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The Rise in Life Expectancy, Health Trends among the Elderly, and the Demand for Health and Social Care

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Abstract

The objective of this report is to review the evidence on (a) ageing and health and (b) the demand for health and social care among the elderly. The issues discussed are: does health status of the elderly improve over time, and how do the trends in health status of the elderly affect the demand for health and social care? The review is based on some 100 published scientific papers. While it is not a complete review, it covers most recent empirical studies of health trends and the changing pattern of demand for health and social care.

Health is a multidimensional concept. It includes self-assessed health, presence of disease, functional status, and disability, usually expressed as capacity to perform activities of daily living (ADL). There are certainly elderly who have no problems in any of these dimensions. But health among elderly varies, and to a much larger extent than among younger people. Many elderly have one or more chronic diseases; if the disease is well controlled, there may be no problems in other dimensions of health. If not, other health problems may follow, lowering self-assessed health, creating ADL limitations etc. When analyzing health trends, it is important to cover all four dimensions of health, since the impact on health care and social care differ, depending on which dimension shows improved health.

The reviewed literature provides strong evidence that the prevalence of chronic disease among the elderly has increased over time. There is also fairly strong evidence that the consequences of disease have become less problematic due to medical progress: decreased mortality risk, milder and slower development over time, making the time with disease (and health care treatment) longer but less troublesome than before. Evidence also suggests the postponement of functional limitations and disability. Some of the reduction in disability may certainly be attributed to improvements in treatments of chronic diseases. But they are apparently also due to the increased use of assistive technology, public transport, accessibility of buildings, etc. The results, hence, indicate that the ageing individual is expected to need health care for a longer (and not necessarily postponed) period of time than previous generations but elderly care for a shorter (and certainly postponed) period of time. Thus, one might say that the development overall has been in accordance with the "dynamic equilibrium" scenario.

A general conclusion of the empirical literature seems to be that expenditures will not be lower over remaining life years but they will be distributed over a longer period of time. Several authors warn against the potential negative impact of an increasing prevalence of obesity on life expectancy, health, and health and social care. The role of technological advances within medicine is highlighted by many authors and its consequences for the elderly analyzed.

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1 Introduction

Life expectancy increases, and the elderly is the fastest growing age group in the population. This is good news, but it also provides a number of challenges to society, not least regarding health care and social care. The question arises whether or not health of the elderly will be improved as life expectancy increases and counteract a rising need for health and social care, or will the elderly in average experience a longer time than before in ill-health, with chronic disease, and with lower capacity to carry on activities of daily life. These issues have received much theoretical and empirical attention ever since the publication of a keynote address, held before the annual meeting of the American Public Health Association in Miami 1976 by Ernest Gruenberg; see Gruenberg (1977). In his speech, Gruenberg emphasized that medical research and new health technologies had been very successful in adding more years to life but less so when it comes to adding more health to these years. So, Gruenberg was later associated with a seemingly pessimistic view or hypothesis of ageing and health – a scenario in which the average period of morbidity during an individual's lifetime would expand.

Gruenberg's paper attracted various responses for and against his scenario of expanded morbidity. One of the most influential papers that came out of the discussion was written by James Fries (1980). He claimed that it was quite possible and more likely that the period of morbidity would be compressed rather than prolonged. Two assumptions were essential, though: a) that there is a biological limit to life expectancy and b) that individuals would be more conscious in their health behavior. These two assumptions were both questioned by George Manton (1982), who claimed that periods of ill-health might certainly be prolonged, when medical research and the use of new medical technology improves life expectancy, but that these periods might be spent in better health status, with less disability, and improved capacity to undertake activities of daily living (ADL).

This makes for three different scenarios or hypotheses regarding ageing and health. In the following, we will review the basic papers behind the scenarios. The main part, however, will report on empirical findings related to ageing, health, and health and social care. Doing so, we will emphasize that, while mortality is fairly easy to define, health is a multidimensional concept. One central aspect of health is the absence of disease; another one is quality of life and capacity to perform activities of daily living; a third one is hearing, vision and other physical and mental functions. There is no obvious one-to-one correlation between the aspects. So, different components might affect the demand for health care and social care differently, and the meaning of health in a specific environment needs to be defined or clarified.

2 Three scenarios or hypotheses on ageing and health

2.1 Expansion of morbidity

What gave rise to a somewhat pessimistic view on ageing and health was an analysis of 40 years of progress in health technology, lowering mortality rates but also extending periods of morbidity (Gruenberg, 1977). Medical research had succeeded to prolong life for a number of diseases but without finding how to cure them completely. Gruenberg mentions several examples of chronic diseases, i.e., diseases where the only alternative to stay ill is death: Down's syndrome, senile dementia, arteriosclerosis, hypertension, schizophrenia, diabetes, spina bifida, pernicious anemia, Huntington's chorea, and hemophiliacs. For each disease, Gruenberg reports on the medical progress achieved and how the prevalence has increased as a result. Being a physician and an epidemiologist, Gruenberg admits that he is disappointed, not because of the progress per se, of course, but because too little resources having been spent on developing preventive health technologies. This would require more research into the causes of chronic disease. By definition, a chronic disease cannot be cured, but it might be possible to prevent. Gruenberg ends his paper stating this recommendation: "For a period at least, health-saving must take precedence over life-saving. And we will not move forward in enhancing health until we make the prevention of nonfatal chronic illness our top research priority." (Gruenberg, 1977, p. 22)

One should observe that Gruenberg did not look upon the development of health technology in the past as given by nature without any possibilities to alter and give it a different direction in the future. Gruenberg himself did not participate in the discussion that followed in the scientific literature, especially after Fries' response (Fries, 1980). He made, though, an empirical contribution on health and the utilization of health services and the implications for setting Medicare payments to HMOs (Gruenberg, 1989). The arguments for the expansion of morbidity hypothesis were discussed at length by Olshansky et al. (1991).

2.2 Compression of morbidity

In the opinion of Fries (1980), increases in life expectancy would be followed by decreased periods of morbidity. His prognosis rests on two premises: a) that the length of life is fixed and b) that chronic disease can be postponed if people improve their life style – give up smoking, change their eating and physical exercise habits, and drink alcohol sensibly. More and more people of a birth cohort will survive until their "natural" time of death, producing a rectangularization of the survival curve (Comfort, 1964). According to Fries, the United States is already, i.e. in 1980 (sic!), approaching the biologically determined upper limit of life expectancy; Fries believes the maximum (and also "ideal") expected length of life at birth to be 85 years. During these circumstances, the following predictions can be made, according to Fries: 1) the number of very old people will not increase; 2) the average period of diminished physical vigor will decrease; 3) chronic disease will occupy a smaller proportion of the typical life span; and 4) the need for medical care later in life will decrease (Fries, 1980, p. 245).

One may consider the idea of a compressed period of morbidity as a possible scenario rather than as a strict scientific hypothesis about how ageing and health will develop as a matter of fact in the future. If there is no limit to what extent we can grow older still or if we do not bother to change our life styles into less risky ones, then there is no reason to believe that morbidity will account for a lesser share of life than before. Fries perceived that the same factors that were responsible for the decline in mortality would also account for increases in health and decreases in the incidence of chronic disease, so that chronic disease would be postponed and strike later in life (Fries, 1980, 2000, 2001, 2003). Strategies for improving health at old age should primarily be directed towards attempts to prevent chronic diseases (Fries and Crapo, 1981; Fries, 1989, 2002). In several publications, Fries and associates show what improved life styles might do for health of the elderly; see, for instance, Hubert et al. (2002). It should be observed, too, that the assumption of a biologically determined upper limit to life is quite central for the idea or scenario of compressed morbidity. There, Fries relies on biologists Shock (1960), Hayflick (1970), Upton (1977) and Keyfitz (1978).

It is interesting to note that Fries' hopes for the future partly coincide with Gruenberg's. Both emphasize preventive measures and preventive health technologies. Fries seems to put more trust on the willingness of individuals to live a healthy life, while Gruenberg wants to see a different direction of medical research. Both claim that mortality and chronic disease are not necessarily directly related to each other. They have certainly quite different opinions, however, on the potential for future increases in life expectancy.

2.3 Dynamic equilibrium

Manton (1982) is critical to the hypothesis that there are biological limits to life and presents theoretical, experimental and empirical arguments at length to refute it. The proportion surviving to the most advanced ages has increased nearly 2½ times as fast as at younger ages. Moreover, even though there are signs that an irreducible mortality rate is approaching at earlier ages, no such indications at age 85 have been observed. He also questions the willingness by which individuals would give up present life styles to start new and healthier lives. Fries (1980) does not provide any evidence or clues either. Moreover, Manton emphasizes the fact that there are also chronic diseases that are completely genetically determined (for instance, Down's syndrome and hemophilia) and, therefore, cannot be altered by personal choice. Manton also refers to Burch (1976), who argues that there is a major genetic component in *all* risks for chronic disease.

Instead, Manton (1982) claims that life expectancy can continue to increase without any apparent upper limit and that prevalence may well rise due to unchanged incidence rates and extended lives. He cites US nationally representative data on disability, activity restriction, self-assessed health, and the rate of long-term institutionalization at advanced ages, showing no marked deterioration in health status among people 65+ during the 1960s and 1970s despite significant increases in life expectancy. Since prevalence of disease increased during this time period, he concludes that something must have been accomplished to reduce the severity and associated disability of disease.

In order to better understand the relation of morbidity and mortality as life expectancy increases, Manton introduces the concept of a "dynamic equilibrium" (Manton, 1982,

p. 226). According to Manton, the concept involves some modification of the basic epidemiological relation that prevalence is a function of incidence and duration. Then, if mortality decreases and incidence is unchanged, duration (and prevalence) must increase. The question is, Manton says, in which way duration is increased. One way is to eliminate lethal consequences of a disease, e.g., pneumonia, while not affecting the basic rate of progression of the disease process. Another way is to change the rate of progression; in this case, duration (and life expectancy) is increased by reducing disease severity. Then, life expectancy may primarily be increased with the period spent in a highly morbid state being relatively constant. Manton suggests that most of recent changes in life-expectancy have been of the second kind, and he refers to diabetes and hypertension, both diseases that can be well managed with inputs of health care and changes in individual life style. "Without treatment, mortality risks could rise; average duration, and hence prevalence, would fall. With treatment, though prevalence increases at the expense of health resources, the quality of life gained is often sufficiently good to justify the efforts. This position does not argue against the merits of the primary prevention of chronic diseases (i.e., incidence reduction) but rather suggests that positive societal benefits can accrue to disease management efforts." (Manton, 1982, p. 227).

In summary, health care costs will be incurred to reduce the severity of chronic disease or to slow its rate of progression, which reduces mortality risks. In return, these costs will accelerate as life expectancy and disease prevalence increase. Since extensions of life are produced by reductions in the rate of progression of the disease, quality of life and ability to work will increase. This may lead, Manton says, to greater economic productivity, not least if people can remain working at older ages than today. Thus, increases in health care costs should not be seen in isolation but balanced against greater economic productivity. For individuals, the message is that they will live longer, certainly with a larger share of life with a chronic disease, but with a higher quality of life and improved capacity to take part in society.

Manton continued to make both theoretical and empirical contributions to the field for a long time. In several papers, he and his colleagues analyzed successive waves of the US National Long-Term Care Surveys (Manton et al., 1995; Manton and Land, 2000; Manton et al., 2006; Manton et al., 2008). They showed significant declines in disability, measured as ADL (activities of daily living) and IADL (instrumental activities of daily living) among the elderly US population during the 1980s and 1990s. ADLs refer to personal maintenance tasks performed daily, such as eating, getting in and out of bed, bathing, dressing, toileting, and getting around indoors. IADLs refer to household maintenance tasks such as cooking, doing the laundry, grocery shopping, travelling, and managing money. Based on the results of declining disability among the elderly in earlier decades, Singer and Manton (1998) and Manton et al. (2007) make projections of lower future spending in the Medicare insurance system. Manton (2008) raises concerns about whether the disability declines will continue because of the current increases in obesity prevalence. Health is part of human capital, the other main part is education (Grossman, 1972); Manton et al. (2007) and Manton et al. (2009) discuss the effects of health capital increases in the ageing US population on labor force participation and long-term economic growth, respectively. Akushevich et al. (2007) present a micro-simulation model, allowing short-term and long-term population changes to be forecast, conditional on the prevalence of one or more health risks (smoking, excessive alcohol consumption and obesity, for instance).

2.4 Conclusions

Careful reading of the original sources for the three scenarios or hypotheses of ageing and health somewhat modifies the picture of how they are generally described and interpreted. Careful reading also makes clear the importance of distinguishing between the different dimensions of health, especially between presence of disease and dimensions of health related to self-assessed health, disability and functional capacity.

The "extension of morbidity" scenario is based on an analysis of the effects of advances in medical technology during the 1930s to 1970s, by which mortality risks have been reduced for a number of chronic diseases without affecting the onset (incidence) of disease. So, the result is an increase in the prevalence of disease and a longer expected life in need of health care. If the severity of disease would remain the same, the rise in costs would be substantial. The "dynamic equilibrium" scenario is based on a thorough analysis of the character of medical advances behind the reduced mortality rates. While some of them have not changed the severity of diseases, most have been accompanied by both reduced severity, slower progression of the disease process, and increased life expectancy as a result of new-technology health care inputs. Since no change in the incidence of disease is assumed, the prevalence of disease and the use of health care, especially primary health care (including pharmaceuticals), will increase, while quality of life will increase and the demand for nursing homes and other forms of elderly care decrease. The important distinction between health as absence of disease and health as quality of life is emphasized; the share of life with a disease is increased, while the share of life with good quality of life is increased.

The first two scenarios above are based on analyses of the impact of medical advances, constant incidence rates, and no foreseeable limit to life extensions. The "compression of morbidity" scenario on the other hand is based on the assumption that people will adopt healthier life styles, thereby reducing and postponing the incidence of disease to later years of life. Since it is also assumed that there is a biological limit to life extensions making larger future increases in life expectancy beyond the present ones improbable, the time with morbidity and health care use will be compressed and both the share of disease-free life time and the share of high-quality life time will increase. The hypotheses and assumed mechanisms behind them are summarized in Table 1.

Table 1 Hypotheses on gains in longevity and health status

Hypothesis	Healthy life expectancy	Mechanisms assumed
Expansion of morbidity, Gruenberg (1977)	Gains in longevity accompanied by additional years with chronic disease	Incidence of disease unchanged, medical progress will successfully improve survival probabilities for a number of chronic diseases requiring life-long treatment, hence increasing the prevalence of chronic disease
Compression of morbidity, Fries (1980)	Both disease-free and disability-free years increasing more than gains in longevity	Healthier lifestyles will decrease and/or postpone the incidence of disease until later ages, while there is a defined upper limit for life extension, hence decreasing the prevalence of both chronic disease and disability
Dynamic equilibrium, Manton (1982)	Gains in longevity accompanied by additional years without disability, not necessarily without chronic disease but disease with less severe progress due to new medical treatments	Incidence of disease unchanged, medical progress will successfully improve survival probabilities while reducing the severity of disease, hence increasing the prevalence of chronic disease but decreasing disability

3 Is there a limit to life expectancy?

An upper limit to life expectancy is a central assumption behind the "compression of morbidity" scenario (Fries, 1980). Gruenberg (1977) and Manton (1982) do not make this assumption. Whether the assumption is true or not has important consequences not only for which scenario seems most likely but for forecasts of life expectancy, population ageing and medical and social programs tied to the size and health status of the elderly population. In the past, hypotheses about an upper limit have often been based on observations of past trends in mortality; for other methods, see, e.g., Olshansky et al. (1990).

Using life tables for the United States in 1980 and 1985, Olshansky et al. (1990) estimate an upper bound, based on hypothesized reductions in current mortality rates necessary to achieve a life expectancy at birth from 80 to 120 years and a life expectancy at the age of 50 from 30 to 70 years. Using conditional probabilities from US life tables, reductions in mortality required to achieve longevity of 80–120 years were compared to those resulting from hypothetical cures for all cardiovascular diseases, ischemic heart disease, diabetes, and cancer. Their results indicate that in order for life expectancy at birth to increase from present US levels to what was referred to by Fries (1980) as the average biological limit to life, i.e., age 85, mortality rates from all causes of death would need to decline at all ages by 55 percent, and at ages 50+ by 60 percent. Given that hypothetical cures for major degenerative diseases would reduce total mortality by 75 percent, the authors conclude that it is highly unlikely that life expectancy at birth will exceed the age of 85. They admit, however, that major advances in genetic engineering and new life-extending technologies might certainly be introduced, followed by marked declines in mortality and increases in longevity.

Using the same methodology but extending the data base to include age and sex-specific death rates from 1985 to 1995 in France, Japan, and the United States, Olshansky et al. (2001) examined whether recent trends conformed with their earlier predictions (Olshansky et al., 1990). They conclude that "future gains in life expectancy will be measured in days or months rather than years" (Olshansky et al., 2001, p.1492). According to the authors, "there are no life-style changes, surgical procedures, vitamins, antioxidants, hormones, or techniques of genetic engineering available today with the capacity to repeat the gains in life expectancy that were achieved during the 20th century" (Olshansky et al., 2001, p.1492).

Referring to observed life expectancies in various countries, Oeppen and Vaupel (2002) question the methods used by Olshansky et al. (1990, 2001) and other writers (e.g., Dublin, 1928). In their 1990 paper, e.g., Olshansky et al. asserted that life expectancy "should not exceed… 35 years at age 50 unless major breakthroughs occur in controlling the fundamental rate of aging." According to Oeppen and Vaupel (2002), however, this limit was surpassed by Japanese women in 1996. After examining a number of similar papers, Oeppen and Vaupel (2002) conclude that the estimates of limits to life expectancy, from Dublin (1928) to Olshansky et al. (1990, 2001) have been broken, "on average five years after publication". Instead, Oeppen and Vaupel (2002) refer to "the astonishing fact… (that) female life expectancy in the record-holding country has risen for 160 years at a steady pace of almost three months per year". In order to make better forecasts of life expectancy, they recommend that officials charged with forecasting trends over future decades should base their calculations on the empirical record of mortality improvements in the past and/or by considering the gap between national performance of life expectancy and the best-practice level.

Similar arguments against the calculations made by Olshansky et al. are put forward by Lee (2001) and by Lee and Carter (1992). Lee (2001) refers, inter alia, to Olshansky et al. (2001), in which they worry that "continued decline at the long-run historical rates would reduce the death rates at ages below 30 to biologically implausible levels, and so constraints the infant mortality rate not to fall below 5 per 1000" (Lee, 2001, p. 1654). According to Lee (2001), however, 12 countries already reported infant mortality below this level; Iceland as low as 2.8. Lee (2001) further asserts that it does not seem probable that medical progress suddenly would cease and conclude that it would be "most prudent to assume that mortality will continue to decline on trend" (Lee, 2001, p. 1654).

Tuljapurkar et al. (2000) provide further evidence. They examined mortality over five decades in the G7 countries (Canada, France, Germany, Italy, Japan, UK, and USA). They found that mortality at each age had declined exponentially at a roughly constant rate in each of the seven countries. Using stochastic mortality forecasting models, they found median forecasts of life expectancy that were substantially larger than existing official forecasts, indicating that future dependency ratios would be largely underestimated. For 2030, the forecasts of the authors were between 6 percent (UK) and 40 percent (Japan) higher than the official ones.

Christensen et al. (2009) updated the estimates of Oeppen and Vaupel (2002), using data from the additional seven years available since that publication. Their results showed that life expectancy keeps rising.

Several researchers claim, however, that current trends in obesity may slow down or even cause declines in life expectancy within the first half of this century. Being severely obese, e.g., reduces life expectancy by an estimated 5 to 20 years. Analyzing US trends in obesity and mortality risks, Olshansky et al. (2005) suggest that the rapid rise in childhood obesity in the USA might shorten life expectancy by as much as five years. Warnings against the potential effects of obesity on mortality rates, prevalence of disease, and health care expenditures also come from, e.g., Goldman et al., 2005; Lakdawalla et al., 2005; Olshansky, 2005; Borg et al., 2005; Ödegaard et al., 2008; Persson and Ödegaard, 2011; Swinburn et al., 2011; Wang et al., 2011. See also chapter 5 of this working paper.

As yet, there is no evidence that the rate of improvement in older age mortality is slowing down or that older age deaths are being compressed into a narrow age band as they approach a hypothesized upper limit to longevity. There is, though, a significant rectangularization of survival probabilities as suggested by Fries (1980). Obesity might reduce future declines in average mortality rates, if current trends persist. Increasing awareness of this threat against population health and life might reduce the problem, though.

4 Ageing and health

There is, of course, a link between health and longevity. People in good health live longer. In fact, at the individual level, there is firm evidence that health status, in particular self-assessed health, strongly predicts mortality; see, e.g., Mossey and Shapiro (1982), Idler and Benyamini (1997), Benyamini and Idler (1999), van Doorslaer and Gerdtham (2003), Helweg-Larsen et al. (2003), Baron-Epel et al. (2004), Benjamins et al (2004), and Shang and Goldman (2008). Individual health status is not determined by age alone; education, income, and wealth as well as genetic factors are also important (Grossman, 1972). Education is important to explain differences in health-risk behavior, which causes individual differences in health. Improvements in average educational levels, higher average incomes, and decreasing rates of smoking are some of the factors behind the increase in population health for many years.

Several literature reviews on changes in health status among the elderly over time are available, even recent ones, updating results of some of the most recent studies. So, in this section, devoted to ageing and health, we will first summarize reviews of international studies. Then we will present recent international studies, not covered by available reviews and, finally, review available original studies from Sweden. There might be some overlapping, though. Health is a multidimensional concept. One central aspect of health is the absence of disease; another one is quality of life and capacity to perform activities of daily living; a third one is hearing, vision and other physical and mental functions. There is no obvious one-to-one correlation between these aspects. One aspect, e.g., prevalence of disease (a negative indicator), may increase, while e.g., quality of life, simultaneously improves. Thus, the meaning of health in a specific environment needs to be defined or clarified. Most studies report on the development of disability, fewer on the prevalence of disease. Disability is most often measured as problems to undertake activities of daily living (ADL) or instrumental activities of daily living (IADL). ADLs refer to personal maintenance tasks performed daily, such as eating, getting in and out of bed, bathing, dressing, toileting, and getting around indoors. IADLs refer to household maintenance tasks such as cooking, doing the laundry, grocery shopping, travelling, and managing money.

4.1 Reviews of international studies

In a systematic review, Freedman et al. (2002) assessed the quality, quantity and consistency of U.S. trends in disability (ADL or IADL) and in physical, cognitive, and sensory functioning among the elderly during the late 1980s and the 1990s. Out of more than 800 articles reviewed, the authors selected and evaluated 16. The authors found that the prevalence of any disability declined significantly; these improvements did not hold for all specific measures of disability, however. The decline in late-life disability was concentrated on IADL limitations, while there was conflicting evidence regarding ADL disability. Cognitive impairments seemed to have declined; limitations in hearing appeared to have been constant; evidence was mixed for self-reported vision. Even though several measures of old age disability and limitations showed improvements, the authors conclude that the implications of their findings for the future demand for medical care suggest that caution is in order. Without a better understanding of the causes of these improvements, it remains unclear “whether medical expenditures have fueled health improvements or whether health improvements will help save medical costs in the future" (Freedman et al., 2002, p. 3146).

Parker and Thorslund (2007) reviewed a number of Swedish and international studies. They concluded that there were favorable trends in disability, and, if they continued, the future need for social services and long-term care would increase at a lower rate than demography. On the other hand, trends in disease and in some functional limitations suggest an increased need for resources in health care, rehabilitation and compensatory interventions, such as assistive technology.

Christensen et al. (2009) reviewed previous and recent research (especially reports published in 2005 and later) on population ageing and trends in health in highly developed countries, focusing on prevalence of disease, risk factors, functional limitations and disability. They found that the prevalence of diseases in the elderly has generally increased over time and that the number of life years with morbidity has been increasing. They mention, for instance, that there have been increases in the prevalence rates of chronic diseases, including heart disease, arthritis, and diabetes, reported from the USA, 12 OECD countries, the Netherlands and Sweden. Obesity has been increasing in almost all studied populations, implying higher risks of death and of developing health problems, including diabetes, arthritis, and stroke. Evidence is mixed regarding functional limitations, even though vision seems to have been improved – the result of developments in cataract surgery. Improvements have been reported from Finland, the Netherlands, Japan, Sweden, and USA for mobility and for the ability to perform activities of daily living; in Sweden, however, the positive trend seems to have been broken, and increases in disability has been reported since the mid-1990s. Life years in good self-rated health have generally been increasing; there is also some evidence (but weak) that life years without disability has been increasing, at least in Europe.

Crimmins and Beltrán-Sanchez (2010) reviewed recent research (i.e. papers published since the year 2000 mainly) on mortality and morbidity trends in the USA to evaluate whether there are signs of a compression of morbidity. They found that in recent years mortality has still declined even though the decline has slowed down, especially for women. They also found substantial evidence that prevalence of disease and functioning loss has increased. As a few examples, they mention that the incidence of a first heart attach has been relatively stable since the 1960s and that the incidence of the most common cancers has been increasing until recently. In addition, there have been substantial increases in the incidence of diabetes during the last decades. Treatment has improved, so the consequences of disease have become less serious. Diseases are now both less lethal and less disabling; they extend over a longer period of time and may also be less progressive. Calculations of life expectancy with and without health problems at ages 20 and 65 indicated an increase in life expectancy with disease and with functioning loss between 1998 and 2006 and a decrease in the years without disease and functioning loss. On the other hand, the authors found substantial evidence that disability has decreased. There was a decrease in the rates of onset of disability and an increase in the expected proportion of disability-free life years.

4.2 Original international studies

Freedman et al. (2013) analyzed five national US surveys to determine whether the prevalence of activity limitations among the older US population continued to decline in the first decade of the 21st century. The authors found no evidence of continued downward trends in ADL or IADL limitations taken together for the 65-and-older population as a whole. Personal care and domestic activity limitations seem to have continued to decline for ages 85 and older (and a lower rate were institutionalized) but were roughly constant for the 65–84 ones. One should observe that modest increases (about one percent higher than the same age group born 10 years earlier) were observed for the 55–64 years old, which would probably increase the future prevalence of activity limitations for the 65-and-older population. That activity limitations have increased in the US population over the last decade among those nearing late life has also been observed by, e.g., Martin et al. (2010) and Seeman et al. (2010). Lakdawalla et al. (2004) reported on increasing rates of disability among people ages 18–59, especially in ages 30–49. Obesity in particular seems to be associated with these trends. The authors conclude that rising disability among the younger US populations could have adverse consequences for future financing of public programs such as disability insurance, Medicare and Medicaid. The future nursing home population might be 10–25 percent larger and Medicare expenditure 10–15 percent higher than they would have been in the absence of the expansion in disability among young people.

Cutler et al. (2014) used data from the annual Medicare Beneficiary Survey, a representative sample (more than 10,000 individuals annually) of the entire elderly US population between 1991 and 2009, to examine the issue of compression of morbidity. They found that measures of capacity to perform daily activities like ADL and IADL were improving but that diseases rates were relatively constant. They concluded that there was strong evidence for compression of morbidity based on measured disability but less clear evidence based on disease-free survival.

Badley et al. (2015) analyzed Canada's longitudinal National Population Health Survey, a nationally representative sample of Canadians (*n* = 8570 at baseline) assessed every 2 years. Using data from 1994 to 2010, they estimated the age trajectories of self-rated health for four birth cohorts: the World War II cohort (born between 1935 and 1944), older baby boomers (born between 1945 and 1954), younger baby boomers (born between 1955 and 1964) and generation X (born between 1965 and 1974). They found, not surprisingly, that self-rated health decreased with age in all cohorts. Differences among cohorts were modest, but there was a significant period effect. There were marked positive effects on self-rated health from increasing education, increasing income and decreasing smoking but negative due to increases in body mass index (BMI). As a matter of fact, the increasing prevalence of overweight and obesity seems to have almost totally counterbalanced the positive effects of better education, higher income, and less smoking in Canada. The authors conclude that they found no evidence to support the expectation that baby boomers will age healthier than previous generations. They emphasize the implications of the increasing BMI for the future need for health care.

Chatterji et al. (2015) analyzed data on ADL and IADL limitations taken from three longitudinal data bases: SHARE (Survey of Health, Ageing, and Retirement in Europe), HRS (Health and Retirement Study), and ELSA (English Longitudinal Study of Ageing). Thus, data covered in total 14 countries; two waves (2004 and 2006) of SHARE, four of ELSA (2002, 2004, 2006 and 2008), and seven of HRS (1995, 1998, 2000, 2002, 2004, 2006 and 2008). In the European SHARE data, the proportion of respondents with ADL or IADL limitations stayed fairly constant between 2004 and 2006 in most countries. The proportion of respondents with ADL limitations decreased over time in England but increased in the USA; the proportion of respondents with IADL limitations increased over time in England but decreased in the USA. The authors also reviewed previous studies, which confirmed the earlier findings that the prevalence of disease is increasing, while the prevalence of disability (ADL and IADL limitations) is decreasing.

4.3 Swedish studies

The longitudinal data used in published Swedish studies come either from one of two nationally representative surveys – the Swedish Survey of Living Conditions and the SWEOLD – or from local data bases. The annual, nationally representative, sample of the Swedish Surveys of Living Conditions (ULF, *Undersökningar om Levnadsförhållanden*), includes about 7000 people aged 18–84; the subsample of 65–84 years old accounts for roughly 20 percent. The ULF survey normally does not include people older than 84. So SWEOLD was created to complement those existing data bases, hence including ages 77+ (no upper limit). For information on the Swedish Panel Study of the Living Conditions of the Oldest Old (SWEOLD I & II), see Lennartsson et al. (2014).

Using the Swedish H70 studies, Steen (2002) presents cohort differences in health status among 70-year-olds born in five different years: 1901/02, 1906/07, 1911/12, 1922, and 1930. The H70 is a set of large and representative gerontological and geriatric population studies in Gothenburg, the second largest city in Sweden. The H70 covers a wide range of aspects of health; for information, see e.g., Steen and Djurfeldt (1993). Among the many results could be mentioned that mean body mass index (BMI) had increased over years, cognitive function increased, no change in hearing ability, oral health had become markedly better, whereas smoking had decreased among men but increased among women.

Wilhelmson et al. (2002) used data from the 1901/02, 1906/07, and 1911/12 birth cohorts of the H70 studies to analyze differences in morbidity in three different cohorts of 70-year-olds. Functional capacity and self-reported health were found to be higher in the later birth cohorts, but the prevalence of disease was also higher. These findings are consistent with the results of many other Swedish and international studies, that the presence of chronic disease has increased but there are less limitations in functional capacity over time.

Also using the H70 data, Eiben et al. (2005) reported on changes in BMI, overweight (BMI 25–29.9 kg/m^2), and obesity (BMI $\geq$ 30). Significant trends were found for all outcomes. In 2000, 20 percent of the 70-year-old men were obese, and the largest increase (almost a 100 percent) occurred between the early 1980s and early 1990s. The prevalence of obesity among women was 24 percent in 2000, an increase of about 50 percent since 1992. The authors conclude that the elderly population is very much part of the obesity epidemic and that the implications of these secular trends should be in focus of future gerontological research.

Rosén and Haglund (2005) analyzed annual data 1980–2002 from the Swedish Survey of Living Conditions (ULF) to examine health trends in the 65–84 years old population. They found that self-rated health and functional capacity increased for all the relevant age groups. There were steady increases over the 23 years for longstanding illness, however. Between 1980 and 2002, the percentage reporting at least one longstanding illness increased from 74 to 77 among men and from 78 to 80 among women. The percentage reporting at least three longstanding illnesses increased from 19 to 23 among men and from 25 to 30 among women. There were clear increases in the prevalence of diabetes among both women and men; also increases in the prevalence of hypertension and heart disease for men but roughly constant for women. An interesting finding was that even people with longstanding illness perceived their general health and functional capacity to have improved over the 23 years. The authors conclude that their results fit well in with the development of a number of breakthroughs in medicine; results were also in accord with slower or no changes towards healthier lifestyles in recent years in comparison with earlier decades.

Using two nationally representative interview surveys, SWEOLD I & II, Parker et al. (2005) examined changes in the health of the 77+ Swedish population between 1992 and 2002. Samples consisted of 537 and 563 elderly, respectively, and included both community-based and institutionalized individuals; response rates were 94 and 89 percent, respectively. States of health and function were self-reported, but there were also objective tests of cognition, lung function, vision and physical capacity. Self-reported items included presence of disease or symptoms, hearing, mobility, ADL and instrumental ADL. The results showed an increased prevalence of both severe and mild problems, markedly so in genital problems, depression, fatigue and joint pain. Increases in health problems were also seen in hearing ability and mobility but not in mild instrumental ADL impairments.

In a follow-up, the two first surveys of SWEOLD were accompanied by a third in 2011; this time the above 85 ages were completed by a larger than proportional sample. Results were reported by Fors et al. (2013). Generally, the same trends were observed as in their previous study. However, mobility increased since 2002, and fewer ADL problems were reported, in fact, even fewer than in 1992. The authors concluded that the elderly got more health problems between 1992 and 2011, but they seemed to cope with daily activities better than before.

Parker et al. (2008) analyzed annual data 1980–2005 from the Swedish Survey of Living Conditions (ULF) to examine trends in functional capacity in the 65–84 years old population. They found improvements for ability to take a short walk and to run a short distance (if in a hurry), seen over the entire time period. The improvements took place mainly during the 1980s and early 1990s, however. For ability to run the trend then reversed; for ability to walk, the trend seemed to cease or at least became slower. Vision improved with no significant difference before and after 1996/97. Hearing got worse, even though the negative trend seemed to weaken after 1996/97. ADL (ability to perform activities of daily living) improved, seen over the entire period, but there were signs of worsening since the mid-1990s. Finally, there was a consistently positive trend in all IADL items (cleaning, shopping, preparing food).

4.4 Conclusions

There is strong evidence, both from Sweden and internationally, that the prevalence of chronic disease among the elderly has increased over time. There is apparently also fairly strong evidence that the consequences of disease have become less problematic due to medical progress: decreased mortality risk, milder and slower development over time, making the time with disease (and health care treatment) longer than before but less troublesome for the individual. However, most evidence also suggests the postponement of functional limitations (vision is probably the best example) and disability. Some of the reduction in disability may certainly be attributed to improvements in treatments of chronic diseases. But they are apparently also due to the increased use of assistive technology, public transport ("kneeling buses", for instance), accessibility of buildings, etc. The results, hence, indicate that the ageing individual is expected to need health care for a longer (and not necessarily postponed) period of time than previous generations but elderly care for a shorter (and certainly postponed) period of time. The threat of present trends in obesity and overweight is real, both for health, disability, health care, social care, possibly also for longevity. One additional lesson, which can be drawn from the above studies, is that one should be extremely cautious when interpreting findings based on only two observational years. The reliability may be low, due to random fluctuations.

5 Ageing, health, and the demand for health and social care

Projections of future health care and social care expenditures in the past were based on expected demographic changes and age-specific costs per capita alone. It is a method, which has been questioned, e.g., by Evans (1985), Getzen (1992), and Chernichovsky and Markowitz (2004), but still widely used by governments. In general, predictions of rapid growth in expenditures based on such projections have not been reflected in observed data; see, for instance, the overview by Payne et al. (2007). Age per se does not adequately reflect the health status of an elderly population, and it seems to be a particularly poor basis for predicting the future. Thus, other indicators of health have been suggested, as time until death (Fuchs, 1984; Lubitz and Prihoba, 1984), the rationale being that expenditures during the last years of life, independent of age, had been found to constitute a very large proportion of total health care expenditures (Piro and Lutins, 1973; Gibbs and Newman, 1982; Helbing, 1983; Lubitz and Prihoba, 1984; McCall, 1984). More recent studies seem to confirm these findings; see, e.g., Lubitz and Riley (1993); Zweifel et al. (1999); Felder et al. (2000); Hogan et al. (2001); and Werblow et al. (2007). Results have been questioned, though, on methodological grounds, inter alia, for the potential endogeneity of time to death. There seems to be no consensus yet in the literature (Payne et al., 2007).

5.1 Studies using time to death as an indirect indicator of health

While there are several retrospective studies, estimating the impact on health care expenditures of actual time to death, there are but a few studies using time to death as a health status indicator, when predicting future health care expenditures. One exception is Spillman and Lubitz (2000), who used time until death as a measure of health status and data from Medicare, the National Mortality Followback Survey, and the National Medical Expenditure Survey, when estimating the effect of longevity on spending for acute (inpatient and outpatient) care and long-term (nursing) care, respectively. They found increasing, but at a decreasing rate, cumulative health care expenditures per patient from the age of 65 until death for acute care but sharply increasing expenditures for nursing-home care. Characteristics of the two cohorts of persons turning 65 in 2000 and in 2015, respectively, were simulated. According to the simulations, mean cumulative expenditures per person would increase with less than one percent for acute care but with 6 percent for nursing-home care. The authors emphasize that their simulations do not account for possible medical advances or for changes in patterns of utilization, disease, or disability or in the Medicare and Medicaid programs.

Miller (2001) used a similar method in order to analyze the effect of increasing longevity on Medicare expenditures. His simulations indicate that the future is characterized by postponement to later in life rather than an expansion or a compression of the high costs for care of the elderly. Some savings due to delay in morbidity might occur but are small in comparison with the increase in total expenditures because of the increasing numbers of persons 65 years old and more.

Stearns and Norton (2004) analyzed data from the Medicare Current Beneficiary Survey Cost and Use Files for 1992–1998 with a total of 12 000 respondents. In their final analysis, there were 215,385 observations at the person-quarter level, representing 22,101 unique individuals. People were followed for up to 20 quarters. Based on this data, they made a number of simulations, with and without time to death as an explanatory variable. The authors found that predictions from the simple model that excludes time to death and uses current life tables were 9 percent higher than from an expanded model controlling for time to death. The difference increased to 15 percent when using projected life tables for 2020.

5.2 Studies using individual health status data

Shang and Goldman (2008) used demographic and individual health status data (major disease conditions, functional status, and health risk factors) as well as health care expenditures from the 1992–1999 Medicare Current Beneficiary Survey (total sample size 83,412) to predict both remaining life expectancy and health care expenditures. The authors found that age had little additional predictive power on health care expenditures after controlling for life expectancy. They also found that the predictive power of life expectancy itself diminished after introduction of individual health variables. This should not come to much surprise, since health status has been shown to strongly predict mortality; see section 4 above.

Lubitz et al. (2003) revised previous estimations by using more refined measures of health, i.e. self-reported health and disability, respectively. Using the 1992–1998 Cost and Use files of the US Medicare Current Beneficiary Survey, they estimated the relation of health status at 70 years of age to life expectancy and to cumulative health care expenditures from the age of 70 until death. The results showed that elderly persons in better health had a longer life expectancy (by nearly three years) but similar cumulative health care expenditures until death as those in poorer health. This means that the health care cost per elderly would be the same, irrespective of health status, but the cost would be allocated over a larger number of life years. The authors conclude that they found no evidence for the idea that better health among the elderly would moderate expected increases in health care spending.

Using Dutch survey and register data, Wong et al. (2012) estimated age-specific time trends from 1980 to 2010 for eight different health care sectors: general practitioner, alternative-medicine practitioner, prescribed pharmaceuticals, over-the-counter pharmaceuticals, dental care, physiotherapy, medical-specialist care, and hospital inpatient care. The authors also examined the influence of medical innovations on the difference in time trends for hospital inpatient care. According to their results, the 65+ age group had the highest proportion of general-practitioner care, prescribed pharmaceuticals, and medical-specialist care during the whole period but by far the lowest of dental care. Significantly higher time trends for the 65+ than for all younger age-groups were observed for prescribed pharmaceuticals, physiotherapy, medical-specialist care, and hospital inpatient care. For dental care, only the age group 45–64 had a higher growth rate than the 65+. As for the impact of changes in the rate of medical innovations, the authors found an age-dependent correlation with changes in the probability of age-specific hospital-care utilization. Thus, the benefits of new medical technology increases with age, and the age curve of health care expenditures becomes steeper over time. The authors fear that future marked changes in the age distribution of health care expenditures might exert pressure on the solidarity between generations in countries with mainly publicly financed welfare systems.

Time to death does not seem to be used very much in recent models for forecasting future health care expenditures among the elderly. Instead, the same kind of more direct measures of health as in studies reporting on the development of health over time are being used. That makes it easier to connect the observations from both that literature and this one.

5.3 An American micro-simulation model

A number of analyses of health and health care expenditures of the future elderly in the USA have been performed using the Future Elderly Model (FEM), developed by Dana Goldman and associates at RAND Health. The authors developed a micro-simulation model that tracks elderly, Medicare-eligible people over time, starting in 2000, to project their health conditions, their functional status, and their Medicare and total health care spending. Demographics include age, gender, ethnicity, education, and geographical area of living. Measures of health status include self-assessed health, ADL, and chronic diseases. Risk factors include smoking and BMI. Details are described in Goldman et al. (2004)

Using the FEM micro-simulation model, Goldman et al. (2005) analyzed the consequences of present health trends among younger populations in the USA and recent innovations in biomedicine for the development of the elderly's health and health care spending over the next 30 years. In their preferred scenario, health trends were based on the recent reports on increasing disability rates among the younger US populations; see, e.g., Lakdawalla et al. (2004); Martin et al. (2010); and Seeman et al. (2010). Alternative scenarios assumed either that entering cohorts to Medicare disability would resemble recent entrants or that there would be a continual improvement in disability among all elderly. Per beneficiary, the preferred scenario would imply an 8 percent increase in health care expenditures between 2000 and 2030 compared to the most optimistic scenario. The three scenarios assumed that no medical innovations would take place that might change medical practice. However, through systematic literature search and panels of distinguished experts the authors identified 34 health technologies most likely to affect the health of the future elderly and expected to be introduced in the near future; all 34 technologies and the process used to identify them are described in detail in Goldman et al. (2004) and in Shekelle et al. (2005). Ten of these technologies were analyzed regarding future health and health care spending: three addressing cardiovascular disease (intraventricular cardioverter defibrillators, left ventricular assist devices, and pacemakers to control atrial fibrillation); three addressing cancer (telomerase inhibitors, cancer vaccines, and anti-angiogenesis); two addressing neurological disease (treatment of acute stroke and prevention of Alzheimer´s); one addressing diabetes (prevention of diabetes by insulin sensitization drugs); and one related to general ageing (a compound that extends life span). The impact would be dramatic. Thus, their conclusion was that society faces its greatest risk as far as health care spending is concerned not from demographic and health trends but rather from medical technologies.

The impact of technological advances in cancer treatment on future spending by the elderly was further analyzed by Bhattacharya et al. (2005). Five scenarios were examined, ranging from a baseline scenario, in which technology stays frozen as it was in 2000, to the most optimistic scenarios, in which an inexpensive cure, a vaccine that prevents cancer, and vastly improved screening techniques are included. Applying the Future Elderly Model (FEM), the authors find that no technological advance in the treatment of cancer alone would change the cost projections for Medicare between 2005 and 2030 very much. True, some savings would be possible but small in comparison with the total budget of Medicare. One reason is that those saved from cancer will die of other (expensive) diseases. A number of life years will be saved, nevertheless, between three and 15 million life years, depending on scenario.

5.4 A Dutch latent Markov simulation model

Wouterse et al. (2013) used a Markov model and Dutch survey and linked register data to simulate the development of health and spending for hospital and long-term care over remaining life years for individuals of different initial health states at age 65. Several indicators of health – chronic diseases, functional capacity, self-perceived health, depressive symptoms, and cognitive impairments – were summarized into a single measure, using latent class analysis. Individuals in good current health and low current expenditures were compared to individuals in poor current health and high current expenditures with respect to expenditures over remaining lifetime. For the first group, expenditures tend to be postponed to later ages. As a result, accumulated hospital expenditures over remaining lifetime would be somewhat lower for the first group; but accumulated long-term care expenditures over remaining lifetime would be considerably higher for this group. The authors conclude that the expectations of costs savings effects due to improvements in health should not be too high; investing in the improvement of health of the elderly should be motivated for its own sake.

In an earlier paper, Wouterse et al. (2011) reached the same conclusion, estimating the longitudinal relationship between each of four different health indicators (self-perceived health, long-term impairments, ADL and comorbidity) and costs of hospital use in the Netherlands over a period of eight years. At relatively young ages, baseline good health was associated with low expected costs; at higher ages, though, the initial lowering effect of good health seemed to be counteracted over time by lower mortality. The general patterns were the same for the four indicators.

Wouterse et al. (2015) used the latent Markov model, introduced by Wouterse (2013) to simulate three main scenarios of future health and health care use over the years 2010–2050 for the 65+ Dutch population, based on the "expansion of morbidity", "compression of morbidity" and "dynamic equilibrium" hypotheses, respectively. In some sub-scenarios, the impact of differences in longevity is analyzed. In the scenarios with a moderate increase in life expectancy, the highest total hospital expenditures were found in the expansion of morbidity scenario as well as in the dynamic equilibrium scenario. Hospital expenditures would decrease or stabilize after 2040 in all three scenarios, though. In contrast, home-care and institutional long-term care expenditures rose over the whole time interval in all scenarios. Home-care expenditures were highest in the dynamic-equilibrium scenario with "extreme" life expectancy, followed by the expansion-of-morbidity scenario with moderate life expectance. Institutional long-term care expenditures were highest in the expansion-of-morbidity scenario with moderate life expectancy, but the differences among the three main scenarios were smaller than for hospital expenditures. Additional life-expectancy gains led to higher total expenditures for all three types of care in the expansion-of-morbidity and dynamic-equilibrium scenarios. One should maybe be reminded about the assumptions behind the three hypotheses (and scenarios); see section 2 above.

The rising prevalence of obesity and overweight has arisen much interest among researchers (see, e.g., Goldman et al., 2005; Lakdawalla et al., 2005; Olshansky et al., 2005; Borg et al., 2005; Ödegaard et al., 2008; Persson and Ödegaard, 2011; Swinburn et al., 2011; Wang et al., 2011). Excess bodyweight increases the risk of several diseases, most notably type II diabetes, coronary heart disease, stroke, several forms of cancer, and osteoarthritis. Using a micro-simulation model, Lakdawalla et al. (2005) estimated that obese 70-year-olds will live about as long as those with normal BMI but will spend more than USD 39,000 more on health care. In addition, they will enjoy fewer disability-free life years and experience higher rates of diabetes, hypertension, and heart disease, all according to simulation results. Wang et al. (2011) used a micro-simulation model to estimate the morbidity, mortality, and cost implications of projected obesity trends in two ageing populations – the USA and the UK – between 2010 and 2030. According to these simulations, there would be 65 million more obese adults in the USA and 11 million more obese adults in the UK by 2030, accruing an additional 6–8 million cases of diabetes, 6–7 million cases of heart disease and stroke, 500–700 thousand additional cases of cancer, and 25–55 million quality-adjusted life years forgone for USA and UK together. The extra health care cost would be USD 48–66 billion per year in the USA and GBP 1.9–2.0 billion per year in the UK by 2030. According to the simulations, there would be an increase during the two decades in the annual costs of obesity-related diseases by 13–16 percent in the USA (4 percent of which from population ageing) and by 24–25 percent in the UK (10 percent from ageing).

5.5 A Swedish dynamic micro-simulation model

There is a Swedish micro-simulation model, which includes modules for health, health care and social care, available (Klevmarken and Lindgren, 2008). The modules were added to an already existing dynamic micro-simulation model, SESIM of the Swedish Ministry of Finance; for a presentation of the model, see Flood (2008). The new modules were based on a number of empirical studies.

Health status is simulated in the model. The indicator of health is an index of four dimensions: self-assessed health, mobility, long-standing illness, and working capacity; for a detailed description, see Bolin et al. (2008). Model equations were estimated, using data of the Swedish Survey of Living Conditions (ULF). In the model, the probability for a better health status is higher for being male, having higher relative income, having longer education, being married or cohabiting, being born in Sweden, and having children. Divorced are less likely to be healthy than those who never have been married or cohabiting, and health is decreasing by age. The health status in the previous year is the most important factor of the current health of the individual. The model simulates decreasing health status for the elderly population over the years. This reflects observations made that the trend towards ever-healthier elderly seems to have been broken. The share of young and middle-aged Swedish men and women, reporting very good or good health status to the Swedish Survey of Living Conditions started to decline already in the early 1990s. As the cohorts are graying, the share of elderly people in good health has started to decline, too (Klevmarken and Lindgren, 2008).

In Klevmarken and Lindgren (2008), the only indicator of the need or demand for health care is inpatient hospital care. In the model, health status, age, education, relative income, gender, civil status (divorced), and foreign country of birth, determine the probability that the individual will have an inpatient stay at hospital and, if so, the length of the stay. The effect of health status is negative, i.e. people in bad health utilize more inpatient days. Being a man, being born in Sweden, and being divorced all increase the expected number of days of inpatient care. Finally, the more inpatient care that was utilized in the previous year, the more inpatient care will be used in the current year.

Three scenarios were simulated. The base-case scenario includes results following the assumptions and predictions directly produced by the model. The expected life span was supposed to increase between 2000 and 2040 from 78 to 83 years for a newborn boy and from 82 to 86 years for a newborn girl, in accordance with the main projections of Statistics Sweden. In the alternative scenarios, improved health was assumed, either accompanied by longer life expectancies or remaining the same as in the base case. In the alternative scenarios, the health status index for those aged 40–90 was adjusted proportionally to their age minus 40 and the calendar year minus 2000 in such a way that a 90-year old person in 2040 would have the same health as an 80-year old in the base-case scenario. Since improved health status should also lead to decreased death risks and longer life expectancies, an alternative simulation scenario let each individual after year 2010 and after the age of 35–40 have the death risks of a five year younger person in the base-case scenario.

In the base-case scenario, the number of days of inpatient care increases by 80 percent for the 75+, by 70 percent for the 65+. Improved health per se should imply that the demand for health care decreases in comparison to the base-case scenario, and so it does, but only marginally for the 65+. On the other hand, if the improvement in health also led to more people surviving as above, the number of hospital days would increase by 150 percent for the 65+, due to the fact that there would be more elderly and the average age of the elderly would be higher.

Increased utilization implies higher costs for inpatient care. Costs would obviously increase even more than utilization, if the unit cost of care also increases, as it has in the past. If the cost for a hospital day would increase by the same rates as the average wage and the CPI in Sweden, and if people also would live longer as above, total cost in 2040 would become six times that in 2000. In the two scenarios without increases in life expectancy, total inpatient hospital costs would increase by a factor 3.6–3.7.

To simulate the demand for old-age care, the model first uses the simulated health of the individual as above together with age and sex to impute the individual's degree of ADL (activities of daily living) limitations. In the next step, the level of assistance or mode of old-age care was imputed. The final step encompasses estimations of annual transitions between states. The base-case scenario suggests that the number of individuals in institutionalized care (all-day surveillance) would almost triple from 2000 to 2040, the number of individuals with home help by 50 percent, and the number of individuals 65+ increase by 85 percent. In the scenario with improved health and decreasing mortality risks, the number of individuals in all-day surveillance would increase even more.

Calculations of the total cost for inpatient care and old-age care taken together for the 65+ population show an estimated increase between 2000 and 2040 by a factor of 3.7 in the base-case scenario, 3.6 in the scenario with improved health, and 6.1 in the scenario with improved health and reduced mortality rates. In all scenarios, the cost of all-day surveillance increases its share of the total cost, most markedly in the last scenario – from almost 40 to almost 50 percent.

For health care, the model has been partly extended to include not only inpatient care but also hospital-based specialist health care, primary care, and pharmaceuticals. Main results are presented in Swedish Ministry of Health and Social Affairs (2010).

5.6 Conclusions

Few studies separate long-term social care from health care, when reporting on the impact of the elderly on expenditures. The general conclusion of the empirical literature, mainly from the USA and the Netherlands, seems to be that expenditures will not be lower over remaining life years but they will be distributed over a longer period of time. Several authors warn against the potential negative impact of an increasing prevalence of obesity on life expectancy, health, and health and social care. The role of technological advances within medicine is highlighted by many authors and its consequences for the elderly analyzed. In the past, technology rather than demography alone has been a driving force behind the increase in health care expenditures for the elderly. There are several medical innovations in pipeline. The impact on life expectancy, the severity and progress process of disease, health, health care and social care could be quite different depending on the character of the innovation. People's habits and health-related behavior may also change over time. Thus, that current trends in health, life expectancy and health and social care utilization will persist should not be taken for granted. Micro-simulation models can be used to make forecasts for alternative relevant future scenarios in order to estimate the sensitivity of assumptions for sustainable health care and social care finances in the future. Such models have been extensively used in the USA and in the Netherlands. There is a Swedish dynamic micro-simulation model available as part of a comprehensive model for the Swedish economy, which might be used, but then it would need a complete update.

6 Conclusions

The objective of this report is to review the evidence on (a) ageing and health and (b) the demand for health and social care among the elderly. Issues are: does health status of the elderly improve over time, and how do the trends in health status of the elderly affect the demand for health and social care? The review is based on some 100 published scientific papers. While it is not a complete review, it covers most recent empirical studies of health trends and the changing pattern of demand for health and social care.

While mortality is fairly easy to define, health is a multidimensional concept. It includes self-assessed health, absence or presence of disease, functional status, and capacity to perform everyday activities (ADL limitations). There are certainly elderly who have no problems in any of these dimensions. But health among elderly varies and to a much larger extent than among younger people. Many elderly have one or more chronic diseases; if the disease is well controlled, there may be no problems in other dimensions of health. If not, other health problems may follow, lowering self-assessed health, creating ADL limitations etc. When analyzing health trends, it is important to cover all four dimensions of health, since the impact on health care and social care differ, depending on which dimension shows improved health. It is obviously not sufficient to seriously talk about health without defining or clarifying which aspect(s) are meant.

The reviewed literature provides strong evidence that the prevalence of chronic disease among the elderly has increased over time. There is also fairly strong evidence that the consequences of disease have become less problematic due to medical progress: decreased mortality risk, milder and slower development over time, making the time with disease (and health care treatment) longer but less troublesome than before. Evidence also suggests the postponement of functional limitations (vision is probably the best example) and disability. Some of the reduction in disability may certainly be attributed to improvements in treatments of chronic diseases. But they are apparently also due to the increased use of assistive technology, public transport ("kneeling buses", for instance), accessibility of buildings, etc. The results, hence, indicate that the ageing individual is expected to need health care for a longer (and not necessarily postponed) period of time than previous generations but elderly care for a shorter (and certainly postponed) period of time. Thus, one might say that the development overall has been in accordance with the "dynamic-equilibrium" scenario.

Few studies separate long-term social care from health care, when reporting on the impact of the elderly on expenditures. The general conclusion of the empirical literature, mainly from the USA and the Netherlands, seems to be that expenditures will not be lower over remaining life years but they will be distributed over a longer period of time. Several authors warn against the potential negative impact of an increasing prevalence of obesity on life expectancy, health, and health and social care. The role of technological advances within medicine is highlighted by many authors and its consequences for the elderly analyzed. In the past, technology rather than demography alone has been a driving force behind the increase in health care expenditures for the elderly.

Projecting the future demand for health and social care among the elderly over several decades is a serious and quite demanding task. Current trends in health, life expectancy and health and social care utilization cannot be taken for granted. There are several medical innovations in pipeline and the impact on life expectancy, the severity and progress process of disease, health, health care and social care would be quite different depending on the character of the innovation. Furthermore, people's habits and health-related behavior may also change over time, e.g., as a result of changes in public-health policy. Immigration is also a factor which might influence future levels of health and the demand for health and social care, since individuals not born in Sweden in average have lower levels of health but also larger consumption of inpatient care in addition to the effect of having a lower level of health.

Micro-simulation models should be used to make forecasts for alternative relevant future scenarios in order to estimate the sensitivity of assumptions for sustainable health care and social care finances. Such models have been extensively used in the USA and in the Netherlands, less so in Sweden, even though there is a Swedish dynamic micro-simulation model available. Since the modules on health and the utilization of health and social care would have to be updated anyway, it might be more worthwhile to develop a completely new model, separated from the more comprehensive dynamic micro-simulation model in which it is now a part.

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Table 2 Health trends among the elderly: literature overview

	Country and years	Ages and samples	Data	Health indicator	Results
Badley et al. (2015)	Canada 1994–2010	20–75, four birth cohorts	Interview surveys	Self-rated health	No difference in self-rated health among birth cohorts; baby boomers were not healthier than previous generations, Increase in BMI seems to have counter-balanced the positive effects of increases in education and income and of the decrease in smoking.
Steen (2002)	Sweden (Gothenburg)	70-year-olds, five cohorts	Interviews, tests (H70)	Functional capacity Risk factors	Increased cognitive function, constant hearing ability, increased oral health. Increasing BMI, increased smoking among women, decreased smoking among men.
Wilhemsen et al. (2002)	Sweden (Gothenburg)	70-year-olds, three cohorts	Interviews, tests (H70)	Diseases, functional capacity, self-reported health	Increased prevalence of diseaeses, increased functional capacity, and improved self-reported health.
Eiben et al. (2005)	Sweden (Gothenburg)	70-year-olds, three cohorts	Interviews, tests (H70)	Risk factor – obesity	Increased prevalence of obesity; more pronounced among women than among men.
Rosén and Haglund (2005)	Sweden 1980–2002	65–84 years	Interview surveys (ULF)	Perceived general health, functional capacity, long-standing illness	Self-rated health and functional capacity improved. Long-standing illness increased, especially among those reporting three or more long-standing illnesses.
Parker et al. (2005)	Sweden 1992 and 2002	77+	Interview surveys and tests (SWEOLD)	Diseases and symptoms; functional capacity; tests	Increased prevalence of diseases and symptoms. Increased hearing and mobility impairments but not in ADL or IADL. Tests showed increased impairments in physical performance, lung function, cognition, and vision.
Parker et al. (2008)	Sweden 1980–2005	65–84	Interview surveys (ULF)	Functional capacity	Mobility, vision, ADL and IADL improved, while hearing worsened, Improvements mainly occured between 1980 and 1996/97; positive trends then ceased or reversed.
Fors et al. (2013)	Sweden 1992, 2002, 2011	77+	Interview surveys and tests (SWEOLD)	Diseases and symptoms; functional capacity; tests	Increased prevalence of diseases and symptoms but no significant change 2002–2011, Significant improvement in ADL ability but not in other functional limitations, Tests showed increased impairments in lung function also 2002–2011; physical performance improved 2002–2011.
Freedman et al. (2013)	United States 2000–2010	55+	Five national interview surveys	Functional capacity	No continued downward trends in ADL or IADL limitations for the 65+ as a whole. Personal care and domestic activity limitations continued to decline for the 85+. Modest increases in ADL or IADL limitations were found for the 55–64.
Cutler et al. (2014)	United States 1991–2009	65+	Interview surveys (Medicare Beneficiary Survey)	Diseases and functional capacity	Unchanged prevalence of diseases. Significant improvements in ADL and IADL ability.
Chatterji et al. (2015)	US and 13 European countries, 1995–2008	55+	Interview surveys (HRS, ELSA, SHARE)	Diseases and functional capacity	Increased prevalence of diseases. In Europe, ADL or IADL limitations stayed relatively constant. In England, ADL limitaions decreased whereas IADL limitations increased. In the United States ADL limitations increased whereas IADL limitations decreased.

Abbreviations: ADL – Activities of Daily Living, IADL – Instrumental Activities of Daily Living, BMI – Body Mass Index, ELSA – English Longitudinal Study of Ageing, H70 – Health of 70-year-olds in Gothenburg (Sweden), HRS – Health and Retirement Study (USA), SHARE – Survey of Health, Ageing, and Retirement in Europe, SWEOLD – Swedish Panel Study of the Living Conditions of the Oldest Old, ULF – Undersökningar om Levnadsförhållanden (Swedish Survey of Living Conditions).

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