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ORIGINAL INVESTIGATION

# Population ageing in Sweden: the effect of change in educational composition on the future number of older people suffering severe ill-health

Ilija Batljan · Mårten Lagergren · Mats Thorslund

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**Abstract** We investigate how expected changes in the educational level composition of the older population may affect future prevalence of severe ill-health among older people in Sweden. Previous research has indicated that the number of older people, given educational differentials in mortality and expected changes in educational composition during the next decades, may increase more than expected following official population projections in Sweden. Eight alternative scenario projections for the possible development in the number of people with severe ill-health in Sweden between 2000 and 2035 are presented. Scenario projections, where both morbidity and mortality inequalities by educational level are taken into account, are compared with scenarios in which only age and gender are modelled. The projections are made with both constant and decreasing mortality. The calculations show that the expected increases in severe ill-health as a result from the ageing of the population in the period 2000–2035 might, to a large extent, be counteracted by the increase in the educational level of the Swedish population. We recommend therefore that in projections of the prevalence of ill-health, in addition to the ageing of the population, also changes in educational level should be taken into account.

**Keywords** Population ageing · Morbidity · Inequalities · Educational level · Future needs of long-term care

## Introduction

Population ageing and the projected rapid increase in the number of older people has caused concerns about future needs of long-term care (LTC) both in the EU (Economic Policy Committee 2001, 2006) and USA (Congressional Budget Office 2004). The number of older people is also projected to increase very sharply over the coming decades in Sweden according to official population projections (Statistics Sweden 2000). Access to human resources[1] within Swedish LTC is crucial for the delivery of services and the welfare state's ability to meet the needs of the older population (Swedish Ministry of Health and Social Affairs 1997, 2000). Future needs of LTC are also a policy concern in many other OECD countries (Organisation for Economic Co-operation and Development (OECD) 2003).

Human resources planning that addresses the needs of LTC of the older population is an important tool in order to prepare for the future demand for LTC. The individual's health needs are crucial for demand for LTC (O'Brien-Pallas et al. 2001) and not solely the number of older persons (Birch et al. 2003).

There are many studies pointing out the association between educational level and mortality (Elo and Preston 1996; Swedish Council for Social Research 1998; Valkonen 2001; Eriksson 2001; van Oort et al. 2005; Zajacova

I. Batljan · M. Thorslund
Aging Research Center, Karolinska Institute and Stockholm University, Stockholm, Sweden

M. Lagergren · M. Thorslund
Stockholm Gerontology Research Center, Stockholm, Sweden

I. Batljan (✉)
Municipality of Nynäshamn, 149 81 Nynäshamn, Sweden
e-mail: ilijab2000@yahoo.se

[1] In this article we use the term human resources planning for both health care and social care for the older people. Other terms, related to the issue of human resources for health care and social care for the older people, used in the literature are workforce planning and manpower planning.

2006) and morbidity (Parker et al. 1996; Karp et al. 2004; Buckley et al. 2004; Groot and Maassen van den Brink 2007). There is evidence for a causal effect of education on health according to results from several studies (Cutler and Lleras-Muney 2006). Possible explanations of this causality could be found using both the life-course perspective (Ben-Shlomo and Kuh 2002; Lundberg1993; Kåreholt 2001; Hayward 2004) and different material, behavioural (i.e. cigarette smoking, heavy alcohol drinking, sedentary lifestyle, diet) and psychosocial factors (van Oort et al. 2005; Mackenbach 2005). Psychosocial factors (life events, job strain, lack of control—or a sense of control—over living and working conditions, lack of social support,…) concern a person's relative position in a society. Relative position or rank within the social distribution, have been found to affect health in animals (Sapolsky 1998) and in humans (Marmot 2002).

Furthermore, in a study where trends in mortality and morbidity were discussed, Freedman and Martin (1998) emphasise that changes in education distribution are explaining an important part of the decrease in the prevalence of functional limitations in the USA. Melzer et al. (2000) have pointed out differences between different socioeconomic groups in disability-free life expectancy. Groot and Maassen van den Brink (2007) show that the effects of education on self-perceived health status become stronger as people get older. Thus, there is a need to recognise socioeconomic mortality and morbidity differentials and that those should be taken into account when projecting future needs. Recently reported socioeconomic differences in access to care (de Looper and Lafortune 2009) also reinforce the crucial need for better knowledge not only on the number of people at older ages but also on the socioeconomic composition of the older population.

The expected increase in number of people suffering ill-health is often estimated by using the method of simple demographic extrapolation. Simple demographic extrapolation means multiplying observed prevalence rates of severe ill-health by projected changes in the numbers of people in the various age groups and of each gender assuming that prevalence of severe ill-health, at all ages and for both sexes, will be unchanged during the projection period, i.e. only taking into account effect of age. Joung et al. (2000) expand the method of simple demographic extrapolation with educational dimension and show, using data from the Netherlands, that the expected increase in number of older people suffering ill-health as a consequence from the ageing of the population, to a large extent might be counteracted by the increase in the educational level of the population. Here, it should be pointed out that the projection of the population used by Joung et al. (2000) do not allow for differential mortality by educational level.

In Sweden there are significant differentials in mortality (Statistics Sweden 2005) and prevalence of ill-health (Swedish National Board of Health and Welfare 2005) between low and high educated among both men and women. Furthermore, there have been and will be substantial changes in the proportion of the population that have attained highest educational level both among men and women. For example, the share of people in age group 70–74 having high education almost tripled between 1985 and 2002 (Statistics Sweden 2005). The same development among the middle aged may be illustrated by the fact that the share of women having post secondary education in the age group 50–54 years increased from 13 to 34% between 1985 and 2002 (Statistics Sweden 2005).

How will this increasing number of well-educated older people in Sweden affect the total need for care when we take into account morbidity differentials by educational level as well? Will probable changes in population composition, towards higher proportions of older people having high education, counteract the expected increase in the need for care?

## Aims

We aim to analyse how expected changes in educational level in the older population may affect the future prevalence of severe ill-health among the older people in Sweden. In this study, we present alternative scenario projections for the possible development of the number of people with severe ill-health in Sweden between 2000 and 2035. Scenario projections where both morbidity and mortality inequalities by educational level are taken into account are compared with scenarios in which only age and gender are modelled. The projections are made with both constant and decreasing mortality. Those comparisons should result in a better informed demographic base for health care and LTC human resources planning.

### Data and methods

We use two different data sources: population projections and survey data on the prevalence of severe ill-health among older people.

The first set of the data we use consists of the population projections presented by Batljan and Thorslund (2009). Those population projections present estimates of the future number of older people by age, gender and educational level given different mortality trends. Statistical offices usually omit socioeconomic mortality differentials and projected changes in the educational structure of the population. That is why population projections by age, gender and educational level are not available on regular basis. Assumptions regarding decreasing mortality by age and gender used by Batljan and Thorslund (2009) are similar to those used by Statistics Sweden (2000). However, population projections that take into account educational mortality differentials and changes in educational composition of the older population result in a higher number of older people in the coming decades than projected by Statistics Sweden (Batljan and Thorslund 2009).

In this study, we use the projections presented in two of the scenarios by Batljan and Thorslund: one main scenario based on the assumption of decreasing mortality (following the trend observed in the last decades) by age, gender and educational level; and the second conservative background scenario assuming constant future mortality rate by age, gender and educational level.

The second data set is taken from the annual surveys of the Swedish National Survey of Living Conditions (SNSLC) carried out in the period 1975–1999. The SNSLC is an annual, nationally representative survey conducted by Statistics Sweden. The sample frame for the SNSLC covers the whole population living in Sweden, both community-living and institutionalised persons.

However, concerning older people, unfortunately, during almost all years the SNSLC has had an upper age limit. Between 1975 and 1979 the upper age limit was 75 years. Between 1980 and 1999 the corresponding limit was 85 years.[2] The surveys cover around 32,000 people in the 65–84 age range. The number of yearly observations in these age groups amount to 1,300 on average. To provide a more stable selection, the surveys have been collated in 5-year intervals (1975–1979, 1980–1984, 1985–1989, 1990–1994 and 1995–1999).

The non-response rate varied between 18.5% in 1975–1979, 20.0% in 1985–1989 and 22.0% in 1995–1999. The main reason for the increasing non-response rate was an increased number of people not available for interviews. The proportion of those that were sick or institutionalised has been found to be relatively stable over time, with a minor increase during the last years.

From these data a health index with four levels—severe ill-health, moderately severe ill-health, slight ill-health and full health—has been constructed from replies to questions about the general state of health (perceived health status), mobility restrictions, restrictions in functional capacity and having long-standing illness. Respondents reporting poor or fair health status (self rated health based on the question: how do you view your general state of health. Is it good, fair or poor), impaired mobility and highly restricted functional capacity due to long-standing illness were coded as having severe ill-health. The index has been described elsewhere (Statistics Sweden 1989; Swedish National Board of Health and Welfare 1997; Boström and Persson 2001).We have here used the indicator on severe ill-health (SIH), the proportion of people with severe ill-health in the 65–84 age group, divided by gender, by 5-year subgroups (65–69, 70–74,…, 80–84) and by educational level. The prevalence of severe ill-health as an indicator of health status has been used for estimates on the number of older persons in need of LTC elsewhere (Lagergren 2005a, b; Batljan and Lagergren 2005). Furthermore, the overall demand for LTC for older people in Sweden is determined, to a large extent, by the number of people suffering from severe ill-health (Batljan and Lagergren 2005).

Given the relatively small number of observations in each stratum (gender, age group and educational level) and in order to get stable prevalence data we use logistic regression models (Kleinbaum 1994) to estimate current differences in the prevalences of SIH by gender, age and educational level. We have fitted separate models for men and women. Fitting separate models for men and women, we have assumed that both mortality and morbidity development by age group and their relationships with education are gender specific. As an example, in Sweden the demographic projections are always done for men and women separately (with different assumptions for mortality development for men and women). Dummy variables have been constructed for age (four 5-years age group for ages 65–84), educational level (three levels) and period (five dummy variables for the period 1975/1979–1995/1999). Applying the parameters from the logistic regression model we get an adjusted time series over the prevalence of SIH by gender, age group and educational level. The adjusted data from SNSLC are used both as a baseline data in all scenarios and as base for trend extrapolations (logarithmic), using the estimated (adjusted) proportions with SIH by gender, age group and educational level from SNSLC during the period 1975/1979–1995/1999.

A limitation of the SNSLC surveys is the upper age limit of 84 years. We have estimated the SIH distribution of the 85–90 and 90+ age groups by using logarithmic extrapolation over gender, 5-year age groups and educational level. Those prevalences have been validated by comparing the proportion with SIH in the (extrapolated) 85+ groups and the corresponding age groups from the new 2002–2003 SNSLC without upper age limit.

In our study we classify educational level in three categories, indicating the number of school years: low: <10 years (i.e. comprehensive school), middle: between 10 and 11 years, and high: >11 years. The limited space and low marginal value of introducing more than three categories resulted in that we have chosen to use similar

[2] Special survey extensions in order to cover all older people, including those 85 years and older, have been made in 1988/1989 and 2002/2003. From the year 2004 the upper age limit has been abolished.

categorisation of educational level that has been used in other epidemiological studies (Iglesias et al. 2003; Sundquist et al. 2004) done on the same Swedish data. The same classification has also been used by Batljan and Thorslund (2009). Educational level is assumed as fixed by age of 35.

The educational composition of Swedish older population by educational level in 2000, 2020 and 2035 is presented in Fig. 1a and b.

As can be seen from Fig. 1, the dramatic differences in educational level between different cohorts will result in dramatic changes in the educational composition of the older population during the next three decades in Sweden.

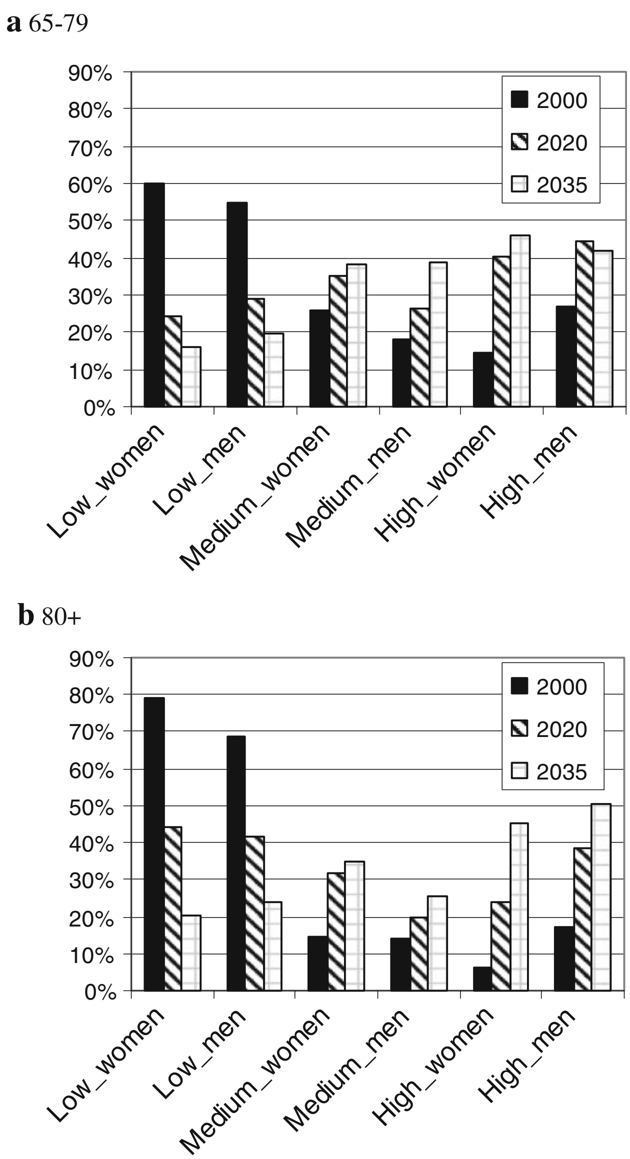


**Fig. 1** Educational composition of Swedish older population by age group, sex and educational level in 2000, 2020 and 2035. Source: Own calculations after projections by Batljan and Thorslund (2009)

The future development in the number of older people suffering SIH in Sweden is a controversial issue (Batljan and Lagergren 2005; Parker and Thorslund 2007). We have created eight alternative scenarios for the development in the number of older people suffering SIH in Sweden. The scenarios were calculated combining assumptions on the development in number of older people based on declining mortality or constant mortality with different assumptions on the proportion of older people suffering SIH. The eight scenarios were made for a period of 35 years from year 2000 up to the year 2035. The future prevalence rates of SIH were calculated by gender, individual age groups and educational level.

The first two scenarios use simple demographic extrapolation without taking into account educational morbidity differentials: one is based upon constant mortality, the other upon declining mortality (in accordance with trend, see Batljan and Thorslund 2009) by gender and age groups. In the next four scenarios, the educational differentials concerning both mortality and morbidity were taken into account. Given gender, age and educational level, we combine constant and declining (following trend estimates) mortality with constant and declining (following trend estimates from adjusted SNSLC data) prevalence of SIH (Fig. 2).

Vågerö (1997) emphasised that higher educational level is a good approximation for what is possible at a given point in time—"the technological frontier"—and may be seen as a mark for the improvement potential among those within a lower level of education. For this reason, we finally create two additional scenarios: converging high and converging low. The idea behind converging scenarios is to illustrate the possible shift to decreasing educational morbidity differentials either by convergence to the level of the highly educated or to the level of the low educated. Different studies (see among others Rosén and Haglund 2005) have argued that the health status among older people may worsen or improve during the next decades. In the "converging low" scenario we assume increasing prevalence of SIH among those having medium and high educational level. Among those who have medium educational level the prevalence of SIH is assumed to increase by 1.5 percent yearly until arriving at the same prevalence of SIH as among those with low educational level. Equivalently, those having high educational level are assumed to arrive at the same prevalence as those having medium educational level. In the "converging high" scenario we assume in a corresponding way the decreasing prevalence of SIH among those having low and medium educational level, until they arrive at the same prevalence level as the above educated group. In our models, the convergence happens after 15 years. In the converging scenarios we use our main scenario concerning population

**Fig. 2** Eight scenarios on future number of older people suffering severe ill-health

| | | **Number of older people based on:** | |
|---|---|---|---|
| | | *Constant mortality (Population projection based on constant age, gender and educational level mortality.)* | *Declining mortality (Population projections based on assumption on yearly reduction of mortality rates by age, gender and educational level.)* |
| **Prevalence of older people suffering severe ill-health based on assumption of:** | *Simple demographic extrapolation* | **Simple/Const. mortality** | **Simple/Trend. Mortality** |
| | Taking into account age and gender educational level mortality and morbidity differentials | | |
| | *Constant prevalence of severe ill health (SIH) by 5 years age group, gender and educational level.* | **Const.edu/Const. mortality** | **Const.edu/Trend. Mortality** |
| | *Declining prevalence of severe ill health (given past trends, 1975-1999).* | **Trend.edu/Const. mortality** | **Trend.edu/Trend. Mortality** |
| | *Convergence of prevalence of morbidity (to those with higher or lower educational level)* | | **Converg.low_edu/ Trend.mortality** |
| | | | **Converg.high_edu/ Trend.mortality** |

projections, based on declining mortality by gender, age group and educational level. All calculations are done per gender, 5-years age group and educational level.

## Results

The number of older people will increase strongly over the next three decades in Sweden. As shown in Fig. 3, the decreasing mortality and changes in the educational structure of the population play an important role as drivers behind the strong increase according to our projections.

The reason why the second Batljan–Thorslund projection arrives at a faster increase in the number of older people than the projection from Statistics Sweden, is because it takes into account educational mortality differentials and expected changes in the socioeconomic composition of the population (Fig. 3).

As shown in Table 1, in Sweden, there is a clear socioeconomic (by educational level) gradient in morbidity (measured as prevalence of SIH) for both sexes and for every age group analysed.

Table 1 (left part) also shows that there has been a decreasing trend in the prevalence of SIH for all educational categories and for all age groups during the period

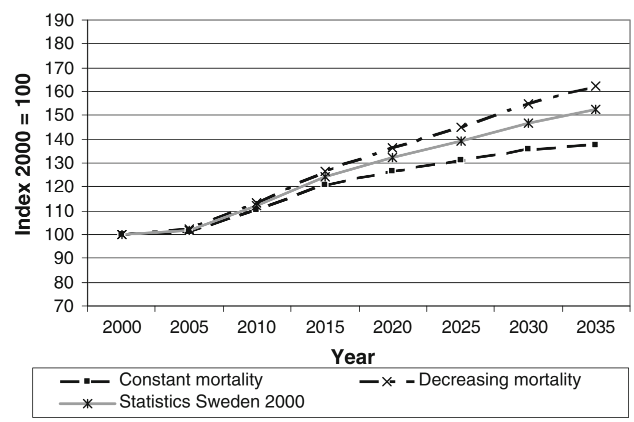


**Fig. 3** The development in projected number of older people in Sweden, two alternative projections according to Batljan and Thorslund (2009) and the projection by Statistics Sweden. Source: Batljan and Thorslund (2009)

1975–1999. However, the pace of decline was lower during the 1990s than for the period 1975–1989.

Batljan and Thorslund (2009) showed that including mortality differentials by educational level has a strong impact on the size of the older population, given the continuing declining mortality trends by gender, age and educational level. As shown in Figs. 4 and 5, also different

**Table 1** Prevalence of severe ill-health, adjusted data 1975/1979–1995/1999 and prevalences by year 2035 in different scenarios

| Education | Age | 1975–1979 (%) | 1980–1984 (%) | 1985–1989 (%) | 1990–1994 (%) | 1995–1999 (%) | Yearly rate of change (%) | 2035 (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Const.edu | Trend.edu | Converg low | Converg high |
| Men | | | | | | | | | | | |
| Low | 65–69 | 16 | 13 | 12 | 11 | 10 | −2.3 | 10 | 7 | 10 | 8 |
| | 70–74 | 20 | 17 | 15 | 14 | 13 | −2.2 | 13 | 8 | 13 | 10 |
| | 75–79 | | 24 | 22 | 20 | 19 | −1.6 | 19 | 13 | 19 | 15 |
| | 80–84 | | 32 | 29 | 27 | 25 | −1.5 | 25 | 17 | 25 | 21 |
| | 85–90 | | | | | | | 34 | 28 | 34 | 28 |
| | 90+ | | | | | | | 46 | 46 | 46 | 38 |
| Medium | 65–69 | 12 | 10 | 9 | 8 | 8 | −2.3 | 8 | 5 | 10 | 6 |
| | 70–74 | 16 | 13 | 12 | 11 | 10 | −2.3 | 10 | 7 | 13 | 8 |
| | 75–79 | | 20 | 18 | 16 | 15 | −1.7 | 15 | 11 | 19 | 12 |
| | 80–84 | | 26 | 24 | 22 | 21 | −1.6 | 21 | 14 | 25 | 16 |
| | 85–90 | | | | | | | 28 | 23 | 34 | 23 |
| | 90+ | | | | | | | 38 | 38 | 46 | 31 |
| High | 65–69 | 10 | 8 | 7 | 6 | 6 | −2.4 | 6 | 4 | 8 | 6 |
| | 70–74 | 13 | 10 | 9 | 8 | 8 | −2.3 | 8 | 5 | 10 | 8 |
| | 75–79 | | 16 | 14 | 13 | 12 | −1.8 | 12 | 9 | 15 | 12 |
| | 80–84 | | 21 | 19 | 17 | 16 | −1.7 | 16 | 12 | 21 | 16 |
| | 85–90 | | | | | | | 23 | 19 | 28 | 23 |
| | 90+ | | | | | | | 31 | 31 | 38 | 31 |
| Women | | | | | | | | | | | |
| Low | 65–69 | 17 | 14 | 13 | 12 | 11 | −2.2 | 11 | 7 | 11 | 9 |
| | 70–74 | 22 | 18 | 16 | 15 | 14 | −2.1 | 14 | 9 | 14 | 11 |
| | 75–79 | | 27 | 24 | 22 | 21 | −1.6 | 21 | 14 | 21 | 17 |
| | 80–84 | | 34 | 31 | 29 | 28 | −1.4 | 28 | 18 | 28 | 23 |
| | 85–90 | | | | | | | 37 | 30 | 37 | 31 |
| | 90+ | | | | | | | 49 | 49 | 49 | 41 |
| Medium | 65–69 | 14 | 11 | 10 | 9 | 9 | −2.3 | 9 | 6 | 11 | 7 |
| | 70–74 | 18 | 15 | 13 | 12 | 11 | −2.2 | 11 | 7 | 14 | 9 |
| | 75–79 | | 22 | 19 | 18 | 17 | −1.7 | 17 | 12 | 21 | 13 |
| | 80–84 | | 28 | 26 | 24 | 23 | −1.5 | 23 | 15 | 28 | 18 |
| | 85–90 | | | | | | | 31 | 25 | 37 | 25 |
| | 90+ | | | | | | | 41 | 41 | 49 | 34 |
| High | 65–69 | 11 | 9 | 8 | 7 | 7 | −2.4 | 7 | 5 | 9 | 7 |
| | 70–74 | 14 | 11 | 10 | 9 | 9 | −2.3 | 9 | 6 | 11 | 9 |
| | 75–79 | | 17 | 15 | 14 | 13 | −1.7 | 13 | 10 | 17 | 13 |
| | 80–84 | | 23 | 21 | 19 | 18 | −1.6 | 18 | 13 | 23 | 18 |
| | 85–90 | | | | | | | 25 | 21 | 31 | 25 |
| | 90+ | | | | | | | 34 | 34 | 41 | 34 |

assumptions on morbidity development, and taking into account morbidity differentials by educational level, have a significant impact on the future number of older people suffering from SIH. Results from the first group of scenarios, where the population projections are based on the assumptions of decreasing mortality rate, are presented in Fig. 4.

The number of older people suffering SIH in Sweden will increase according to our scenario "Trend.edu/Trend.mortality" (following observed trends on mortality and morbidity) by 14% (combined effect of education, ageing and trend with continuing decrease in the prevalence) during the period 2000–2035, compared to the 75% increase in the scenario "Simple/Trend.mortality" (only

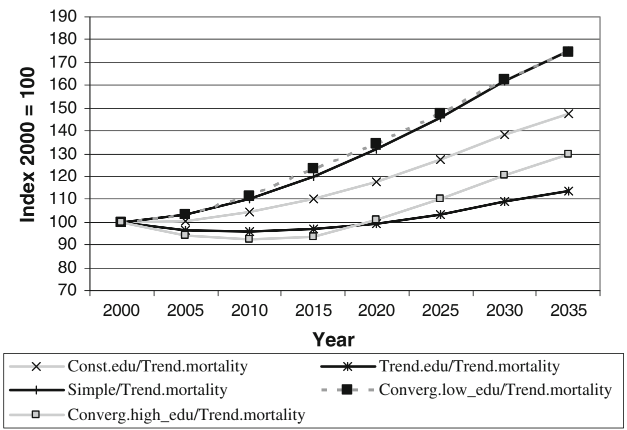


**Fig. 4** Development in the projected number of older people suffering severe ill-health 2000–2035, scenarios based on population projections with decreasing mortality. The population projections with declining mortality lead to an increase of 75% of the number of persons with severe ill-health with the simple scenario, of 48% with the scenario of constant prevalence, and of 14% with scenario of declining prevalence in educational groups according the trend. The scenarios of low and high converging prevalences result in 74 and 30% increase of the number of persons with severe ill-health

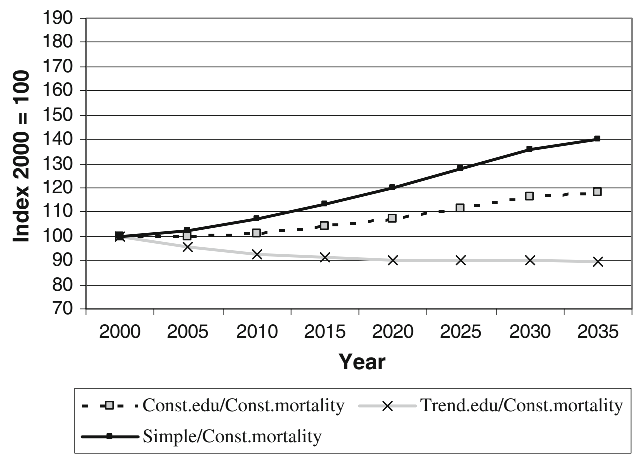


**Fig. 5** Development in the projected number of older people suffering severe ill-health 2000–2035, scenarios based on population projections with constant mortality. The population projections with constant mortality lead to an increase of 40% of the number of persons with severe ill-health with the simple scenario, of 18% with the scenario of constant prevalence of severe ill-health in educational groups and to a decrease of 11% with the scenario of declining prevalence in educational groups

ageing of the population taken into account). That means the predicted increase, when educational level and continuing trend towards lower prevalences of severe ill-health are taken into account, is only 18% (14/75) of the increase predicted when only age is taken into account. The effect of changes in educational composition may be assessed by comparing "Simple/Trend.mortality" scenario with "Const.edu/Trend.mortality" scenario. The effect of additionally taking educational level into account is 63% (48/75) of the increase in SIH compared to taking only age into account.

Taking into account educational morbidity differentials counterbalances the expected increases in the prevalence of ill-health when only age is taken into account by more than half (39% of the expected increase = 30/75), even in our scenario "Converg.high_edu/Trend.mortality" compared to "Simple/Trend.mortality" (Fig. 4).

As shown in Table 1 above, we assume that prevalences of SIH for medium and high educated persons by year 2035 in our scenario "Converg.low_edu/Trend.mortality" are the same as the prevalences observed in the 1980–1984, which means dramatically reversed health trends compared to the whole period 1975–1999. However, even such worsening of health status does not increase the future number of persons suffering SIH more than in the scenario "Simple/Trend.mortality" based on simple demographic extrapolation (Fig. 4), because of the dramatic changes in the population composition by educational level. This result emphasises the importance of including educational mortality and morbidity differentials when assessing the impact of population ageing on future LTC needs and demand for LTC human resources.

The second group of scenarios that we analyse as background scenarios are those where the population projection is based on the assumption of constant mortality rate (which is a very conservative assumption). In our scenario "Trend.edu/Const.mortality", the assumed decreasing prevalence of SIH following the observed trend combined with changes in educational composition, given the assumption of constant mortality, will result in an 11% decrease in the number of older persons suffering ill-health (Fig. 5), despite a 37% projected increase in the number of older persons. The corresponding increase according to the simple demographic extrapolation was 40% in scenario "Simple/Const.mortality").

Figure 5 shows, furthermore, that according to scenario "Const.edu/Const.mortality" (constant morbidity rates during the next 35 years) the inclusion of educational mortality and morbidity differentials together with projected changes in population composition by educational level result in a more than halved increase in the number of persons suffering SIH compared to the corresponding increase as a result from the scenario based on simple demographic extrapolation.

## Discussion

The number of older people, given educational differentials in mortality and expected changes in educational composition during the next decades, will probably increase more than expected by the official population projections in Sweden. This may result in a greater increase in the number of people suffering SIH in Sweden compared to results previously reported by Batljan and Lagergren (2005). However, mortality is not the only health indicator that is associated with educational level. Taking into account morbidity differentials by educational level and changes in educational composition, we show that the projected increase in the number of older people suffering SIH, as a consequence of population ageing, may be counterbalanced to a large extent by changes in the educational composition towards a higher proportion of the population having a high educational level. According to one of the scenarios, the number of older people suffering SIH will even decrease, despite the strong increase in the number of older people by the year 2035.

Our assumptions concerning the continuing decrease in the prevalence of SIH according to trend are comparable to assumptions used by the US Congressional Budget Office (Congressional Budget Office 2004). They are also comparable to the assumptions used in the Ageing Working Group (AWG) of the EU Economic Policy Committee "Constant disability scenario" where the disability-free life expectancy is assumed to increase in the same pace as the rise in longevity (Economic Policy Committee 2006). Furthermore, according to our results concerning the trend 1975–1999, the health status of older persons in Sweden has developed favourably. However, the picture is less clear concerning the late 1990s. There are other studies from Sweden (Parker et al. 2005) pointing out that health status among the older adults may have been deteriorating in the beginning of 2000. The available evidence does not unambiguously imply that one of our scenarios is more likely to occur than the others.

In this study, we have tried to link trends in changes in educational composition of the population with trends in educational mortality and morbidity differentials. The fact that our population projections allow for mortality differentials by educational level is one improvement when compared with other studies (Joung et al. 2000). One other improvement is that we also tested scenarios with unchanged mortality and tried to make comparisons possible with the often used assumption of unchanged prevalence of ill-health in health care and LTC human resources planning. In our study, we have also been able to illustrate how decreasing health disparities in accordance with our scenario "converging high" and "converging low" may affect the number of older people suffering SIH and thereby future LTC needs.

We have also shown that the assumption of the unchanged prevalence of SIH and the often used method of simple demographic extrapolation requires relatively extreme health development in accordance with our scenario "converging low".

There are several limitations that should be kept in mind when interpreting our results. We do not extend our analyses to diverging scenarios (increased health inequalities as a result from worsening health among low educated and improving health among high educated), particularly because of space restrictions. However, according to Joung et al. (2000) increasing educational health inequalities will result in an even greater reduction in the projected increase in the number of people suffering SIH compared to the results from scenarios with constant prevalence rates.

Concerning educational level in the analyses, we do not allow an increase in educational level for new cohorts arriving at the age of 35 years. This may affect our results only marginally because we are making projections for a period of 35 years and the extent of changes in educational level is decreasing very fast with increasing age. That means we use information in our projections from the changes in the educational composition of population that effectively have already occurred.

We are here focusing on education. However, there is also a strong association between other socioeconomic indicators like income, occupational class, housing tenure (Matthews et al. 2006), and marital status (Zajacova 2006) and mortality and morbidity. We are not making adjustments for confounding effects from those factors. Adjustments made in a study by Joung et al. (2000) hardly affected the results from the projections based on education only.

The increased non-response in Swedish NSLC is not biased by education level (Statistics Sweden 2003). Socioeconomic (measured by income and education) inequality in self-perceived health is unlikely to be biased by reporting error (Van Doorslaer and Gerdtham 2003).

The effect of education on mortality in the coming decades will depend on the nature of the association between education and mortality. Although it is not established which of the pathways discussed in different hypotheses concerning the association between educational level and health "matter more for health, they each are likely to contribute to the overall pattern of higher years of schooling being associated with better health status" (Hernandez and Blazer 2006, p. 28).

The same hypotheses are valid for analysing the association between educational level and both mortality and morbidity. However, an important question that needs to be addressed is, whether there are situations where education will affect mortality and morbidity in different ways. Life saving health care may be more accessible for well-educated and their families. This may be true, even with a completely equal access to health care, particularly as a consequence of the fact that new technologies are often available first on request, and the well-educated have better opportunities to get information and are more active to seek information (Goldman and Lakdawalla 2005).

Many life-prolonging measures require complex treatments. The well-educated have been found to better comply with treatments (Goldman and Smith 2002) and to be able to manage chronic conditions better (Goldman and Lakdawalla 2001). One other difference may be related to susceptibility. The better educated may survive longer with life-threatening diseases and with impaired health. This may result in that more people suffering from ill-health survive. This may be the case in our scenario “Converg.low_edu/Trend.mortality”.

Above, we have discussed several caveats that should be kept in mind when interpreting our results. However, the main limitation is the uncertainty regarding whether any association between educational status and health will persist in the same way as it has over the last decades when the number of highly educated people surges during the coming decades. As concerns to the material and behavioural explanation, increasing educational level will probably have a direct effect resulting in lower mortality and better health. In Sweden, better educated older people have greater material resources (higher pension income) than those with primary education (Alm Stenflo 2002). Middle-aged people with higher levels of education in Sweden (the future older people) smoke less, eat better, and exercise more than those with less education (Swedish National Board of Health and Welfare 2005). This will support our scenario “Trend.edu/Trend.mortality”.

The relationship is much more complicated regarding the psychosocial explanation of the association between educational level and health. Psychosocial explanation may by studied as a part of the status syndrome. This status syndrome captures psychological experience of inequality, but also adverse conditions at work, in residential areas, and in general, lack of empowerment and lack of control over own life. According to Marmot (2004), the syndrome has been shown to be a persistent factor behind inequalities in health. However, the status syndrome may be affected in at least two different ways when a larger share of the population is highly educated. At first, those without a higher educational level may tend to be even more marginalised in a society where a relatively large share of the population is highly educated. At second, the perception of “belonging to the privileged part of the society” may be weaker when a majority of the population is highly educated. Not only the perception, but also the direct benefits of “belonging to the privileged part of the society” may be constrained by competition for scarce resources (no matter if the resource is new treatment, good working conditions or a good environment). Therefore, there is a possibility that signs of decreasing marginal utility of the effect of education on health may appear.

At the same time, no matter which specific explanation, it is possible that when the composition of the population changes, the determinants of being in one group rather than in the other one may also change. This structural change could affect the association between education and health. As long as the structural change as well as the declining marginal utility influence the effect of education on both mortality and ill-health in the same way, this could be captured somewhere in between the two scenarios “Trend.edu/Trend.mortality” (18% of the expected increase) and “Const.edu/Const.mortality” (45% of the expected increase).

Concerning the life-course perspective it seems that our results from the scenario “Trend.edu/Trend.mortality” or at least from the scenario “Converg.high_edu/Trend.mortality” will be relatively stable, given the development observed after Second World War in which all new generations in Sweden that will be approaching old age the next decades have enjoyed better living conditions as children than their predecessors.

Our different scenarios show clearly that projections informed by educational mortality and morbidity differentials will have huge consequences for the assessment of future needs of LTC. We need to further evaluate different scenarios in order to understand future development. The value of the scenarios does not lie in their perfect match with the future. It lies in the fact that different likely, or probable, or merely possible scenarios concerning future health trends can have an important role in shaping public health policy (Murray and Lopez 1997), particularly in such a personnel-intensive field as LTC. It is important to know what will happen, if the development will continue in the same direction, or alternatively what may happen if the preconditions are changed (Thorslund and Larsson 2002). Planning which takes into account demographic changes as well as other changes in society that impact on the need for care in the population will improve and refine health human resource policies (Birch 2002).

## Conclusion

The expected increases in SIH that result from the ageing of the population in the period 2000–2035 might, to a large extent, be counteracted by the increase in the educational level of the Swedish population. This outcome will also hold when a substantial increase in the prevalence of SIH by educational level is allowed for in this period. Even a very strong assumption on the increasing prevalence of SIH by gender and age towards the prevalences among the more disadvantaged as regards to educational level, result in a lower increase than projected, using simple demographic extrapolation. Having information on educational differentials in morbidity and disability is thus essential in order to understand how population ageing affects future LTC needs and demand for LTC human resources. The projected increase in educational level is not an event that is still to happen, rather this is a dramatic societal change rooted in the past. It should also been emphasised that the cohorts that are arriving at ages 80 and older during the next decades have had both lower mortality rates and morbidity prevalence at ages 65–80 than older people from previous cohorts as shown in the data on different age groups at different points of time in our two studies. Those new cohorts of older people 80 years and older have furthermore had better health and better living conditions during almost all of their lives than the generations before. From the life-course perspective, this could be seen as a support for our scenario "Trend.edu/Trend.mortality" or at least for our scenario "Converg.high_edu/Trend.mortality".

We recommend therefore that in projections of the prevalence of ill-health and when discussing the demographic dimension within health care and LTC human resources planning or when assessing financial sustainability of health care and LTC in the future, in addition to the ageing of the population and the health status (Batljan and Lagergren 2005), also changes in the population composition by educational level are taken into account.

Taking into account educational differentials in morbidity and mortality as well as changes in the educational composition of the population seem to have substantial implications for the projections of the number of people suffering from SIH. The predictive validity of those new projections should be the issue for further research. That is why our projections should not be regarded as forecasts of the future. However, our analyses show that the projections of the number of people suffering from SIH are very sensitive to changes in the educational population composition, and for taking into account educational morbidity and mortality differentials.

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