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TRENDS IN LIFE EXPECTANCY BY INCOME AND THE ROLE OF SPECIFIC CAUSES OF DEATH

by

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Trends in life expectancy by income and the role of specific causes of death[1]

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Abstract

This study explores how life expectancy at age 35 has evolved across the income distribution in Sweden between 1970 and 2007. During this period, income inequality increased in most western countries, but especially in Sweden. Drawing on a large sample of the Swedish population, our results show that the gap in life expectancy between the richest and poorest fifths of the income distribution also increased during this period. This was the case for both individual measures of income and for family income. The increase was larger for men than for women, but the only group with stagnant life expectancy at age 35 was women in the lowest income quintile group. The difference between the lowest and the highest family income quintile increased by about one year for women and by three years for men. The causes of death that most significantly contributed to the enlarged gap among women were circulatory and respiratory diseases. For men, circulatory disease mortality alone caused most of the increased disparities. Across individual income groups, alcohol, accidents and violence also contributed to the increased gap in male life expectancy, but this was not evident for family income measures.

JEL Classification: I120 I140

Keywords: Life expectancy, income distribution, socio-economic gradient, register data

1 Introduction

The fact that life expectancy is positively associated with socioeconomic status is well-documented in many countries (e.g. Fawcett, Blakely, and Kunst, 2005; Kunst, Leon, Groenhof, and Mackenbach, 1998; Næss, Leyland, Smith, and Claussen, 2005; Lleras-Muney, 2005). Individuals with higher earnings and more education can expect to live longer than less advantaged groups. In Sweden, for example, employed men in the lowest income quintile group have more than twice the mortality risk of men in the highest income group (Torssander and Erikson, 2010). Most analyses of the link between socioeconomic status and mortality however refer to a single point in time, or to short time spans. While inequality in mortality is cause for concern *per se*, the aim of this paper is to document how differences in life expectancy across income groups have changed over time in Sweden.

During the last decades, there have been large changes in income distributions in many parts of the world. Especially inequality of income has increased substantially (OECD, 2011). Remarkably, in the historically egalitarian Sweden, the increase in inequality has been more rapid than in any other OECD country. Against this background, we ask if also mortality differences by income have widened during this period. Although there is much research examining the income-mortality relationship and its causes, only one previous paper studies changes in this association in Sweden. Using survey data, Wamala, Blakely, and Atkinson (2006) show decreasing absolute inequalities in mortality among Swedish men – but increasing inequalities among women – across household income levels during the 1980s and 1990s.

In this paper, we provide estimates of life expectancy across the income distribution for a longer study period – 1970 to 2007 – using administrative register data covering a large part of the Swedish population. We focus on a typical health measure, life expectancy at age 35, and present estimates for each quintile group of income for both individual income (men only) and family income (both men and women). Our results show, in part, a different picture of the development than that in Wamala, Blakely, and Atkinson (2006). In the longer time span of our paper, we document increasing disparities in life expectancy for both men and women, but a greater increase for men. Male life expectancy in the lowest fifth of individual income had in 2007 only started to reach the life expectancy that the average man in the population had 30 years ago. In addition, even though female life expectancy inequalities are smaller, women in the lowest fifth of family income are the only group whose life expectancy was stagnant. The conclusion is that although life expectancy increased for most income groups during the period, the

signs of increased inequality in life expectancy in the present paper are evidence of a public health equity problem that has largely been overlooked in Sweden.

In the second part of the paper, we document the contribution of seven groups of causes of death to changes in life expectancy by income level. Such cause-specific mortality trends by income level have to our knowledge not been studied in Sweden before. In the overall population, there has been a large decline in deaths due to heart diseases, but our results show that the lowest income group has not benefited as much as the highest group from this reduction. The same pattern of a larger positive contribution to life expectancy for high-income groups is also found for several other causes of death, for example lung cancer and respiratory disease mortality.

The remainder of this paper is structured as follows. We review and discuss the related literature in Section 2. In Section 3, we describe our data and discuss some of their shortcomings, and how we have addressed those. The main results are presented and discussed in Section 4. Section 5 offers some concluding comments.

2 Related literature

Increasing differences in life expectancy between socio-economic groups have recently been observed in a number of high-income countries; for example in the US (Montez and Zajacova, 2013); the UK (Marmot and Brunner, 2005), and in Norway (Steingrimsdottir et al., 2012; Strand et al., 2010). For Sweden, the difference in mortality risk between educational levels has widened during the last decades (Shkolnikov et al., 2012; The National Board of Health and Welfare [Socialstyrelsen], 2013). Similarly, life expectancy gaps across occupational classes have increased during the 1980s and 1990s (Burström, Johannesson, and Diderichsen, 2005).

Because of increasing income inequality in Sweden and elsewhere, the trend in life expectancy differences across income groups is particularly interesting. In addition, while increasing mortality inequality by education may be affected by compositional changes due to the expansion of tertiary education since the mid-20th century (Erikson and Jonsson, 1996), the sizes of relative income groups are by definition unchanged. Reports of stagnating or decreasing trends for mortality inequalities across income groups are rare (cf. Wamala, Blakely, and Atkinson, 2006), but trend figures may vary across income measures. In particular, since female labour force participation has increased considerably during the 20th cen-

tury, individual income has become a more important part of women's economic circumstances as well as of the total resources in the household. Widening gaps in mortality have been reported for household disposable income (Tarkiainen, Martikainen, Laaksonen, and Valkonen, 2012), but increasing inequalities have also been established for poverty measures (Smith, Dorling, Mitchell, and Shaw, 2002), individual disposable income (Brønnum-Hansen and Baadsgaard, 2007), and earnings (Waldron, 2007).

To review a few income-life expectancy studies in more detail, Waldron (2007) estimates trends in life expectancy by earnings for male Social Security-covered workers in the US between 1972 and 2001. She finds that the top half of the average relative earnings distribution experienced much faster improvements in life expectancy than the bottom half did. Similarly, Singh and Siahpush (2006) conclude that the 2.8 years gap in life expectancy between the top and bottom decile deprivation index groups in the U.S. population in 1980-82 had widened to 4.5 years in 2000. In the paper closest to ours, Tarkiainen, Martikainen, Laaksonen, and Valkonen (2012) show that differences in mortality across household disposable income groups have widened dramatically in Finland between 1988 and 2007. The difference in life expectancy at age 35 for women in the bottom fifth of the income distribution compared to the highest fifth amounted to 3.9 years in 1988. In 2007, the difference was 6.8 years. The corresponding figures for Finnish men were 7.4 years in 1988 and 12.5 years in 2007. Hence, during these 20 years, the life expectancy gap had increased with around three years for women and five years for men. As income inequality in Finland and Sweden exhibit quite similar trends (OECD, 2011), we might expect increasing inequality in all-cause mortality inequality in Sweden as well. Even though health inequalities have traditionally been more pronounced in Finland, especially for men (Mackenbach et al., 2008), the socio-economic forces at play may be largely similar in the two countries.

In previous studies, increasing mortality inequalities are shown to be driven by an increasing gap in cardiovascular disease mortality (Mackenbach et al., 2003) and other smoking-related causes of death such as lung cancer and lower respiratory diseases (Strand et al., 2010). In Finland, the increase is mainly explained by a growing disparity in alcohol-related deaths, as well as many cancers, between high- and low-income groups (Tarkiainen, Martikainen, Laaksonen, and Valkonen, 2012). For Sweden, there is to our knowledge no previous research on cause-specific mortality trends by income level.

3 Data and methods

The data we use are assembled from several administrative registers, put together by Statistics Sweden by means of unique personal identity numbers. The study population emanates from a 35 percent random sample of cohorts born in 1932-1967, present in the Multi-generation Register (Statistics Sweden, 2008) which includes all persons born in 1932 or later and living in Sweden in any year from 1961 and onwards.[1] All biological and social parents, as well as siblings, and the children of the sample persons and their siblings, are added from the population register and included in the study population. As a result, a large part of the Swedish population is included in the analyses. Overall, we use information on 1,239,417 deaths and 94,295,224 person years.

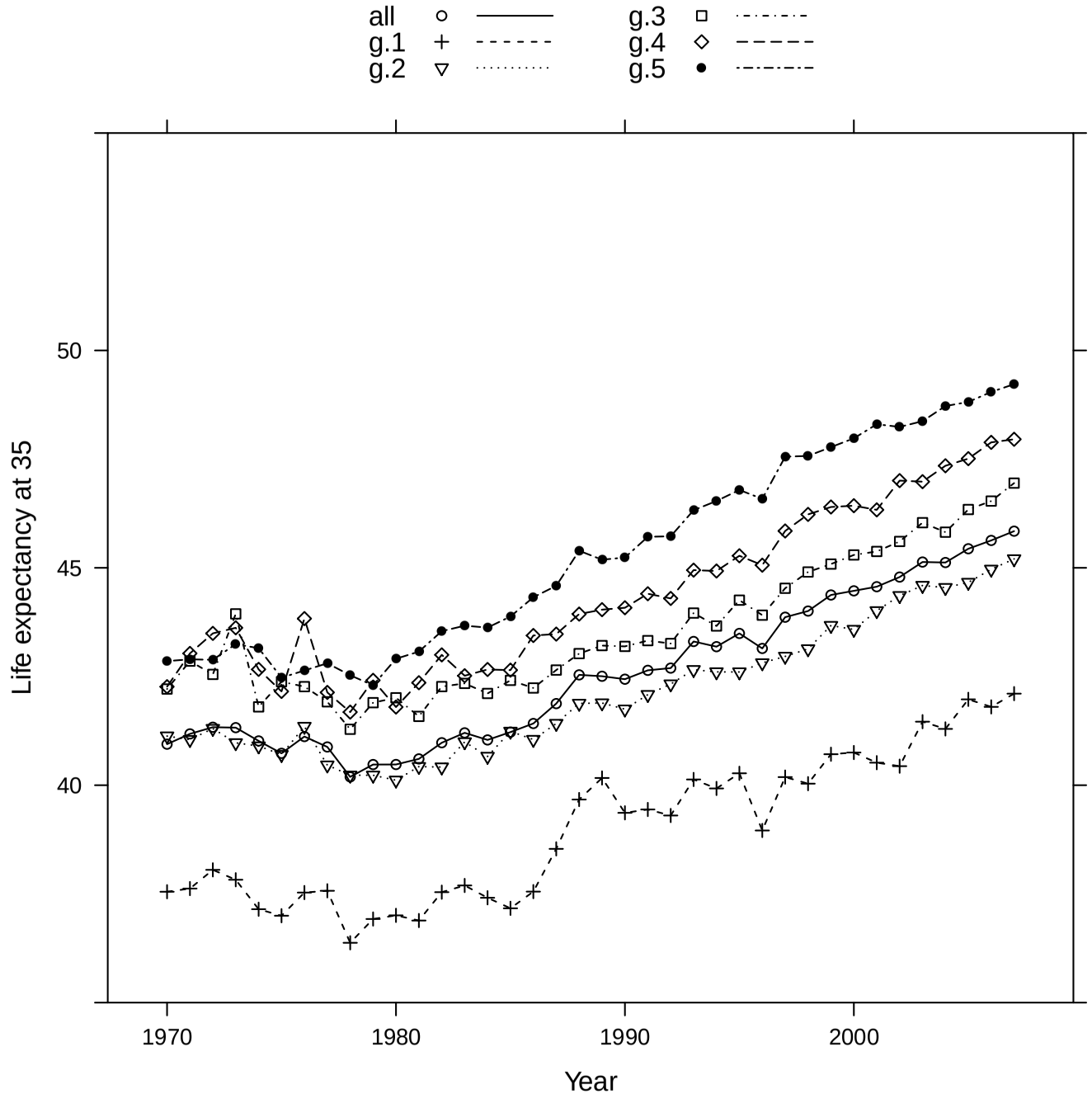
Information about date of death from 1970 to 2007 stems from Statistics Sweden. Information on the underlying cause of death, available up until 2004 and classified as listed in the International Classification of Diseases, ICD, versions 8 to 10, originates from the Cause of Death Register kept by The National Board of Health and Welfare (*Socialstyrelsen*). We follow the classification for different ICD versions according to the European Shortlist for Causes of Death (Eurostat, 1998) when applicable. In the cause-specific analyses, we distinguish between seven major groups of causes of death as well as a remaining category: (1) Circulatory diseases (I00-99); (2) Lung cancer (including malignant neoplasms of larynx/trachea/bronchus, C34-34); (3) Other cancers (C00-D48, except C32-34); (4) Respiratory diseases (J00-J99); (5) Major alcohol-related causes (F10, K70, X45); (6) Suicide and intentional self-harm (X60-84); (7) Other external causes (including violence and accidents) (V01-Y89, except X60-84 and X45); and (8) All other causes of death.

Individual annual income stems from Statistics Sweden's Income Register, which in turn is based on the Swedish tax assessment procedure. These data are available for the entire population from 1968 and onwards. The income register provides data on total income from all sources, i.e., work, self-employment, capital, real estate, work-related pensions, and, after a tax change in 1973, unemployment insurance and sick pay.

We use two income measures: Individual income (for men only) and family income. The individual income measure corresponds to total market income (*Summa förvärvs- och kapitalinkomster*), including all the income sources men-

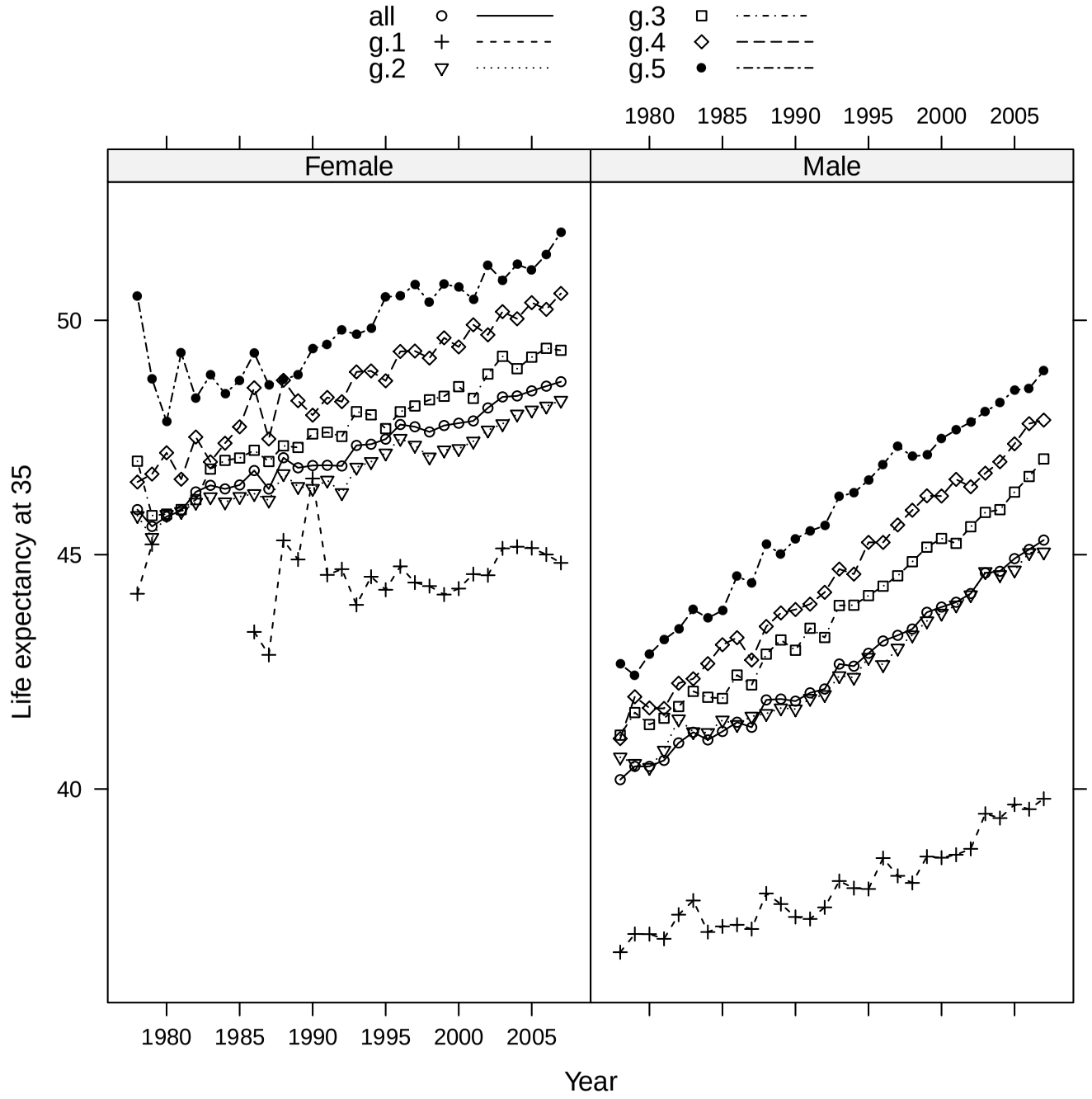
[1] The requirement that the persons must have been registered in Sweden from 1961 and onward implies that persons who died between 1932 and 1960 are not included.

Figure 1 Life expectancy at age 35 by income quintile in Sweden (invididual income, only men)



Source: Authors' calculations from Swedish register data.

Figure 2 Life expectancy at age 35 by family income quintile in Sweden



Source: Authors' calculations from Swedish register data.

tioned above. Life expectancy trends by individual income could not be estimated for women since many of them were not and had not been previously active in the labour market in the beginning of the study period. Instead, we use a measure of family income, available from 1978, for both men and women. Family income is the sum of the individual incomes, defined as above, of a married couple and individual income only for non-married persons. More precisely, we know the spouse's income for those who are married and for cohabiters who have a common child. Cohabiters who do not have common children are treated as unrelated individuals. Ideally, we would like to adjust family income for household economies of scale by using an equivalence scale. Unfortunately, we do not have information on household structure and opt for using the income as described above. In all analyses, both for individual and family measures, those with zero income in three successive years are excluded from the analyses.

Note that we are not attempting to capture the relationship between permanent or lifetime income and length of life. It is now well-established that the relationship between lifetime and annual income is a complex one and that the classical measurement error model is grossly inadequate at most stages of the lifecycle and that individual income processes can be very different for men and women (see Haider and Solon, 2006; Böhlmark and Lindquist, 2006; Nybom and Stuhler, 2011). Our aim is simply to describe the evolution of the cross-sectional bivariate distribution of income and length of life across time. Using data on deaths in each year and incomes of both the deceased and the living in the three preceding years, we measure life expectancy in each quintile group of income.

The analysis is conducted as follows. First, annual income is regressed on fully interacted cohort, year and sex indicators, and the residual from these regressions is kept for each individual in each year. Second, for a given year t, we take the average residual from t to $t-2$ (to somewhat reduce its variability from year to year), and assign each person to the quintile group that the average residual belongs to. Third, we measure life expectancy (grouped into five-year age intervals) by sex and income group in year t using that year's population at the end of the year and the deaths during the year $t+1$. Lastly, we estimate life expectancy at age 35 from life tables based on the death rates for each income group and for men and women separately. Finally, we aggregate deaths across four years at the beginning and end of the period – 1970-1973 and 2000-2003 for individual incomes and 1978-1981 and 2000-2003 for family incomes – and decompose the change in life expectancy by cause of death using the same methods as Tarkiainen, Martikainen, Laaksonen, and Valkonen (2012), which in turn are based on United Nations Secreteriat (1988).

4 Results

All-cause mortality

Since the 1970s, life expectancy at age 35 increased for all income groups in Sweden both according to measures of individual income (Figure 1, estimates available for men only) and family income (Figure 2). On average, life expectancy at age 35 increased by 5 years for men and 3 years for women between 1978 and 2007. (See also appendix tables A1 and A2 which show each series.) However, the mortality improvements were generally greater among individuals with high incomes and it is clear that an increase in the inequality of life expectancy has taken place during this period. This is mainly because the increase in life expectancy was more rapid for the highest income group than for individuals with the lowest incomes. Generally, the life expectancy gap for adjacent income groups was largest between the lowest and the second lowest income quintiles, while the 2nd to 5th quintiles (i.e., those with the 80 percent highest incomes) had more similar trends and levels of life expectancy across the period. However, the increase in life expectancy was somewhat slower also for the second lowest income group compared to the highest group, particularly among men.

For women with the lowest family incomes (Figure 2), the trend has been particularly unfavourable. In 1978, life expectancy at age 35 for these women was 44.2 years. Almost thirty years later, it had increased by only 0.6 years. Nevertheless, the increase in inequality (both in the absolute and relative sense) between income groups in life expectancy was smaller for women than for men. The gap widened from 6.3 years to 7.1 years for women and from 6.2 years to 9.1 years for men between the lowest and highest family income quintile (between 1978 and 2007, see Figure 2), i.e. by about one year for women and about three years for men.

Comparing individual and family income measures for men, the increase in life expectancy differences across income groups were more marked when using the family income measure. According to individual income quintile groups, in 1970 a 35-year-old man in the poorest group could expect to live another 37.5 years while a man in the richest group could expect to live 42.9 more years i.e., a difference of 5.4 years. In 2007, the corresponding life expectancies were 42.1 and 49.2 years, respectively, a difference of 7.1 years. The increase in the difference in expected lifeyears between the two income groups amounted to about 31 percent ((7.1-5.4)/5.4). For family income measures, the corresponding relative increase (but now between the years 1978 and 2007) was 13 percent for women and 47

percent for men.

Cause-specific mortality

Next, we analyse how specific causes of death, according to the underlying cause in the national Cause of Death Register, contributed to the change in life expectancy at age 35. Cause-specific information is available to us only up until the year 2003. In Tables 1 (individual income for men) and 2 (family income), we show the contribution of seven major causes of death, as well as a residual category, to the changes in life expectancy between the beginning and the end of the period. For individual income, men in the highest quintile group (the three last columns of Table 1) increased their life expectancy with 5.2 years between the beginning of the 1970s (averaging 1970—1973) and the beginning of the 2000s (2000—2003). This increase was mainly due to a clear decline in deaths due to circulatory diseases (principally ischaemic heart disease), while none of the specific causes of death had any negative impact on life expectancy among the richest fifth. The situation was partly different for men in the poorest fifth (the three first columns of Table 1). This group also increased their life expectancy – with 3.0 years – but the increase was in principle only due to a decline in deaths due to circulatory diseases and cancers (except lung cancer).

Thus, both income groups have benefited more from the reduction in deaths due to heart and cerebrovascular diseases than from reductions in any other causes of death. It is, however, evident that – in terms of additional years of life – the lowest income group did not benefit as much as the highest group from the large overall reduction in circulatory diseases. The largest difference originated from deaths occurring at older ages, from 65 years of age and above. In total, differential improvements in circulatory disease mortality stand for half of the increased inequality in life expectancy (51 %).[2] Three other cause groups contributed to at least 10 % of the increased longevity gap across men's individual income groups: Alcohol-related mortality (12 %), lung cancer (11 %), and external causes (e.g., accidents and violence, 11 %). Our finding that high-income groups benefit relatively more from reduced mortality due to heart and cerebrovascular diseases is in line with the results in Mackenbach et al. (2003), who analyse mortality inequalities in six Western European countries.

Taken together, in all specific causes of death distinguished here except other

[2]These percentages correspond to the differences in the contribution (in years) divided by the total difference between the highest and the lowest groups.

Table 1 The contribution of causes of death to changes in life expectancy at age 35 years from 1970–1973 to 2000–2003 in Sweden by income group (individual income, only men)

	Poorest fifth			Richest fifth		
	All	35-64	65+	All	35-64	65+
Circulatory	2.94	1.11	1.83	4.08	1.14	2.94
Lung cancer	−0.05	0.01	−0.05	0.19	0.05	0.14
Other cancer	0.39	0.35	0.03	0.37	0.23	0.13
Respiratory	−0.03	0.01	−0.03	0.12	0.02	0.10
Alcohol	−0.27	−0.22	−0.05	0.00	0.00	0.00
Suicide	0.10	0.08	0.02	0.14	0.12	0.02
Other external	0.02	0.04	−0.02	0.26	0.14	0.12
All other	−0.11	−0.01	−0.09	0.06	0.16	−0.10
Total	3.00	1.36	1.64	5.21	1.87	3.34

Source: Authors' calculations from Swedish register data.
Note: Estimates are based on deaths aggregated across four years at both the beginning and the end of the series.

Table 2 The contribution of causes of death to changes in life expectancy at age 35 years from 1978–1981 to 2000–2003 in Sweden by income group (family income, both men and women)

	Poorest fifth			Richest fifth		
A. Men						
	All	35-64	65+	All	35-64	65+
Circulatory	1.95	0.74	1.21	3.80	1.05	2.76
Lung cancer	−0.04	0.01	−0.05	0.26	0.11	0.14
Other cancer	0.03	0.03	0.00	0.50	0.33	0.18
Respiratory	0.05	0.06	−0.01	0.25	0.05	0.19
Alcohol	0.21	0.24	−0.04	0.03	0.03	0.00
Suicide	0.04	0.03	0.01	0.16	0.13	0.03
Other external	0.04	0.07	−0.02	0.09	0.06	0.03
All other	−0.47	−0.17	−0.31	−0.17	0.06	−0.23
Total	1.81	1.02	0.79	4.92	1.82	3.10
B. Women						
	All	35-64	65+	All	35-64	65+
Circulatory	1.69	0.36	1.33	2.11	0.29	1.82
Lung cancer	−0.39	−0.20	−0.19	−0.16	−0.07	−0.09
Other cancer	0.10	0.37	−0.27	0.39	0.38	0.01
Respiratory	−0.33	−0.05	−0.28	0.21	0.04	0.16
Alcohol	0.03	0.05	−0.01	0.00	0.01	−0.01
Suicide	0.08	0.08	0.00	0.08	0.08	0.00
Other external	−0.03	0.03	−0.06	−0.09	0.00	−0.09
All other	−1.08	−0.06	−1.02	−0.66	0.07	−0.74
Total	0.06	0.57	−0.51	1.88	0.81	1.07

Source: Authors' calculations from Swedish register data.
Note: Estimates are based on deaths aggregated across four years at both the beginning and the end of the series.

cancers, the positive contribution to life expectancy was larger for the highest income group. On top of that, it was only in the lowest individual income group that some causes of death contributed to a decline in life expectancy. For example, alcohol-related causes decreased life expectancy with 0.3 years for individuals in the lowest income group. Similar findings, but smaller in magnitude, also applied to lung cancer, respiratory disease mortality, and the residual category of all other diseases.

For men, the cause-specific result for family income (Table 2) partly mirrors the estimates for individual income. For example, the major source to the inequality increase in life expectancy years was different trends in circulatory disease mortality. Lung cancer also showed similar figures for family income, contributing to about one tenth of the increase. However, in contrast to the result when assigning men to their individual income quintile groups, alcohol-related mortality did not contribute to an increase in inequality across family income groups (the impact was actually reversed). Moreover, violence and accidents was a less important contributor to increased mortality inequality when men were categorized according to their family income.

Women in the lowest family income category could not expect to live much longer in the end (2003) than in the beginning of the period (1978); the increase amounted to only 0.06 years. The trend was however more positive in younger ages (<65 years), while negative among poor women above 65 years of age. For high-income women, the mortality decline was prevalent both before and after 65 years of age. Like for men, but to a lesser extent, circulatory disease mortality was one of the causes behind the increasing life expectancy gap. High-income women (according to family income) could expect to live another 2.1 years due to declining mortality from heart and cardiovascular diseases, while the corresponding number of years for women in the lowest income group was 1.7. As a consequence, circulatory diseases accounted for 23 % of the widening female mortality disparities. In addition, respiratory diseases and lung cancer clearly contributed to the increased gap for women. Together they accounted for almost half of the increased gap. Both these causes had a clear negative impact on expected life-years among women with low family incomes: Lung cancer with -0.4 years and respiratory disease mortality with -0.3 years. The mortality trend was negative for all groups of women for both middle- and old-age mortality, but consistently more unfavourable for women in the lowest family income group.

Regarding alcohol-related causes of death, suicide, and other external causes, none of these affected the gap in expected life years at age 35 for women. In sum, five cause groups contributed to the increased inequality in female life expectancy

between the top and the bottom income quintiles: Circulatory diseases together with the residual category of all other causes (both 23 %), respiratory diseases (30%) cancer except lung cancer (16 %), and lung cancer (13 %).[3] Together, differential trends in these causes amounted to the total increase in the gap in female life expectancy across income groups. To summarize the figures for men, heart diseases contributed most significantly to increasing vital inequalities regardless of the income measure. Lung cancer also had similar impact on the gap for the two income measures, while alcohol-related mortality, accidents and violence (other external causes) only contributed to the increased gap between individual income groups.

5 Concluding comments

The main finding of this paper is that inequality in life expectancy across the income distribution increased in Sweden from the 1970s and onwards. This rise was driven by a more rapid increase in expected life-years for high-income than for low-income individuals. Thus, although all groups could expect improved longevity during the period, the increase was much more modest for individuals in the poorest income fifth. The increase in life expectancy inequality across income groups was greater for men than for women. In 2007, the life expectancy difference at age 35 between the lowest and the highest family income quintile was 9.1 years for men and 7.1 years for women. Thirty years earlier, the difference was 6.2 (men) and 6.3 (women) years, respectively. In comparison with similar analyses for Finland (Tarkiainen, Martikainen, Laaksonen, and Valkonen, 2012), the increasing gap in life expectancy was smaller in Sweden. However, Swedish women in the lowest income group experienced a particularly poor trend with stagnating life expectancy during the study period. This is consistent with figures for life expectancy differences between educational groups in Sweden (The National board of health and welfare [Socialstyrelsen], 2009) which have shown that life expectancy for women with only a basic educational level more or less stagnated after 1990.

We also analyse which major causes of deaths have contributed to the changes in life expectancy differences over time. During the last decades, there has been a large decline in deaths due to heart diseases in the overall population. However, this decline was more rapid among high-income groups. For men in par-

[3]These percentages correspond to the differences in the contribution (in years) divided by the total difference between the highest and the lowest groups.

ticular, differential progress rates in circulatory diseases were the main cause of increasing vital inequalities. Circulatory disease mortality also accounts for the increasing gap for women, amounting to about a fourth of the rise. For women, however, smoking-related mortality, such as lung cancer and respiratory diseases, contribute more to the increase than circulatory diseases. Taken together, these causes explain more than forty per cent of the increased gap among women. During our study period, smoking has been more prevalent among lower educated individuals than among higher educated individuals, with lower educated women having the least favourable trends (Cavelaars et al., 2000; Giskes et al., 2005). This may explain the greater impact of lung cancer and respiratory diseases on female life expectancy disparities; still, smoking is also an important risk factor to ischaemic heart diseases and cardiovascular diseases (Kannel, McGee, and Catelli, 2000; Shaper et al., 1985).

Alcohol-related mortality did not influence the increase in vital inequalities for women. In line with this result, a recent Swedish study on educational disparities in alcohol-related mortality since 1990 shows that the contribution of these causes to overall mortality differentials is unchanged for women (Landberg and Budhiraja, 2013). For men, our all-cause decomposition yields diverse result for individual and family income measures, which calls for a more thorough analysis of the impact of the family structure on these causes before any further conclusions can be drawn.

Compared to papers that examine mortality differences across educational levels and social classes, basing the analyses on income quintile groups, like we do, simplifies comparisons across time as the income groups, by definition, are equally large. For instance, the distribution of the population across different levels of education has changed considerably. One might be concerned that the least educated group, which has diminished over time, is more select today compared to thirty years ago. Of course, the composition of income groups is also likely to have changed across time. Further research should examine the role of compositional change regarding, e.g., education, family structure, and labour market attachment, all of which are associated with mortality risks.

There are also limitations in the present study that call for caution in interpreting the results. First, our family income measure is crude due to the lack of information on household composition. This is a concern as low (high) income also reflects the likelihood of living alone (cohabiting). The results are therefore likely to reflect the association between family structure and longevity besides the income-mortality relationship. In addition, the family income does not accurately signal household consumption standards since information on the number of in-

dividuals in the household is missing. Secondly, the international classification of diseases (ICD) has undergone several changes during the study period, and the different versions are not fully comparable. This is particularly challenging when comparing alcohol-related deaths over time (Office of National Statistics, 2006). Lastly, for computational reasons, people with zero income during three or more years did not contribute to the life expectancy estimates. The vital inequalities in the total population are therefore likely to be greater than the values in our analyses since the most disadvantaged individuals are excluded.

Given what we know from previous research on the association between income and health (Deaton, 2003; Smith, 1999), it is unsurprising that income correlates negatively and strongly with health and life expectancy. What stands out in our results, though, is that the gap in life expectancy has increased over time, and that the increase took place during a relatively short time period. The causal story is, however, yet to be uncovered (for Swedish evidence, see Lindahl, 2005). It is evident that many social and behavioural processes are associated with health and length of life (Elo, 2009). Public health researchers tend to stress the impact of income on health (Kawachi, Adler, and Dow, 2010), but it is, however, also clear that a large part of the relationship between income and mortality is caused by ill-health reducing the possibilities of higher incomes (Deaton, 2003). Reduced sickness benefits, for example, would therefore widen the gap in life expectancy across income groups even if any effect of income on health remained constant.

During the period we study, income inequality in Sweden increased substantially. Our results make clear that this increase in inequality coincided with an increase in differences in life expectancy between high- and low-income earners. We can not tell what caused either development. However, the increased disparities in mortality constitute a serious public-health and social-policy concern.

Table A 1 (Apppendix) Life expectancy by income group (individual income, only men)

	all	g.1	g.2	g.3	g.4	g.5
1970	40.9	37.5	41.1	42.2	42.3	42.9
1971	41.2	37.6	41.0	42.9	43.0	42.9
1972	41.3	38.1	41.3	42.5	43.5	42.9
1973	41.3	37.8	41.0	43.9	43.6	43.2
1974	41.0	37.1	40.9	41.8	42.7	43.2
1975	40.7	37.0	40.7	42.4	42.2	42.5
1976	41.1	37.5	41.4	42.3	43.8	42.6
1977	40.9	37.6	40.5	41.9	42.1	42.8
1978	40.2	36.4	40.2	41.3	41.7	42.5
1979	40.5	36.9	40.2	41.9	42.4	42.3
1980	40.5	37.0	40.1	42.0	41.8	42.9
1981	40.6	36.9	40.4	41.6	42.4	43.1
1982	41.0	37.5	40.4	42.3	43.0	43.5
1983	41.2	37.7	41.0	42.3	42.5	43.7
1984	41.0	37.4	40.7	42.1	42.7	43.6
1985	41.2	37.2	41.2	42.4	42.6	43.9
1986	41.4	37.6	41.1	42.2	43.4	44.3
1987	41.9	38.5	41.4	42.6	43.5	44.6
1988	42.5	39.7	41.9	43.0	43.9	45.4
1989	42.5	40.2	41.9	43.2	44.0	45.2
1990	42.4	39.4	41.7	43.2	44.1	45.2
1991	42.6	39.4	42.1	43.3	44.4	45.7
1992	42.7	39.3	42.3	43.3	44.3	45.7
1993	43.3	40.1	42.7	44.0	44.9	46.3
1994	43.2	39.9	42.6	43.7	44.9	46.5
1995	43.5	40.3	42.6	44.3	45.3	46.8
1996	43.1	39.0	42.8	43.9	45.1	46.6
1997	43.9	40.2	43.0	44.5	45.8	47.6
1998	44.0	40.0	43.1	44.9	46.2	47.6
1999	44.4	40.7	43.7	45.1	46.4	47.8
2000	44.5	40.8	43.6	45.3	46.4	48.0
2001	44.6	40.5	44.0	45.4	46.3	48.3
2002	44.8	40.4	44.4	45.6	47.0	48.2
2003	45.1	41.5	44.6	46.0	47.0	48.4
2004	45.1	41.3	44.5	45.8	47.3	48.7
2005	45.4	42.0	44.7	46.3	47.5	48.8
2006	45.6	41.8	45.0	46.5	47.9	49.0
2007	45.8	42.1	45.2	46.9	48.0	49.2

Table A 2 (Apppendix) Life expectancy by family income group

	Women						Men					
	all	g.1	g.2	g.3	g.4	g.5	all	g.1	g.2	g.3	g.4	g.5
1978	46.0	44.2	45.8	47.0	46.5	50.5	40.2	36.5	40.7	41.1	41.1	42.7
1979	45.6	45.2	45.4	45.8	46.7	48.7	40.5	36.9	40.5	41.6	42.0	42.4
1980	45.8	*Inf*	45.9	45.9	47.2	47.8	40.5	36.9	40.5	41.4	41.7	42.9
1981	45.9	*Inf*	45.9	46.0	46.6	49.3	40.6	36.8	40.8	41.5	41.7	43.2
1982	46.3	*Inf*	46.1	46.2	47.5	48.3	41.0	37.3	41.5	41.8	42.3	43.4
1983	46.5	*Inf*	46.2	46.8	47.0	48.8	41.2	37.6	41.2	42.1	42.4	43.8
1984	46.4	*Inf*	46.1	47.0	47.4	48.4	41.0	36.9	41.2	42.0	42.7	43.6
1985	46.5	*Inf*	46.2	47.1	47.7	48.7	41.2	37.1	41.5	41.9	43.1	43.8
1986	46.8	43.4	46.3	47.2	48.6	49.3	41.4	37.1	41.4	42.4	43.2	44.5
1987	46.4	42.9	46.2	47.0	47.5	48.6	41.3	37.0	41.6	42.2	42.8	44.4
1988	47.1	45.3	46.7	47.3	48.7	48.7	41.9	37.8	41.6	42.9	43.5	45.2
1989	46.9	44.9	46.5	47.3	48.3	48.8	41.9	37.5	41.7	43.2	43.8	45.0
1990	46.9	46.6	46.4	47.6	48.0	49.4	41.9	37.3	41.7	43.0	43.8	45.3
1991	46.9	44.6	46.6	47.6	48.4	49.5	42.1	37.2	41.9	43.4	43.9	45.5
1992	46.9	44.7	46.3	47.5	48.3	49.8	42.1	37.5	42.0	43.2	44.2	45.6
1993	47.3	43.9	46.9	48.1	48.9	49.7	42.7	38.0	42.4	43.9	44.7	46.2
1994	47.4	44.5	47.0	48.0	48.9	49.8	42.6	37.9	42.4	43.9	44.6	46.3
1995	47.5	44.3	47.2	47.7	48.7	50.5	42.9	37.9	42.8	44.1	45.3	46.6
1996	47.8	44.8	47.5	48.0	49.3	50.5	43.2	38.5	42.7	44.3	45.3	46.9
1997	47.7	44.4	47.3	48.2	49.3	50.8	43.3	38.1	43.0	44.5	45.6	47.3
1998	47.6	44.3	47.1	48.3	49.2	50.4	43.4	38.0	43.3	44.8	45.9	47.1
1999	47.8	44.1	47.2	48.4	49.6	50.8	43.8	38.6	43.6	45.2	46.3	47.1
2000	47.8	44.3	47.3	48.6	49.4	50.7	43.9	38.5	43.7	45.3	46.3	47.5
2001	47.9	44.6	47.4	48.3	49.9	50.4	44.0	38.6	43.9	45.2	46.6	47.7
2002	48.1	44.6	47.7	48.9	49.7	51.2	44.2	38.7	44.1	45.6	46.4	47.8
2003	48.4	45.1	47.8	49.2	50.2	50.9	44.6	39.5	44.6	45.9	46.7	48.0
2004	48.4	45.2	48.0	49.0	50.0	51.2	44.6	39.4	44.6	46.0	47.0	48.2
2005	48.5	45.1	48.1	49.2	50.4	51.1	44.9	39.7	44.7	46.3	47.4	48.5
2006	48.6	45.0	48.2	49.4	50.2	51.4	45.1	39.6	45.0	46.7	47.8	48.5
2007	48.7	44.8	48.3	49.4	50.6	51.9	45.3	39.8	45.1	47.0	47.9	48.9

References

Brønnum-Hansen, H. and M. Baadsgaard (2007). "Increasing social inequality in life expectancy in Denmark". *The European Journal of Public Health* 17.6, pp. 585–586.

Burström, K., M. Johannesson, and F. Diderichsen (2005). "Increasing socio-economic inequalities in life expectancy and QALYs in Sweden 1980–1997". *Health Economics* 14.8, pp. 831–850. ISSN: 1099-1050.

Böhlmark, A. and M. J. Lindquist (2006). "Life-Cycle Variations in the Association between Current and Lifetime Income: Replication and Extension for Sweden". *Journal of Labor Economics* 24.4, pp. 879–896.

Cavelaars, A. E., A. E. Kunst, J. J. Geurts, R. Crialesi, L Grötvedt, U. Helmert, E. Lahelma, O. Lundberg, J. Matheson, A. Mielck, et al. (2000). "Educational differences in smoking: international comparison". *BMJ: British Medical Journal* 320.7242, p. 1102.

Deaton, A (2003). "Health, Inequality, and Economic Development". *Journal of Economic Literature, 41: 113-158.* 41, pp. 113–158.

Elo, I. T. (2009). "Social class differentials in health and mortality: Patterns and explanations in comparative perspective". *Annual Review of Sociology* 35, pp. 553–572.

Erikson, R. and J. O. Jonsson (1996). "The Swedish Context: Educational Reform and Long-term Change in Educational Inequality". In: *Can Education Be Equalized*. Ed. by Erikson and Jonsson. Westwiew Pres, pp. 65–93.

Eurostat (1998). *Nomenclatures*. Available at `http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL_LINEAR&IntCurrentPage=1&StrNom=COD_1998&StrLanguageCode=EN`.

Fawcett, J., T. Blakely, and A. Kunst (2005). "Are Mortality Differences and Trends by Education Any Better or Worse in New Zealand? A Comparison Study with Norway, Denmark and Finland, 1980-1990s". *European Journal of Epidemiology* 20.8, pp. 683–691.

Giskes, K., A. E. Kunst, J. Benach, C. Borrell, G. Costa, E. Dahl, J. A. Dalstra, B. Federico, U. Helmert, K. Judge, et al. (2005). "Trends in smoking behaviour between 1985 and 2000 in nine European countries by education". *Journal of epidemiology and community health* 59.5, pp. 395–401.

Haider, S. and G. Solon (2006). "Life-Cycle Variation in the Association between Current and Lifetime Earnings". *American Economic Review* 96.4, pp. 1308–1320.

Kannel, W., D. McGee, and W. Catelli (2000). "Latest perspective on cigarette smoking and cardiovascular disease: the Framingham experience". *J Cardiac Rehab* 4, pp. 267–277.

Kawachi, I., N. E. Adler, and W. H. Dow (2010). "Money, schooling, and health: Mechanisms and causal evidence". *Annals of the New York Academy of Sciences* 1186.1, pp. 56–68.

Kunst, A. E., D. A. Leon, F. Groenhof, and J. P. Mackenbach (1998). "Occupational class and cause specific mortality in middle aged men in 11 European countries: comparison of population based studiesCommentary: Unequal inequalities across Europe". *BMJ* 316.7145, pp. 1636–1642.

Landberg, J and M Budhiraja (2013). "Socio-economic disparities in alcohol-related mortality in Sweden, 1991–2006: A register- based follow-up study". Paper presented at the 39th annual alcohol epidemiology symposium of the Kettil Bruun Society. Kampala, Uganda, 3-7 June 2013.

Lindahl, M. (2005). "Estimating the effect of income on health and mortality using lottery prizes as an exogenous source of variation in income". *Journal of Human Resources* 40.1, pp. 144–168.

Lleras-Muney, A. (2005). "The Relationship Between Education and Adult Mortality in the U.S". *Review of Economics and Statistics* 72.1, pp. 189–221.

Mackenbach, J. P., V. Bos, O. Andersen, M. Cardano, G. Costa, S. Harding, A. Reid, Ö. Hemström, T. Valkonen, and A. E. Kunst (2003). "Widening socioeconomic inequalities in mortality in six Western European countries". *International Journal of Epidemiology* 32.5, pp. 830–837.

Mackenbach, J. P., I. Stirbu, A.-J. R. Roskam, M. M. Schaap, G. Menvielle, M. Leinsalu, and A. E. Kunst (2008). "Socioeconomic inequalities in health in 22 European countries". *New England Journal of Medicine* 358.23, pp. 2468–2481.

Marmot, M. and E. Brunner (2005). "Cohort profile: the Whitehall II study". *International Journal of Epidemiology* 34.2, pp. 251–256.

Montez, J. K. and A. Zajacova (2013). "Explaining the Widening Education Gap in Mortality among US White Women". *Journal of Health and Social Behavior* 54.2, pp. 165–181.

Næss, Ø., A. H. Leyland, G. D. Smith, and B. Claussen (2005). "Contextual effect on mortality of neighbourhood level education explained by earlier life deprivation". *Journal of epidemiology and community health* 59.12, pp. 1058–1059.

Nybom, M. and J. Stuhler (2011). *Heterogeneous Income Profiles and Life-Cycle Bias in Intergenerational Mobility Estimation*. Discussion Paper 5697. `http://ftp.iza.org/dp5697.pdf`. Bonn: IZA.

OECD (2011). *Divided We Stand: Why Inequality Keeps Rising*. Paris: OECD.

Office of National Statistics (2006). *Defining alcohol related deaths*. `http://www.ons.gov.uk/ons/about-ons/get-involved/consultations/user-surveys/defining-alcohol-related-deaths---discussion-document.pdf`.

Shaper, A., S. Pocock, M Walker, A. Phillips, T. Whitehead, and P. Macfarlane (1985). "Risk factors for ischaemic heart disease: the prospective phase of the British Regional Heart Study." *Journal of Epidemiology and Community Health* 39.3, pp. 197–209.

Shkolnikov, V. M., E. M. Andreev, D. A. Jdanov, D. Jasilionis, Ø. Kravdal, D. Vågerö, and T. Valkonen (2012). "Increasing absolute mortality disparities by education in Finland, Norway and Sweden, 1971–2000". *Journal of Epidemiology and Community Health* 66.4, pp. 372–378. eprint: http://jech.bmj.com/content/66/4/372.full.pdf+html.

Singh, G. K. and M. Siahpush (2006). "Widening socioeconomic inequalities in US life expectancy, 1980–2000". *International Journal of Epidemiology* 35.4, pp. 969–979.

Smith, G. D., D Dorling, R Mitchell, and M Shaw (2002). "Health inequalities in Britain: continuing increases up to the end of the 20th century". *Journal of Epidemiology and Community Health* 56.6, pp. 434–435.

Smith, J. P. (1999). "Healthy bodies and thick wallets: the dual relation between health and economic status". *Journal of Economic Perspectives* 13.2, pp. 145–166.

Statistics Sweden (2008). *Flergenerationsregistret (Multi-generation register)*. Statistical database, http://www.scb.se/sv_/Vara-tjanster/SCBs-data-for-forskning/SCBs-datalager/Flergenerationsregistret/.

Steingrimsdottir, A., O. Naess, J. O. Moe, E.-K. Groholt, D. S. Thelle, B. H. Strand, and K. Baevre (2012). "Trends in life expectancy by education in Norway 1961–2009". *European Journal of Epidemiology* 27 (3), pp. 163–171. ISSN: 0393-2990.

Strand, B. H., E.-K. Grøholt, Ó. A. Steingrímsdóttir, T. Blakely, S. Graff-Iversen, and Ø. Næss (2010). "Educational inequalities in mortality over four decades in Norway: prospective study of middle aged men and women followed for cause specific mortality, 1960-2000". *BMJ: British Medical Journal* 340.

Tarkiainen, L., P. Martikainen, M. Laaksonen, and T. Valkonen (2012). "Trends in life expectancy by income from 1988 to 2007: decomposition by age and cause of death". *Journal of epidemiology and community health* 66.7, pp. 573–578.

The National Board of Health and Welfare [Socialstyrelsen] (2013). *Folkhälsan i Sverige*.

The National board of health and welfare [Socialstyrelsen] (2009). *Folkhälsorapport 2009*.

Torssander, J. and R. Erikson (2010). "Stratification and mortality—A comparison of education, class, status, and income". *European Sociological Review* 26.4, pp. 465–474.

United Nations Secreteriat (1988). "Sex differences in life expectancy and mortality in developed countries: an analysis by age groups and causes of death from recent and historical data." *Population Bulletin of the UN* 25.x, pp. 65–107.

Waldron, H. (2007). "Trends in Mortality Differentials and Life Expectancy for Male Social Security-Covered Workers, by Socieoeconomic Status". *Social Security Bulletin* 67.3, pp. 1–28.

Wamala, S., T. Blakely, and J. Atkinson (2006). "Trends in absolute socioeconomic inequalities in mortality in Sweden and New Zealand. A 20-year gender perspective". *BMC Public Health*.