in a state of physical independence without cognitive impairment.

Conclusion: even at ages 92–93, a substantial proportion of the remaining lifetime is spent in reasonably good health.

Keywords: cognitive functioning, Denmark, health expectancy, oldest olds, physical functioning, self-rated health, elderly

Introduction

As more people survive to an advanced age, the number of very old people will increase [1], which might mean increasing proportions of oldest olds with disability and poor health.

Health expectancy is an indicator that represents the average lifetime in different health states. Many concepts of health expectancy indicators have been applied [2–6]. The most common are disability-free life expectancy, expected lifetime without chronic morbidity or impairments, expected lifetime without functional limitations and expected lifetime in self-rated good health. Depending on the health dimension being studied, the trends go in different directions [4–7], although most studies suggest declining disability rates among recent cohorts of younger elderly people. Because death rates are continuing to fall, dependence in late lifetime might nevertheless increase. In order to plan long-term care needs, it is important to know how long the oldest people live in an independent state with relatively good health, such that comprehensive assistance in daily activities and medical treatments is needed to only a moderate extent. To our knowledge no studies have estimated health expectancy among the oldest olds.

The expected lifetime without functional limitations and with self-rated good health at age 65 increased substantially in Denmark, but the expected lifetime without long-standing illness increased only modestly [8]. Although self-rated good health declines with age, more than half of Danes aged 90 years or over rate their health as good [9].

The purpose of the present study was to estimate lifetime according to health status, on the basis of self-rated health, physical functioning and cognitive status among the oldest olds in Denmark. The study was based on longitudinal data on Danes born in 1905.

Material and methods

The 1905 Danish cohort survey covered all Danes born in 1905, of whom 3,600 were still alive in 1998. The survivors were identified through the Danish civil registration system by means of the unique personal identification number and
invited to participate in the intake survey in 1998, irrespective of residence, health or cognitive state [10–12]. The personal identification number ensures complete follow-up for all inhabitants of Denmark, with the exception of people who emigrate, which is a negligible number at this age. The first interview was conducted between August and October 1998 and involved 2,259 persons (62.8%). All subsequent deaths were registered by linkage to the Danish civil registration system, except for one person who had emigrated (date missing), who was excluded from the study. Follow-up by new interviews with the survivors took place in 2000, 2003 and 2005, with participation rates between 69% and 78%. The interviews were conducted at home by professionals from the Danish National Institute of Social Research. If a person was too weak to participate, a proxy, usually a son or daughter or another member of the family, was asked to assist.

Self-rated health was measured from answers to the question: ‘How would you rate your health in general?’ The five original response categories (‘very good’, ‘good’, ‘fair’, ‘poor’ and ‘very poor’) were grouped into ‘good’, ‘fair’ and ‘poor’, because ‘very good’ and ‘very poor’ were seldom reported. The response was missing for participants who were too weak to answer as the proxies did not answer this question. A person was considered to be physically independent if he or she did not require assistance to get up from a chair or a bed, walk around in the house and go to the toilet. Cognitive function was measured by the Mini-Mental State Examination (MMSE) (scale 0–30) [13], and a person was classified as cognitively intact if his or her score was above 22 [14]. The method for imputing MMSE item scores when a question was coded as missing or skipped has been described previously [15]. Five items could be more or less impossible to respond by persons with visual impairment, and the score was replaced by the mean score for the purpose of computing the overall MMSE score. Physical and cognitive functioning were combined to estimate the lifetime in a state of physical independence without cognitive impairment.

One interview was missing for 93 persons, two interviews were missing for 248 persons and three interviews were missing for 16 persons. When health status was missing from an interview between two accomplished interviews, lifetime between the interviews was distributed evenly according to the reported health states. We used the same method when health status changed between two consecutive interviews. Despite these imputations of missing data, health state was still inestimable in some periods. For instance, health state could not be estimated when health information was missing at the intake interview for a person who died before the first follow-up. The values from the last interview were considered to be valid until the end of follow-up (31 December 2005). When the last interview was performed more than 6 months before death, the health status at that interview was considered to be valid until 3 months before death and to be in the worst category during the last 3 months. Person-years in various health states by sex and age were summarised, and the average lifetime by health state was estimated. To validate the influence of missing values, the results were recalculated after replacing missing values for a person by the best- and worst-reported health state at the other interviews with that person. The results of these recalculations made up the lower and upper limits for lifetime in the various health states.

Results

Of the 2,258 participants interviewed in 1998, only 199 (8.8%) were still alive on 1 January 2006. The average lifetime between the first interview and the end of follow-up on 31 December 2005 was 2.70 years for men and 3.31 years for women.

Table 1 shows the average lifetime in self-rated good, fair and poor health. Men spent 16 months of their late lifetime in good health, 10 months in fair health, 4 months in poor health and 2 months in an inestimable health state. For women, the lifetime in self-rated good health was almost 19 months, and they spent a little more than 11 months in self-rated fair health, almost 5 months in poor health and almost 5 months in an inestimable health state. If a person’s missing self-rated health was replaced by the best health reported by that person at the other interviews, the average lifetime spent in good health would have been 20 months for men and 25 months for women, while the lifetime in self-rated poor health would have been reduced only modestly (Table 1). Replacing missing values by worst-reported health would have reduced the lifetime in good health to 15 months for men and 18 months for women, whereas the average lifetime

Table 1. Average lifetime in self-rated good, fair and poor health between ages 92 and 100 for Danes born in 1905 and followed up until 2006

<table>
<thead>
<tr>
<th>Sex</th>
<th>Average lifetime (years)</th>
<th>Average lifetime in self-rated good health (years)</th>
<th>Average lifetime in self-rated fair health (years)</th>
<th>Average lifetime in self-rated poor health (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Worst; best</td>
<td>Worst; best</td>
<td>Worst; best</td>
</tr>
<tr>
<td>Men</td>
<td>2.70</td>
<td>1.33</td>
<td>1.26; 1.65</td>
<td>0.85</td>
</tr>
<tr>
<td>Women</td>
<td>3.31</td>
<td>1.55</td>
<td>1.49; 2.07</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Health state was inestimable for 0.18 years for men and 0.41 years for women.

*a* Estimated by replacing missing values for a person by the best- and worst-reported health at the other interviews for that person.
Table 2. Average lifetime in physical independence between ages 92 and 100 for Danes born in 1905 and followed up until 2006

<table>
<thead>
<tr>
<th>Sex</th>
<th>Average lifetime (years)</th>
<th>Average physically independent lifetime (years)</th>
<th>Worst; best</th>
<th>Average physically dependent lifetime (years)</th>
<th>Worst; best</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>2.70</td>
<td>2.10; 2.00; 2.09</td>
<td>0.69; 0.71; 0.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>3.31</td>
<td>2.37; 2.36; 2.47</td>
<td>0.93; 0.95; 0.84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Average lifetime with physical and cognitive functioning between ages 92 and 100 for Danes born in 1905 and followed up until 2006

<table>
<thead>
<tr>
<th>Sex</th>
<th>Average lifetime (years)</th>
<th>Average physically independent lifetime (years)</th>
<th>Worst; best</th>
<th>Average physically dependent lifetime with physical and/or cognitive impairment (years)</th>
<th>Worst; best</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>2.70</td>
<td>1.13; 1.11; 1.27</td>
<td>1.57; 1.60; 1.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>3.31</td>
<td>1.13; 1.10; 1.27</td>
<td>2.16; 2.21; 2.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Average lifetime with physical and cognitive functioning between ages 92 and 100 for Danes born in 1905 and followed up until 2006

<table>
<thead>
<tr>
<th>Sex</th>
<th>Average lifetime (years)</th>
<th>Average physically independent lifetime (years)</th>
<th>Worst; best</th>
<th>Average physically dependent lifetime with physical and/or cognitive impairment (years)</th>
<th>Worst; best</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>2.70</td>
<td>1.13; 1.11; 1.27</td>
<td>1.57; 1.60; 1.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>3.31</td>
<td>1.13; 1.10; 1.27</td>
<td>2.16; 2.21; 2.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Lifetime in various states of self-rated health appears to be distributed equally for the oldest-old men and women, with almost 50% of lifetime in good health. It is striking that almost 75% of total lifetime was spent in a state of physical independence, although cognitive impairment reduced lifetime of independence.

A shortcoming of the study was the low rates of participation in the surveys. A comparison between participants and non-participants has been described previously [10]. For instance, the hospitalisation patterns in the 25 years before the intake survey in 1998 indicated no difference in health state between participants and non-participants; however, non-participants had higher mortality rates than participants in the first 6 months after the start of the survey.

We have previously shown in the 1905 cohort and other longitudinal surveys among elderly that grip strength, which is associated with general physical functioning and survival, varied according to response profile in the successive waves. Participants who completed two follow-ups were stronger than participants who completed only one follow-up, who were stronger than those who participated in only the baseline survey. Furthermore, participants who were non-responders in the next follow-up were stronger than those who died before the next follow-up [16].

The assistance of proxies when participants were too weak (20% at the first interview) reduces the bias due to non-participation, although information on self-rated health was necessarily missing. It should also be noted that the lifetime in inestimable self-rated health among women was twice that among men.

As 45% of total person-years were lived after the last interview, we evaluated the robustness of our assumptions about health state after the last interview. If it is assumed that all persons who were interviewed more than 6 months before the end of follow-up or death had the worst health status during the last 6 months of their life, the average lifetime in self-rated good health would be reduced by a little more than 1 month, that in fair health would be reduced by a little less than 1 month and that in poor health would be increased by 2.3 months for men and 2.5 months for women (lifetime in an inestimable state was reduced somewhat by this assumption). The assumption transfers 1.8 months from a state of physical independence to a dependent state but less than 1 month from a state of physical independence without cognitive impairment to one of dependence.

For men, the results of the ‘worst-reported health’ scenario on the basis of self-rated health were close to the recalculated results reported above, whereas for women the ‘worst-reported health’ scenario differed, with more weight on poor health, mainly because women contributed to a longer lifetime in an inestimable state, which tended to be redefined as ‘poor’.

The sensitivity test allayed our concern about the results. For instance, the percentage of lifetime in self-rated good health was 49 for men and 47 for women, 47% and 45%, respectively, in the ‘worst-reported health’ scenario and 45% and 44% in the recalculated results when it was assumed that the worst health state was in the last 6 months of life.

The commonest method for estimating lifetime in various health states is that of Sullivan [17], which is directly...
applicable when life tables and cross-sectional sex- and agespecific prevalences of health state are available. Obviously, longitudinal data would be preferable, and it was a strength of our study that we were able to estimate lifetime by health status at the individual level on the basis of the 1905 Danish cohort study.

The dramatically increasing proportion of very old people is a major challenge. Thus, according to population projections from Statistics Denmark, the number of nonagenarians is expected to be 10 times greater in 2050 than today for men and almost five times greater for women, although the total population will remain almost unchanged: 5.4 million in 2007 and 5.7 million in 2050. Demographers’ studies of mortality predictions have taught us, however, that population projections are generally too pessimistic with regard to declining mortality rates, and consequently the proportion of very old persons might be even higher [1].

Life expectancy in Denmark is still lower than that in the neighbouring countries, due to a long period of stagnation [18]. Although it did increase substantially during the recent decade, i.e. the period during which our 1905 cohort was followed, Denmark is not currently bridging the longevity gap, remaining 2–3 years below the best European values, including the very high life expectancy in the neighbouring country of Sweden. However, in the same period a recent Danish study of trends in health expectancy at age 65 reported substantial improvements in the expected lifetime without functional limitations and in self-rated good health [8]. This optimistic finding confirms the results from several recent studies of adults and younger elderly people, although it seems that improvements might depend on age group, period, gender, social and educational levels, and the choice and levels of health indicators [4–7], e.g. the recent health trends in Sweden do not appear to be so positive for several health indicators. It may therefore be suggested that the recent positive health trends in Denmark are merely the consequences of the past period of stagnation. But they may also be the result of financial support to health care, long-term care and home services for the elderly, which in the 1990s increased substantially in Denmark after a long period of restraints. Whatever explains the improvement in life expectancy and health expectancy at age 65 in the past decade, it might be followed by a reduction in lifetime dependence among the oldest Danes in the future.

The conclusion of our study is that the average lifetime between ages 92 and 100 was ∼3 years, of which almost 75% was spent in a state of physical independence, almost 50% in self-rated good health and a little more than 33% in a state of physical independence without cognitive impairment. Thus, even these very old persons spend a substantial proportion of their remaining lifetime in reasonably good health.

**Key points**

- This study quantifies average lifetime in different health states among the oldest olds.
- The study is based on the Danish 1905 cohort survey comprising 2,258 participants.
- The average lifetime between ages 92 and 100 was ∼3 years, of which almost 50% was in self-rated good health, almost 75% in a state of physical independence and a little more than 33% in a state of physical independence without cognitive impairment.

**Conflicts of interest**

The authors declare that they have no conflict of interest in connection with the paper.

**Funding**

The study was funded by grants from the Danish Health Insurance Fund, the National Board of Social Services and a grant from the National Institute on Aging P01AG08761. The Danish Aging Research Center is supported by a grant from the VELUX foundation.

**References**

Differentials in mortality up to 20 years after baseline interview among older people in East London and Essex

ANN BOWLING1, EMILY GRUNDY2

1Department of Primary Care and Population Sciences, University College London, Hampstead Campus, London NW3 2PF, UK
2Centre for Population Studies, London School of Hygiene and Tropical Medicine, 49-51 Bedford Square, London WC1 3DP, UK

Address correspondence to: A. Bowling. Tel: (+44) 207 830 2239; Fax: (+44) 207 794 1224. Email: a.bowling@ucl.ac.uk

Abstract

Objective: to identify socio-psychological predictors of mortality during a 20-year follow-up period among people aged 65 to <85 and 85+ at baseline interview.

Study design and setting: elderly people living at home in East London and mid-Essex, who responded to surveys of successful survival in older age in the late 1980s; their mortality was traced through the National Health Central Registry.

Results: adjusted analyses show that, as expected, the hazard rate for mortality over a 20-year follow-up was reduced for younger respondents and increased for less functionally able respondents. The hazard ratio for males was almost one and a half times that of females. The hazard rate was also reduced with each categorical increase in life satisfaction and was consistently reduced for those who undertook crafts, social visiting and activities regularly. There was some variation by age and sex.

Conclusion: the results show that social participation is associated with lower risks of death, particularly among people aged 65 to <85, and that life satisfaction is also protective, particularly among females and people aged 85+, even when health status and socio-demographic circumstances are controlled. The study thus provides support for the hypothesised influence of social participation and subjective well-being on survival in older age.

Keywords: mortality, survival, ageing, life satisfaction, social participation, elderly

Background

Self-rated health is predictive of mortality [1–4], although the extent of the association varies by gender and between studies. Prospective studies have also shown that low levels of social ties and participation, and being unmarried are independently associated with increased mortality risk in