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ORIGINAL INVESTIGATION

Trends in health expectancy at age 65 for various health indicators, 1987–2005, Denmark

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Abstract Record life expectancy does not appear to be approaching its limit—it is still increasing, as is the maximum life span. An important question is whether the longer life is accompanied by an increasing lifetime in good health. The aim of the study was to determine the trends in health expectancy at age 65 in Denmark during the period 1987–2005, including the end of a period of stagnation (until 1995) and the beginning of a new period with increasing life expectancy (after 1994). The study was based on nationwide register data on mortality and data on health status from the Danish Health Interview Surveys carried out in 1987, 1994, 2000, and 2005. Expected lifetime in various health states was estimated with Sullivan's method. Life expectancy at age 65 increased only after 1994 by almost 2 years among men and by about 1 year among women. The increase in expected lifetime without long-standing, limiting illness, lifetime without functional limitations, and lifetime with self-rated good health was all substantial in both genders (1.4–3 years depending on gender and health indicator), and was followed by a decrease in lifetime with the unhealthy state resulting in increasing proportions of lifetime in a healthy state. Overall, expected lifetime in good health increased more than life expectancy in both genders during the second half of the period 1987–2005, i.e. after the stagnation period.

Keywords Denmark · Older people · Health expectancy · Life expectancy

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Introduction

Although rapid progress can be followed by slower rise or even stagnation as observed recently in Denmark (Jacobsen et al. 2002, 2004; Juel 2004), best practise or record life expectancy has increased linearly by 2–3 years per decade for more than a century, suggesting a regular stream of continuing progress in survival improvements (Oeppen and Vaupel 2002). Not only life expectancy, but also maximum life span is increasing (Vaupel et al. 1998; Jeune 2002). An important question is whether these improvements are followed by increasing lifetime in good health.

Health expectancy (HE) is a health indicator that extends measures of life expectancy (LE) to account for health states by combining information about mortality and health status. HE can be calculated by different methods of which Sullivan's method (Sullivan 1971) is the most used despite its limits (Barendregt et al. 1994; Mathers and Robine 1997). It is based on the combination of the observed prevalence of a selected health measure and a life table. There are many concepts of health states or health indicators (Robine et al. 1999; Deeg and Kriegsman 2003; Crimmins 2004; Freedmann and Martin 2006; Parker and Thorslund 2007) and, consequently, there are as many possible health expectancies. The most common are expected lifetime without chronic morbidity or impairments, expected

lifetime without functional limitations, expected lifetime without disability, and expected lifetime with self-rated good health.

Most studies have shown that increasing LE is accompanied by increasing lifetime in good health which is higher for women than for men, higher for individuals with more education or income than for those with less education and income, and that the socioeconomic differences are higher for HE than for LE (Davis et al. 1999; Cambois et al. 2001; Mathers et al. 2001, 2004; Brønnum-Hansen et al. 2004; Crimmins and Saito 2001; Crimmins 2004; Perenboom et al. 2005; Sagardi-Villamor et al. 2005; Robine 2006; Wood et al. 2006). However, the trends of HE seem to depend on the choice of health indicator and on which age, period, and cohort the health indicator is measured. Expected lifetime without severe disability seems to progress in parallel with total LE in many countries while lifetime without moderate disabilities and expected lifetime without chronic disease seem to remain constant. Furthermore, it seems that social inequalities in health expectancy still persist or even increase (Brønnum-Hansen and Baadsgaard 2008).

Although LE in Denmark has increased after a period of stagnation, it is still relatively low compared with other OECD-countries—in 2006 it was 80.5 years for women and 75.9 years for men, i.e. 2–3 years lower than in Sweden (82.9 for women and 78.7 for men). LE in Denmark at birth and at age 65 stagnated or increased very slowly for men from 1955 to 1995 and almost stagnated for women between 1977 and 1995 (Brønnum-Hansen 2005). This Danish mortality experience with a long stagnation period led to a longevity gap between Denmark and the other low mortality European countries. However, since 1995 LE at birth and at age 65 strongly increased for both genders. But Denmark did not reduce the gaps with the best life expectancies observed in Europe very much. The longevity gap of LE at age 65 compared to Sweden was only reduced modestly in the period 1995–2005 (from 1.9 to 1.4 among men and from 1.9 to 1.6 among women).

The almost 20-year-period of stagnation in Danish LE for women has recently been shown to be caused mainly by a lack of decline in mortality among middle-aged women born in the 1920s and 1930s (Jacobsen et al. 2002, 2004), but a good explanation for the much longer 40-year-period with a very slow increase of LE for men is lacking. Interestingly, the mortality among the oldest-old continued to decline during the stagnation period (Vaupel and Jeune 1995; Jacobsen et al. 2001), especially among oldest-old women while the progress for men has been modest resulting in a change of sex-ratio for centenarians from 2 to 5. Contrary to the influence of cohort effects on mortality among middle-age women, cohort effects played a minor role compared to period effects on this increased difference in mortality for oldest-old women and men (Jacobsen et al. 2008).

It is therefore interesting to follow the trend of HE at age 65 in Denmark in the end of the period of stagnation and in the beginning of a probably new period with increasing LE, and especially to examine whether the increasing LE is followed by an increase in lifetime in good health. This is possible because the Danish Health Interview Surveys have been carried out since 1987, and as the last one was carried out in 2005 we have an almost 20-year period including the end of the stagnation period and the beginning a new period with increasing LE.

The aim of this study is to determine the trends in health expectancy for various health indicators among 65-year-old Danes during the period 1987–2005.

Methods

In the Danish Health Interview Surveys, random samples of Danes aged 16 or more (including people living in institutions) were interviewed. The surveys were carried out in 1987, 1994, 2000, and 2005. Professionals from the Danish National Institute of Social Research visited and interviewed 864 individuals aged 65 or more in 1987, 827 in 1994, 3,015 in 2000, and 3,012 in 2005. The participation rates declined moderately during the period: 76.5, 68.5, 70.2 and 63.9%, respectively.

Long-standing illness was measured by answers to the question 'Do you suffer from any long-standing illness, long-standing after-effect of injury, any handicaps, or other long-standing condition?' Whenever long-standing illness was reported, its nature was clarified by means of an open question. The answers to this question were subsequently coded according to the World Health Organisation's International Classification of Diseases and classified into 14 disease groups of which musculoskeletal disease, diseases of the circulatory system, diseases of the respiratory system and diseases of the nervous system or sense organs were reported most frequently. About 96% of the diseases were reported to have been diagnosed by a physician.

Regretfully, the interview questionnaire did not include any questions about activities of daily living (ADL), and therefore did not assess self-reported disability. But in the 1994, 2000, and 2005 surveys interviewees who reported long-standing illness were asked if the disease implied restrictions to daily life or at work. Long-standing illness was considered to be limiting if it was stated to cause daily restrictions. As most disabilities are caused by chronic diseases, *long-standing*, *limiting illness* may be considered as a measure of self-reported disability, although it can lead to an underestimation as it does not include disability

caused by 'old age' without the presence of a diagnosed disease (Wolf et al. 2005).

Self-reported functional limitations were assessed in two domains—mobility and communication. A person was considered to have *mobility limitations* if he/she could do one or more of the following activities only with difficulty or not at all:

- walk 400 m without resting,
- walk up or down a staircase from one floor to another without resting,
- carry 5 kg.

A person was considered to have *communication limitations* if he/she could do one or more of the following, only with difficulty or not at all:

- read ordinary newspaper print,
- hear what is being said in a normal conversation between three or more persons, or
- speak with minor or major difficulty (assessed by the interviewer).

Self-rated health was measured by answers to the question: 'How do you rate your present state of health in general?' The five original response categories (very good, good, fair, poor, and very poor) were dichotomised into 'good', and 'fair or poor'.

Standard life tables from Statistics Denmark for 1986–1987, 1993–1994, 1999–2000, and 2004–2005 were used to calculate health expectancy by Sullivan's method for each period. Thus, expected numbers of years lived in age groups of 5 years were multiplied by age-specific proportions of people in a specific state of health, and expected lifetime in that state from age 65 was then calculated by adding up these years and dividing the sum by the number of survivors at age 65. By relating years in good health to life expectancy, a measure of the proportion of lifetime in good health was established. The only source of random variation was assumed to arise from the health interview surveys, and confidence intervals were estimated from the formulae suggested by the International Network on Health Expectancy (Jagger et al. 2001).

Results

During the period 1987–2005 life expectancy at the age of 65 did not increase until 1994, in contrast to an increase in the second half of the observed period by almost 2 years among men and by about 1 year among women in 2005 (Table 1). Thus the gender gap was reduced from 3.8 years in 1987 to 3.0 years in 2005.

The expected lifetime without long-standing illness did not change until 2000, but increased significantly from 2000 to 2005—by 1.4 years in both genders while the expected lifetime with long-standing illness remained unchanged in both genders during the whole period. This led to an almost unchanged proportion of expected lifetime without longstanding illness until the end of the period where it was still below 50% in both genders but slightly higher among men than among women.

However, expected lifetime without long-standing, *limiting* illness increased more than life expectancy in the period 1994–2005—by 2.6 and 2.9 years among men and women, respectively, and expected lifetime with long-standing, limiting illness decreased by 0.8 and 1.5 years among men and women, respectively (Table 2). These improvements resulted in a substantial increase in the proportion of expected lifetime without long-standing, limiting illness—from 56.2 to 66.0% among men, and from 46.6 to 58.4% among women. Although the gap was

Table 1 Life expectancy, expected lifetime with and without *long-standing illness* and proportion of expected lifetime without long-standing illness at age 65 in Denmark in 1987, 1994, 2000, and 2005

Calendar year	Life expectancy	Expected lifetime without long-standing illness		Expected lifetime with long-standing illness		Proportion of expected lifetime without long-standing illness	
	Years	Years	95% CI	Years	95% CI	%	95% CI
Men							
1987	14.1	6.5	5.8–7.2	7.6	6.9–8.3	46.3	41.3–51.3
1994	14.1	6.8	6.0–7.5	7.4	6.7–8.1	47.8	42.7–52.9
2000	15.0	6.4	6.0–6.8	8.7	8.3–9.1	42.4	39.8–45.0
2005	16.0	7.8	7.4–8.2	8.2	7.7–8.6	48.9	46.2–51.5
Women							
1987	17.9	7.8	7.0–8.6	10.1	9.3–10.9	43.7	39.2–48.1
1994	17.6	6.5	5.7–7.3	11.1	10.3–11.9	36.8	32.4–41.3
2000	18.1	7.0	6.6–7.5	11.1	10.6–11.5	38.9	36.5–41.2
2005	19.0	8.4	7.9–8.9	10.5	10.1–11.0	44.4	41.9–46.8

Table 2 Life expectancy, expected lifetime with and without *long-standing, limiting illness* and proportion of expected lifetime without long-standing, limiting illness at age 65 in Denmark in 1994, 2000, and 2005

Calendar year	Life expectancy	Expected lifetime without long-standing, limiting illness		Expected lifetime with long-standing, limiting illness		Proportion of expected lifetime without long-standing, limiting illness	
	Years	Years	95% CI	Years	95% CI	%	95% CI
Men							
1994	14.1	7.9	7.2–8.7	6.2	5.5–6.9	56.2	51.2–61.3
2000	15.0	8.9	8.5–9.3	6.1	5.8–6.5	59.1	56.5–61.7
2005	16.0	10.5	10.1–10.9	5.4	5.0–5.8	66.0	63.5–68.5
Women							
1994	17.6	8.2	7.4–9.0	9.4	8.6–10.2	46.6	42.0–51.1
2000	18.1	9.5	9.0–9.9	8.6	8.2–9.1	52.3	49.9–54.7
2005	19.0	11.1	10.6–11.5	7.9	7.4–8.3	58.4	56.0–60.9

Table 3 Life expectancy, expected lifetime with and without *mobility limitations* and proportion of expected lifetime without mobility restrictions at age 65 in Denmark in 1987, 1994, 2000, and 2005

Calendar year	Life expectancy	Expected lifetime without mobility restrictions		Expected lifetime with mobility restrictions		Proportion of expected lifetime without mobility restrictions	
	Years	Years	95% CI	Years	95% CI	%	95% CI
Men							
1987	14.1	10.2	9.6–10.8	3.9	3.2–4.5	72.6	68.3–77.0
1994	14.1	10.7	10.1–11.4	3.4	2.8–4.0	75.9	71.7–80.2
2000	15.0	12.4	12.1–12.7	2.6	2.4–2.9	82.4	80.4–84.4
2005	16.0	13.3	12.9–13.6	2.7	2.4–3.0	83.0	80.9–85.0
Women							
1987	17.9	11.0	10.2–11.7	7.0	6.2–7.7	61.1	56.8–65.3
1994	17.6	10.5	9.8–11.3	7.1	6.3–7.9	59.8	55.5–64.2
2000	18.1	11.9	11.5–12.3	6.2	5.8–6.6	65.6	63.4–67.7
2005	19.0	13.1	12.7–13.5	5.8	5.4–6.3	69.2	67.0–71.4

reduced slightly, this proportion was still higher among men than among women in 2005.

The increase of expected lifetime without mobility limitations was also substantial (Table 3), especially during the second half of the observed period, and higher for men than for women—it increased by about 3 years among men and by about 2 years among women, resulting in the same life expectancy without mobility limitations in both genders in 2005. The expected lifetime with mobility limitations decreased by 1.2 years in both genders, resulting in the same gender gap of 3 years. The proportion of expected lifetime without mobility limitations therefore increased more among men than among women resulting in an even higher proportion among men than among women in 2005 (83.0 vs. 69.2%).

The increase of expected lifetime without communication limitations was smaller than that without mobility limitations: 1.9 years for men and 1.4 years for women (Table 4), and the expected lifetime with communication limitations remained approximately the same during the period both among men and women. Therefore, the increase in the proportion of expected lifetime without communication limitations was moderate, and about the same among men and women (about 85%).

The expected lifetime in self-rated good health increased substantially—from 8.2 to 11.0 years among men, and from 9.3 to 12.1 years among women, i.e. with almost 3 years in both genders, while the gender gap remained at 1.1 years (Table 5). In the same time period expected lifetime in self-rated 'fair or poor' health decreased by almost 1 year for men and by almost 2 years for women, resulting in a substantial increase in the proportion of expected lifetime with self-rated good health. In spite of the better improvement among women, this

Table 4 Life expectancy, expected lifetime with and without *communication limitations* and proportion of expected lifetime without communication restrictions at age 65 in Denmark in 1987, 1994, 2000, and 2005

Calendar year	Life expectancy	Expected lifetime without communication restrictions		Expected lifetime with communication restrictions		Proportion of expected lifetime without communication restrictions	
	Years	Years	95% CI	Years	95% CI	%	95% CI
Men							
1987	14.1	11.8	11.2–12.3	2.3	1.8–2.8	83.6	80.0–87.3
1994	14.1	12.7	12.2–13.1	1.5	1.0–1.9	89.6	86.5–92.7
2000	15.0	12.9	12.6–13.2	2.2	1.9–2.4	85.7	83.9–87.5
2005	16.0	13.7	13.4–14.0	2.3	2.0–2.6	85.5	83.6–87.4
Women							
1987	17.9	14.9	14.3–15.5	3.0	2.4–3.6	83.1	79.8–86.4
1994	17.6	14.9	14.3–15.5	2.8	2.2–3.3	84.3	81.1–87.6
2000	18.1	15.3	15.0–15.6	2.8	2.5–3.1	84.3	82.7–86.0
2005	19.0	16.3	15.9–16.6	2.7	2.4–3.0	85.8	84.1–87.6

Table 5 Life expectancy, expected lifetime in *self-rated good, fair or poor health* and proportion of expected lifetime in self-rated good health at age 65 in Denmark in 1987, 1994, 2000, and 2005

Calendar year	Life expectancy	Expected lifetime in self-rated good health		Expected lifetime in self-rated fair or poor health		Proportion of expected lifetime in self-rated good health	
	Years	Years	95% CI	Years	95% CI	%	95% CI
Men							
1987	14.1	8.2	7.5–8.9	5.9	5.2–6.6	58.2	53.2–63.1
1994	14.1	9.1	8.4–9.8	5.0	4.3–5.7	64.4	59.5–69.3
2000	15.0	9.7	9.3–10.1	5.4	5.0–5.7	64.3	61.8–66.8
2005	16.0	11.0	10.6–11.4	5.0	4.6–5.4	68.6	66.1–71.1
Women							
1987	17.9	9.3	8.4–10.1	8.6	7.8–9.5	51.7	47.2–56.2
1994	17.6	9.4	8.6–10.2	8.2	7.4–9.0	53.5	48.9–58.0
2000	18.1	10.3	9.8–10.7	7.9	7.4–8.3	56.6	54.2–59.0
2005	19.0	12.1	11.7–12.6	6.8	6.4–7.3	64.0	61.7–66.4

proportion was still lower among women than among men in 2005 (64.0 vs. 68.6%).

Discussion

The number of life years expected to be spent in a healthy state increased as much as or more than LE in both genders during the period 1987–2005. Except for expected lifetime with long-standing illness, for all other health indicators this was followed by a decrease in lifetime expected to be spent in an unhealthy state resulting in increasing proportions of healthy lifetime to more than 50% in 2005. Except for mobility limitations, for all other health indicators lifetime in good health was higher for women than for men both in the beginning and in the end of the observed period, but the improvements of expected lifetime in good health during the observed period were higher for men than for women (except for self-rated good health), and the proportions of healthy lifetime were higher for men than for women (except for communication limitations).

A strength of this study is the almost 20-year-long observation period (1987–2005) with four cross-sectional, nationally representative samples of which the two latest samples included more than 3,000 older Danes. Furthermore, the same trained interviewees from the Danish National Institute of Social Research carried out the interviews, and the same questions were used to assess the different health indicators. A shortcoming of this study is the non-response rates in the health surveys: Danish studies

have shown that individuals in poor health are more likely to be non-responders (Osler and Schroll 1992; Vestbo and Rasmussen 1992). This bias would tend to overestimate expected healthy lifetime. Because the response rate declined moderately during the period, the improvement in health expectancy may be slightly less distinct than found in this study.

Some caution is needed when interpreting secular trends in health expectancy estimated by Sullivan's method, as this method is not suitable for detecting sudden changes in populations (Barendregt et al. 1994). Health prevalence data from cross-sectional surveys only implicitly reflect past transitions between state of health and changes in mortality rates. Thus, population health changes may bias the Sullivan health expectancy estimates because of time lags in these changes. Although LE in Denmark was almost constant during the stagnation period, i.e. the period of the first two cross-sectional samples (1987 and 1994), it increased during the following 10 years including the last two cross-sectional samples (2000 and 2005) by almost 2 years for men and more than 1 year for women. However, the conclusion of a study that compared health expectancy trends estimated by Sullivan's method and the multistate life table method, including scenarios assuming declining mortality rates and various changes in disability incidence and recovery, was that Sullivan's method is generally acceptable for monitoring relatively smooth long-term health expectancies (Mathers and Robine 1997).

Already in our previous study (Brønnum-Hansen 2005), which ended in year 2000, we found that the improvement of expected lifetime in good health among older Danes first appeared after the stagnation period when the life expectancy began to increase again. In the present study which ended in 2005 this improvement is clearly confirmed as it shows that during the second half of the observed period, i.e. the post-stagnation period, the increase in healthy lifetime for most of the included health indicators is higher than the increase in LE. This important and optimistic finding confirms the results from several recent studies (Mathers et al. 2001; Crimmins 2004; Sagardi-Villamor et al. 2005; Robine 2006).

As stressed by others (Crimmins 2004; Perenboom et al. 2005; Parker and Thorslund 2007), expected lifetime with morbidity did not improve, indicating that advancement in medical care may result in better survival *with* chronic diseases, although these chronic diseases seem less disabling than earlier, probably because they are less severe and/or better treated. The results from this study suggest that factors which increase survival also have a positive influence on disabilities, functional limitations and self-rated health.

However, in explaining the results it has to be taken into consideration that Denmark is not currently bridging the longevity gap, remaining 2–3 years below the best European values, including the very high LE in the neighbouring country Sweden. But the recent health trends in Sweden do not appear to be so positive for several health indicators (Parker and Thorslund 2007; Parker et al. 2008). It may therefore be suggested that the recent optimistic health trends in Denmark are merely the consequences of the past stagnation period. But it may also be a result of different financial support to health care, long-term care, and home services for older people, which in the 1990s increased substantially in Denmark (after a long period with restraints) but was restrained in Sweden. Such an explanation is, however, pure speculation as we have no evidence supporting it.

In conclusion, during the post-stagnation period, i.e. since 1995, Denmark experiences a strong increase in life expectancy at age 65, a proportional increase in expected lifetime without long-standing illness, and a much stronger increase in expected lifetime without long-standing, limiting illness, expected lifetime without mobility limitations and expected lifetime in self-rated good health.

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