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Health Monitoring

Health expectancy in Denmark, 1987–2000

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Background: While life expectancy quantifies average length of life, health expectancy represents the average lifetime in different health states and offers the possibility to evaluate quality of life with respect to health. The purpose of the study was to estimate changes in health expectancy in Denmark from 1987 to 2000 and to assess theories about the relation between increased total lifetime and lifetime in various health states. **Methods:** Data on health status derived from the Danish Health Interview Surveys carried out in 1987, 1991, 1994 and 2000 were combined with life-table data. Expected lifetime in selfrated good health, life expectancy without longstanding illness and disabilityfree life expectancy were estimated by Sullivan's method. **Results:** In 1987, the life expectancy of a 65-year-old man was 14.1 years, 8.9 years of which were expected to be disabilityfree. In 2000, life expectancy had increased to 15.0 years, 11.3 years of which were disabilityfree. Thus, life expectancy had increased by 0.9 years, whereas disabilityfree life expectancy had increased by 2.4 years. Among 65-year-old women, life expectancy had increased by 0.2 years and disabilityfree life expectancy by 1.1 years. Expected lifetime in selfrated good health had also improved, but the trend in life expectancy without longstanding illness went in the opposite direction, and expected lifetime with longstanding illness had increased. **Conclusion:** The recent rise in life expectancy in Denmark after many years of stagnation appears to be accompanied by generally improved health status among the elderly, but health expectancy trends depend on the health indicator chosen.

Keypoints

- Health expectancy expresses average lifetime in various states of health.
- The study examines changes in expected lifetime in selfrated good health, lifetime without longstanding illness and lifetime without longterm disability.
- Among 65-year-olds the percentage of disabilityfree life expectancy increased from 63.4% to 74.9% for men and from 55.6% to 61.0% for women between 1987 and 2000.
- Health status among elderly Danes has apparently improved, but secular trends in health expectancy depend on the choice of health indicator.

Keywords: Denmark, health expectancy, life expectancy

An earlier Danish study of trends in health expectancy, i.e. average lifetime in various states of health, concluded that expected lifetime in selfrated good health among men and longterm disabilityfree life expectancy among elderly men improved between 1987 and 1994, whereas no improvement was seen among women.[1] But life expectancy without longstanding illness did not improve for men, and the expected lifetime of women with longstanding illness even increased.[1] In Denmark, life expectancy has not changed much since the 1970s,[2] and, in fact, the life expectancy of Danish men has stagnated since the 1950s. At the end of the century, however, life expectancy began to increase (figure 1). This new development may also be reflected in health expectancy. But longer life and improved health do not necessarily go together. Life-prolonging treatment of fatal or chronic diseases increases life expectancy but can hardly be said to increase expected lifetime in good health at the population level unless the incidence of the diseases declines. Improved population health also does not necessarily extend life expectancy, but postponement of the onset of chronic disease prolongs lifetime in good health. Three main theories about the relationship between increasing life expectancy and expected lifetime without chronic diseases or disability have been discussed since the 1980s. The claim that postponement of death aggravates chronic diseases is called the 'pandemic of mental disorders, chronic diseases and disabilities'[3] or the 'expansion of morbidity hypothesis'.[4] The opposite view is the hypothesis of 'compression of morbidity', arguing that length of life has an upper limit but onset of chronic diseases is delayed. Therefore lifetime with morbidity is compressed into a shorter period.[5] The third assertion is that of 'dynamic equilibrium' according to which mortality declines and prevalence of chronic diseases increases. But the diseases will generally be less severe.[6] Thus, longer life may involve more healthy years as well as more unhealthy years, and besides examining the absolute lifetime in different states of health the theories can be described by relating healthy lifetime to life expectancy, as we would expect this proportion to decline (expansion), increase (compression) or change depending on severity of diseases (equilibrium). Robine *et al.* discussed the theories in the light of the development of disabilityfree life expectancy in six countries[7] and the conclusion tends to support the theory of dynamic equilibrium.

The present study updates the previous paper on trends in health expectancy in Denmark[1] and comprises data from four health interview surveys. It specifically examines whether the development supports the hypothesis of expansion, compression or equilibrium.

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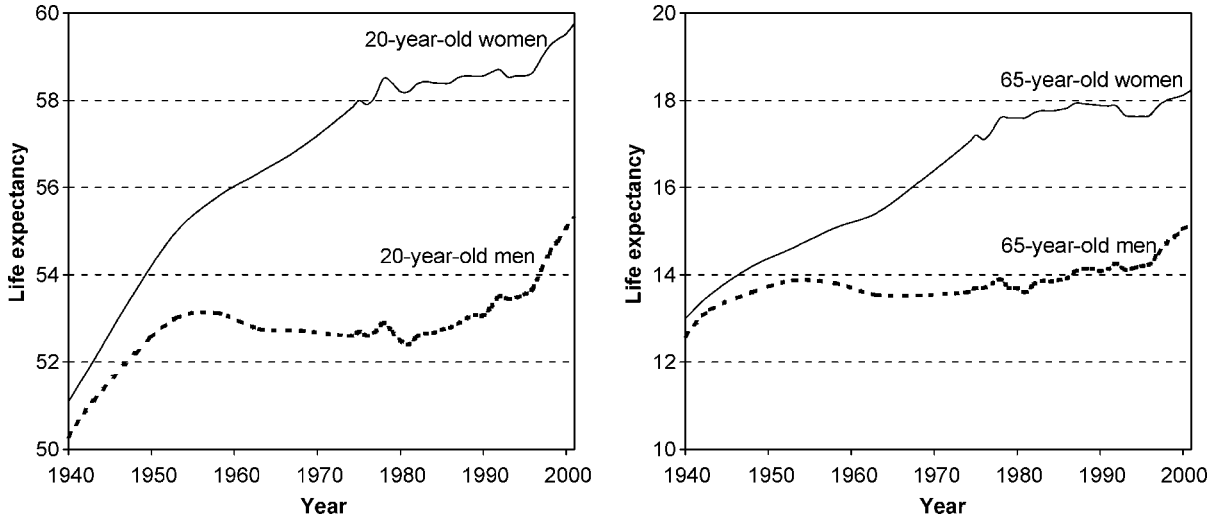

Figure 1 Life expectancy at age 20 and 65 in Denmark, 1940–2001 (Source: Statistics Denmark. Statistical yearbooks since 1943)

Methods

In the Danish Health Interview Surveys, random samples of Danes (including people living in institutions) whose personal details were extracted from the Danish Civil Registration System were interviewed. The samples of 1987, 1991 and 1994 comprised approximately 6000 individuals aged 16 or more; the 2000 sample comprised almost 22,500 Danes and was stratified to ensure sufficient data for each county of Denmark. In order to eliminate seasonal variation, the interviews were conducted in three rounds, in February, May and September. Professionals from the Danish National Institute of Social Research carried out the interviews, and these were obtained for 78–81% of the samples in 1987, 1991 and 1994 and for 74% of the 2000 sample. In the first three surveys, the non-response rate was almost the same for men and women, but it increased with age and was highest among single people and in the metropolitan area.[8–10] The rate of non-response in the 2000 survey was low among married men and widowers and highest among elderly women and people living in the metropolitan area.[11]

The questions in the four health surveys that are relevant for this study were identical. Selfrated 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 dichotomized into 'good' and 'fair or poor'. Longstanding illness was measured by answers to the question 'Do you suffer from any longstanding illness, longstanding aftereffect of injury, any disability, or other longstanding condition?' Whenever longstanding 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.[11] About 96% of the diseases were reported to have been diagnosed by a physician.[11]

Questions about longterm disability were included only in the 1987, 1994 and 2000 surveys and were posed only to persons aged 60 years or more. A person was considered to be disabled if he/she could do one or more of the following, 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,
- 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).

Standard life tables from Statistics Denmark for 1986–1987, 1990–1991, 1993–1994 and 1999–2000 were used to calculate health expectancy by Sullivan's method:[12] for each period the expected numbers of years lived in age groups of five years were multiplied by age-specific proportions of healthy people taken from the health survey data. Health expectancy from a given age was then calculated by adding up these years and dividing the sum by the number of survivors at that age. By relating health expectancy to life expectancy, a measure of the proportion of lifetime in good health was established. For the 2000 survey, the variances of the proportions of health status were estimated with weights to compensate for the stratification in the health survey sample. The only source of randomness was assumed to arise from the health survey proportions, and confidence intervals were estimated from the formulae suggested by the International Network on Health Expectancy.[13]

Results

Table 1 shows life expectancy, expected lifetime in selfrated good, fair or poor health and the proportion of expected lifetime in selfrated good health for 20- and 65-year-old men and women in 1987, 1991, 1994 and 2000. From 1987 to 2000, the life expectancy of 20-year-olds increased by 2.2 years for men and 1.0 year for women. For men, this increase corresponded mainly to expected lifetime in selfrated good health (2.1 years) and was most pronounced among elderly men. Thus, for 65-year-old men, expected lifetime in selfrated good health increased by 1.5 years (table 1). Also for women a trend towards more years in selfrated good health and fewer years in fair or poor health among 65-year-olds was seen (table 1).

Expected lifetime without longstanding illness decreased and expected lifetime with longstanding illness increased for 20-year-old men and women (table 2). The changes were statistically significant and were due partly to increased prevalence of musculoskeletal disease and diseases of the circulatory system and the respiratory system. Lifetimes expected to be spent with the four most common diseases are shown in table 3. In general, the expected lifetime with these diseases did not change noticeably for 65-year-olds,

Table 1 Life expectancy, expected lifetime in selfrated good, fair or poor health and proportion of expected lifetime in selfrated good health at age 20 and 65 in Denmark in 1987, 1991, 1994 and 2000

Calendar year	Life expectancy (years)	Expected lifetime in selfrated good health		Expected lifetime in selfrated fair or poor health		Proportion of expected lifetime in selfrated good health	
		Years	95% CI	Years	95% CI	%	95% CI
20-year-old men							
1987	52.9	40.9	40.0; 41.9	12.0	11.0; 12.9	77.4	75.6; 79.1
1991	53.3	42.5	41.6; 43.4	10.7	9.8; 11.6	79.8	78.1; 81.5
1994	53.4	43.1	42.2; 44.0	10.3	9.4; 11.2	80.7	79.0; 82.4
2000	55.1	43.0	42.5; 43.5	12.1	11.6; 12.6	78.1	77.2; 79.0
65-year-old men							
1987	14.1	8.2	7.5; 8.9	5.9	5.2; 6.6	58.2	53.2; 63.1
1991	14.1	8.5	7.8; 9.2	5.7	5.0; 6.4	59.9	54.9; 64.9
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
20-year-old women							
1987	58.5	42.4	41.3; 43.4	16.1	15.1; 17.2	72.5	70.6; 74.3
1991	58.6	44.0	43.0; 45.0	14.6	13.6; 15.6	75.1	73.4; 76.8
1994	58.5	42.3	41.3; 43.4	16.1	15.1; 17.2	72.4	70.6; 74.2
2000	59.5	44.1	43.6; 44.7	15.4	14.8; 16.0	74.1	73.2; 75.1
65-year-old women							
1987	17.9	9.3	8.4; 10.1	8.6	7.8; 9.5	51.7	47.2; 56.2
1991	17.8	9.5	8.7; 10.3	8.3	7.5; 9.1	53.6	49.2; 58.0
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

Table 2 Life expectancy, expected lifetime with and without longstanding illness and proportion of expected lifetime without longstanding illness at age 20 and 65 in Denmark in 1987, 1991, 1994 and 2000

Calendar year	Life expectancy (years)	Expected lifetime without longstanding illness		Expected lifetime with longstanding illness		Proportion of expected lifetime without longstanding illness	
		Years	95% CI	Years	95% CI	%	95% CI
20-year-old men							
1987	52.9	34.8	33.7; 35.8	18.1	17.1; 19.2	65.8	63.8; 67.8
1991	53.3	33.0	31.9; 34.0	20.3	19.2; 21.4	61.9	59.8; 63.9
1994	53.4	33.5	32.4; 34.6	19.9	18.8; 21.0	62.7	60.6; 64.7
2000	55.1	31.9	31.3; 32.5	23.2	22.6; 23.8	57.9	56.8; 59.0
65-year-old men							
1987	14.1	6.6	5.9; 7.3	7.5	6.8; 8.2	46.7	41.7; 51.7
1991	14.1	6.4	5.7; 7.2	7.7	7.0; 8.4	45.6	40.6; 50.7
1994	14.1	6.7	6.0; 7.4	7.4	6.7; 8.1	47.5	42.4; 52.6
2000	15.0	6.4	6.0; 6.8	8.7	8.3; 9.0	42.4	39.8; 45.1
20-year-old women							
1987	58.5	36.8	35.6; 37.9	21.7	20.6; 22.9	62.8	60.9; 64.8
1991	58.6	35.0	33.9; 36.1	23.6	22.4; 24.7	59.8	57.8; 61.7
1994	58.5	32.8	31.7; 34.0	25.6	24.4; 26.8	56.2	54.2; 58.2
2000	59.5	33.4	32.7; 34.0	26.2	25.5; 26.8	56.0	55.0; 57.1

Table 2 (*continued*)

Calendar year	Life expectancy (years)	Expected lifetime without longstanding illness		Expected lifetime with longstanding illness		Proportion of expected lifetime without longstanding illness	
		Years	95% CI	Years	95% CI	%	95% CI
65-year-old women							
1987	17.9	7.8	7.0; 8.6	10.1	9.3; 10.9	43.8	39.3; 48.2
1991	17.8	7.2	6.4; 7.9	10.6	9.9; 11.4	40.2	35.9; 44.5
1994	17.6	6.5	5.7; 7.3	11.1	10.3; 11.9	36.9	32.4; 41.3
2000	18.1	7.1	6.6; 7.5	11.1	10.6; 11.5	39.0	36.6; 41.3

except for a statistically significant increase in diseases of the circulatory system among men.

Table 4 shows a definite increase in longterm disabilityfree life expectancy. For 65-year-old men, life expectancy increased from 14.1 years to 15.0 years, whereas longterm disabilityfree life expectancy increased from 8.9 years to 11.3 years. Thus, the proportion of expected years lived free from disability increased from 63.4% to 74.9%. An insignificant increase in life expectancy was seen for 65-year-old women (from 17.9 years to 18.1 years), but disabilityfree life expectancy increased from 9.9 years to 11.0 years, corresponding to an increase from 55.6% to 61.0% in the proportion of disabilityfree life expectancy.

Discussion

The previous Danish study of trends in health expectancy covered the period 1987–1994 during which life expectancy almost stagnated.[1] Since then life expectancy has increased (figure 1) and in the present study data for 2000 were added and made it possible to evaluate how prolonged life influences quality of life with respect to health. For expected lifetime without disability the results were clear and demonstrated improved health among the elderly. Furthermore, the lengthening of life seems to be composed of years in selfrated good health, although young men could expect also more years in fair or poor health. It might appear paradoxical that expected

Table 3 Expected lifetime and proportion of expected lifetime with the four most common diseases at age 20 and 65 in Denmark in 1987, 1991, 1994 and 2000

Calendar year	Expected lifetime with diseases of the							
	Musculoskeletal System		Circulatory system		Respiratory system		Nervous system or sense organs	
	Years	%	Years	%	Years	%	Years	%
20-year-old men								
1987	7.0	13.2	3.0	5.6	2.7	5.0	2.4	4.5
1991	7.9	14.9	3.7	6.9	2.5	4.6	2.6	4.8
1994	7.5	14.0	3.7	6.9	3.2	5.9	2.5	4.7
2000	8.3	15.1	4.3	7.7	2.9	5.4	3.1	5.5
65-year-old men								
1987	2.9	20.5	1.8	12.9	1.3	9.5	1.0	6.8
1991	2.5	17.4	2.3	16.5	1.3	9.5	1.0	6.3
1994	2.1	15.1	2.7	19.0	1.2	8.7	0.9	6.2
2000	2.5	16.9	3.0	20.1	1.4	9.4	1.2	8.0
20-year-old women								
1987	9.5	16.2	4.1	7.1	2.2	3.7	3.5	6.0
1991	11.8	20.1	4.0	6.8	2.3	3.9	3.4	5.7
1994	11.3	19.4	4.6	7.9	3.2	5.5	3.8	6.6
2000	11.5	19.3	4.5	7.5	2.9	4.9	3.3	5.6
65-year-old women								
1987	4.9	27.2	2.8	15.8	0.8	4.6	1.7	9.3
1991	5.4	30.2	2.8	15.5	1.0	5.4	2.1	11.7
1994	4.9	27.9	3.3	18.7	1.4	8.2	2.0	11.6
2000	5.4	29.9	3.1	17.3	1.2	6.4	1.7	9.3

Table 4 Life expectancy, expected lifetime with and without longterm disability and proportion of expected lifetime without longterm disability at age 65 in Denmark in 1987, 1994 and 2000

Calendar year	Life expectancy (years)	Expected lifetime without longterm disability		Expected lifetime with longterm disability		Proportion of expected lifetime without longterm disability	
		Years	95% CI	Years	95% CI	%	95% CI
Men							
1987	14.1	8.9	8.3; 9.6	5.2	4.5; 5.8	63.4	58.7; 68.1
1994	14.1	10.0	9.4; 10.7	4.1	3.5; 4.8	70.8	66.3; 75.3
2000	15.0	11.3	10.9; 11.6	3.8	3.4; 4.1	74.9	72.7; 77.2
Women							
1987	17.9	9.9	9.2; 10.7	8.0	7.2; 8.7	55.6	51.3; 59.8
1994	17.6	9.7	9.0; 10.5	7.9	7.1; 8.6	55.4	51.0; 59.7
2000	18.1	11.0	10.7; 11.4	7.1	6.7; 7.5	61.0	58.8; 63.1

lifetime without longstanding illness decreased between 1987 and 2000. The increased prevalence of longstanding illness in almost all age groups since 1987[11] may to some extent reflect a change in the attitude towards illness, with a growing awareness of illness and a tendency to report small infirmities more often. Illness perceived to be disabling declined between 1994 and 2000, and disabling illness is strongly associated with self-reported poor health.[11] Thus, a trend towards a decrease in disabling longstanding illness may explain why the more specific measure of health problems at old age, longterm disability, is reported less frequently and why disabilityfree life expectancy and expected lifetime in selfrated good health has increased. Thus, the paradox may reflect a decrease of severe diseases but an increase of less severe diseases, and support the theory of 'dynamic equilibrium'. In the Danish health surveys the interviewees were asked questions about limitations in mobility and communication but not about other longterm limitations in major activities of daily living. Thus, as the functional limitations measured in this study reflect less severe disabilities, the improvement in disabilityfree life expectancy may even indicate 'compression of morbidity'. A similar phenomenon has been observed in other countries. In France, for instance, disabilityfree life expectancy increased during the 1980s although the most prevailing chronic diseases among the elderly increased.[14]

As the health indicators are based on the same questions asked in all health interview surveys, trends in population health could be evaluated. However, some caution must be exercised when interpreting secular trends in health expectancy estimated by Sullivan's method, as this method is not suitable for detecting sudden changes in population health.[15,16] Health prevalence data derived 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 life expectancy was almost constant until recently, age-specific mortality rates may have changed. The mortality rates of Danes under 35 and of Danes over 70 have declined since the 1970s, whereas those of 35–70-year-olds have changed only little. The modest changes in mortality can hardly bias the Sullivan health expectancy trends seriously.

A shortcoming of this study is the non-response rates in the health surveys. There is some inconsistency in the health status of responders and non-responders, but most studies show that individuals in poor health are more likely to be non-responders.[17–19] This bias would tend to overestimate health expectancy. Because the response rate declined slightly during the period, the improvement in expected lifetime in selfrated good health and disabilityfree life expectancy may be less distinct, whereas the decrease in expected lifetime without longstanding illness may be more marked.

Selfrated health is a widespread health indicator and is frequently used in health expectancy calculations in many countries. But comparisons between heterogeneous populations of selfrated health should be made with caution.[20,21] Also international comparisons of population health by other indicators should be made cautiously, as health status indicators vary according to the health survey questions asked, the answer categories and the formulation of answers. Although ongoing efforts to harmonise selfreported health measurements will improve comparability between countries, comparisons will remain difficult because of cultural differences.[20–22] It seems more difficult to make international comparisons of the absolute number of years in various states of health than to compare directions of time trends between countries. But still, time trends depend on the health expectancy indicator. For instance trends in life expectancy without severe disability improved in Australia, Canada, France and the USA for men, whereas trends in life expectancy without disability at all levels of severity combined went in different directions.[7] Furthermore, trends may differ between subpopulations within a country.[23,24]

Although trends depend on the health indicator chosen, the study predominantly indicates that health expectancy among Danes improved at the end of the century, particularly among the elderly. Thus, the results support the theories of compression or dynamic equilibrium rather than the hypothesis of expansion of morbidity.

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