The Rising Income Gradient in Life Expectancy in Sweden over Six Decades*

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Key points

Questions What is the long-term evolution of the income gradient in life expectancy and what is the background to the observed development?

Findings The income gradient in life expectancy, a measure of health inequality, increased continuously from 1962 to 2021 in Sweden. This trend appears to be independent of the development of income inequality, which decreased from 1962 until 1990, in the country. Life expectancy in the upper half of the income distribution rose faster than what would have been expected from the cross-sectional relation between income and life expectancy. The rising income gradient in mortality was apparent in both preventable and treatable conditions.

Meaning Taken together, the results obtained in this study suggest that factors that extend beyond, yet associated with, income have driven the long-term development of the health income gradient, including differences in adoption of healthy lifestyles and improved medical treatments by income.

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Abstract

Importance The income gradient in life expectancy, as well as the rise in this gradient over recent decades, have been documented for several countries but are not fully understood.

Objective To examine the long-term association between income and life expectancy along with the factors contributing to the increasing income gradient in life expectancy.

Design and setting A registry-based study including all Swedish permanent residents aged at least 40 years from 1960 to 2021.

Exposures Equivalent pretax household income from labor, business, and government transfers.

Results The study analyzed data from 9,752,925 individuals aged 40 or older, spanning from 1960 to 2021, resulting in 217,194,200 person-year observations and 3,873,788 deaths. After excluding negative, zero and missing incomes and the lowest 3% of income earners, the mean age was 60.35 (SD 13.40) years. The gap in life expectancy between the 5th and 95th income percentiles widened substantially: for men, it increased from 2.7 years in the 1960s to 8.1 years by the 2010s. For women, the increase was from 3.6 to 6.3 years from the 1970s to the 2010s. The long-term reduction in income inequality or the expansion of social spending, observed between the 1960s and the 1990s, did not coincide with a decrease in health inequality. Further results indicated that life expectancy gains in the lower half of the income distribution aligned with what could be expected from the cross-sectional income-life expectancy association, while gains in the upper half significantly exceeded such expectations. Analysis of causes of death identified circulatory diseases as the main contributor to improved longevity across income groups, with greater gains observed in the upper part of the income distribution. Analysis of preventable and treatable deaths before age 75 revealed an increasing income gradient in these types of mortality.

Conclusions and Relevance A sufficiently strong association between income and life expectancy would suggest a similar development of income inequality and the income gradient in life expectancy. The documented absence of a similar long-term development challenges the idea of a link between income inequality and life expectancy. Instead, the increase in the income gradient in life expectancy appears to be driven by a "third factor", correlated with both income and life expectancy, rather than by increasing differences in economic resources per se. Analysis of causes of death indicated that high income earners are adopting healthier life habits and medical improvements more rapidly.

1 Introduction

Two recent studies have examined the relationship between income and life expectancy in the US and Norway, respectively.[1,2] Both studies confirm the previously documented positive association between income and life expectancy.[3,4,5,6,7] Each of the studies also identify an increasing income gradient in life expectancy, consistent with trends observed in research based on data for other countries[8,9,10,11] with some exceptions,[12] as well as with research on the SES gradient in life expectancy.[13,14,15] However, the background to the income gradient and why it has increased remains unclear, motivating the following questions: First, how has the income gradient in life expectancy evolved in the long-term? Second, how is the evolution of the income gradient related to other long-term trends in the society, such as changes in income inequality, government social spending, the adoption of new medical technologies, and changes in lifestyle habits?

Sweden provides an interesting case to study these questions empirically. The country witnessed decreasing income inequality from the early 1960s to the 1990s and an increase thereafter. Additionally, Sweden's tax-funded healthcare and welfare systems provided enhanced support for those at the lower end of the income distribution.[16] The availability of administrative income and mortality data from 1960 to 2021 allows for a consistent analysis of the long-term evolution of the income gradient. Mortality data, categorized by cause of death, grant insights into contributing factors.

The four aims of the study were to (1) analyze the long-term development of the income gradient in mortality; (2) examine the association between income inequality, the income gradient in health and social spending; (3) assess the relationship between real income and life expectancy over time; and (4) assess the income-related gaps in life expectancy into causes of death and avoidable mortality.

2 Materials and Methods

The study was approved by the Swedish Ethical Review Authority (Etikprövningsmyndigheten), reference number 2015/420. Participant consent was waived as the analysis was based on existing, anonymized data from 4 Swedish national registries.

2.1 Data Sources and Study Population

This study analyzed individual-level data from the Population Register, National Tax Registry, Longitudinal Database for Health, Insurance and Labour Market Studies (LISA), and the Cause of Death Register, covering individuals aged 18–74 annually. Income information from 1960–2019 was sourced from the National Tax Registry, excluding 1967. For 1960–1966, a 10% sample of the male, tax-filing population, not representative for women due to couple taxation until 1971, was available. For 1968–2019, complete taxpayer income records were used. Household income calculations began in 1960, incorporating spouse's income. From 1968, income was calculated for households based on household

identifiers from the Population Register, defined pre-1987 as married couples and post-1987 as married couples or cohabiting couples with joint children. The analysis excluded individuals with missing, negative, or zero income and the lowest 3% of positive earners (around 7% of sample in recent years). Mortality data from 1962–2021 came from the Cause of Death Registry, analyzing mortality rates for those aged 40+, without adjusting for ethnic composition (unlike Chetty et al[1]). Sensitivity tests excluding first-generation immigrants showed minimal effect on results (see Figure A.2).

2.2 Income Measures

The primary income measure, "equivalized household income", was derived from individuals' taxable income, including wages, business profits, pensions, and taxable transfers. This measure was obtained by dividing the household's total income by the square root of the number of household members. Households were defined as either a single adult or a married/cohabiting couple, with adult children considered as separate single adults. Minor children were excluded due to inconsistent historical data. Incomes were inflation-adjusted to 2018 values using the Consumer Price Index (CPI). Sensitivity analyses using other income measures such as individual or disposable income confirmed the robustness of the main findings (see Figure A.2).

2.3 Causes of Death

Year and cause of death were obtained from the Cause of Death Registry, with causes classified into seven subgroups using the International Classification of Diseases ICD-6 through ICD-10 chapters (refer to Table A2). Diseases were identified as treatable or preventable following the OECD/Eurostat list[17] and matched to respective ICD codes.

2.4 Statistical Methods

This study followed Chetty et al's[1] methodology with minor necessary adaptations to accommodate data from the early decades. Individuals received percentile ranks (1–100) based on equivalized household income by gender, age and year. For specific analyses, incomes were grouped into quartiles or ventiles. For the rank calculation, income from two years (three years in 1969 due to missing data) prior to calculating within-group mortality rates was used.

The approach diverges from Chetty et al,[1] who used income rank at age 63 for older ages, due to data constraints in the 1960s and 1970s. Sensitivity checks using the ranking approach by Chetty et al[1] confirmed the main findings to be unaffected by this deviation, likely because the income measure includes pension income.

Period life expectancy at age 40 was calculated using annual mortality rates by gender, age and income percentile, assuming constant future mortality rates. To counteract unreliable mortality estimates in smaller percentile groups, the study applied the Gompertz-Makeham law, positing a linear link between age and log mortality for ages 40 to 76

and extrapolating mortality rates for ages 77 to 89. For ages 90 to 100, Sweden's overall mortality rates from Statistics Sweden were used, overlooking income percentile mortality variances. Life expectancy calculations used the integrated survival function from these rates.

Section A.4 presents a comparison of the income gradient in life expectancy in Sweden with findings from Norway,[2] the United States,[1] and Canada.[12] To ensure consistency across these studies, several methodological adjustments were made to align the income measures and sample restrictions, which are described in detail along with the results in that section.

Since our main results are obtained on the entire Swedish population and are not based on any statistical model, we do not report any confidence intervals or standard errors, other than for the results on average income gradients reported in Section 3.1 that are estimates from regression models and the results referred to in Section 4 that are obtained from surveys.

The results were obtained using Stata 17.0, MP-Parallel Edition (StataCorp).

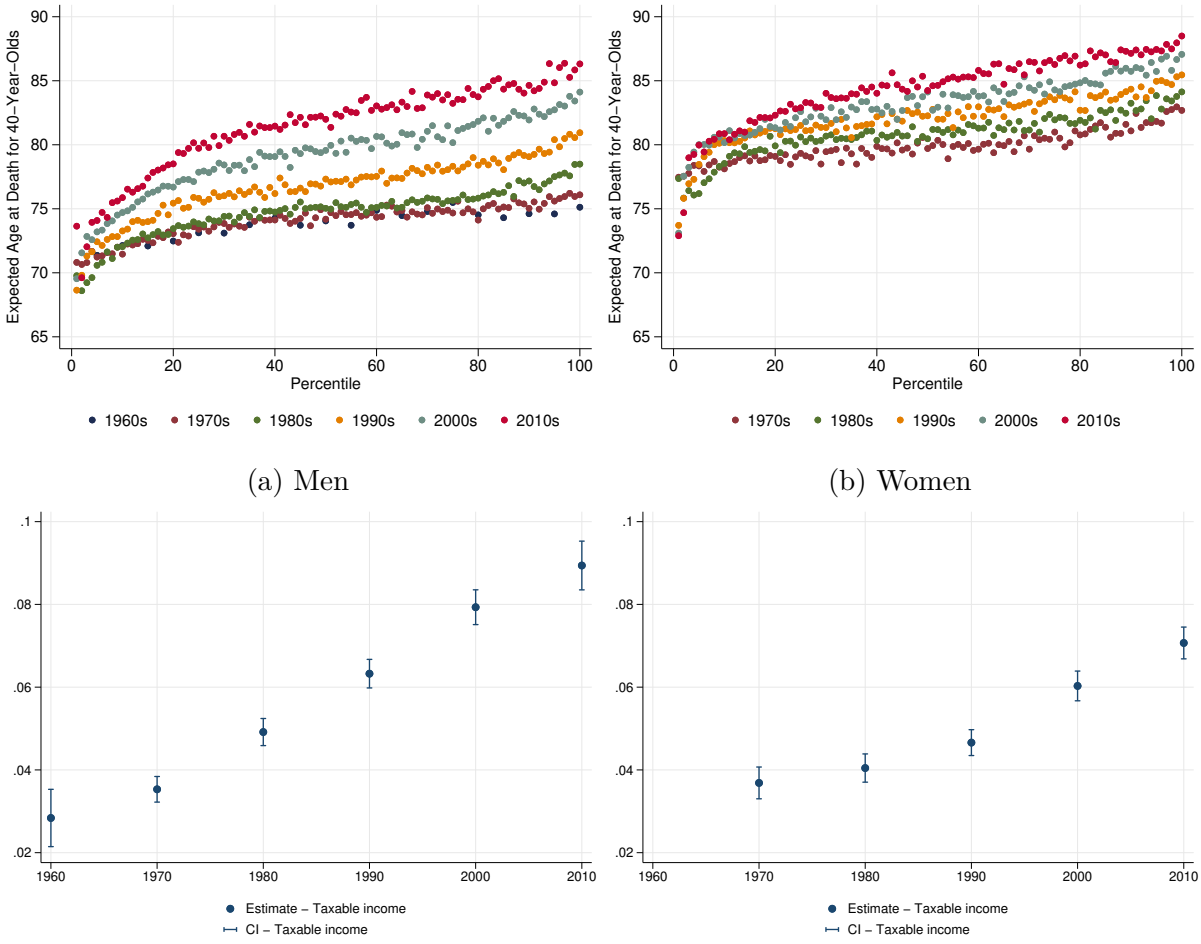
3 Results

The main study population consisted of 9,752,925 persons aged 40 or older, and 217,194,200 person-year observations from 1960–2021. They accounted for 3,873,788 observed deaths. Individuals with missing, negative and zero income as well as the lowest 3% of the income distribution were excluded. The mean (SD) age in this population was 60.35 (13.40) years and the mean (SD) household size decreased from 1.61 (0.0008) in 1960 to 1.33 (0.0002) in 2021.

3.1 Trends in the Income Gradient in Mortality

The top two panels of Figure 1 illustrate life expectancy at age 40 across income percentiles for each studied decade, highlighting three key observations. First, they underscore the established concave link between income and life expectancy noted in earlier research.[3,4] Second, an upward shift in life expectancy in all income brackets over all decades suggests general health improvements. Third, the progressively steeper slope of this income-life expectancy gradient over time points to a widening gap in mortality inequality with larger gains at the higher end of the income distribution.

The bottom two panels of Figure 1 present income gradient estimates based on the OLS regression slope coefficient, reflecting the life expectancy increase per income percentile. For men, the slope grew from 0.03 in the 1960s to 0.09 in the 2010s. Thus, the difference in life expectancy between the 5th and the 95th income percentile increased from 2.7 to 8.1 years across these decades. For women, changes in the income gradient were less pronounced, with the slope coefficient growing slightly from under 0.04 in the 1970s to 0.07 in the 2010s, with a notable increase towards the period's end. Thus, the gap in life expectancy between women at the 5th and 95th percentiles widened from 3.6 to 6.3 years.



(a) Men

(b) Women

(c) Men

(d) Women

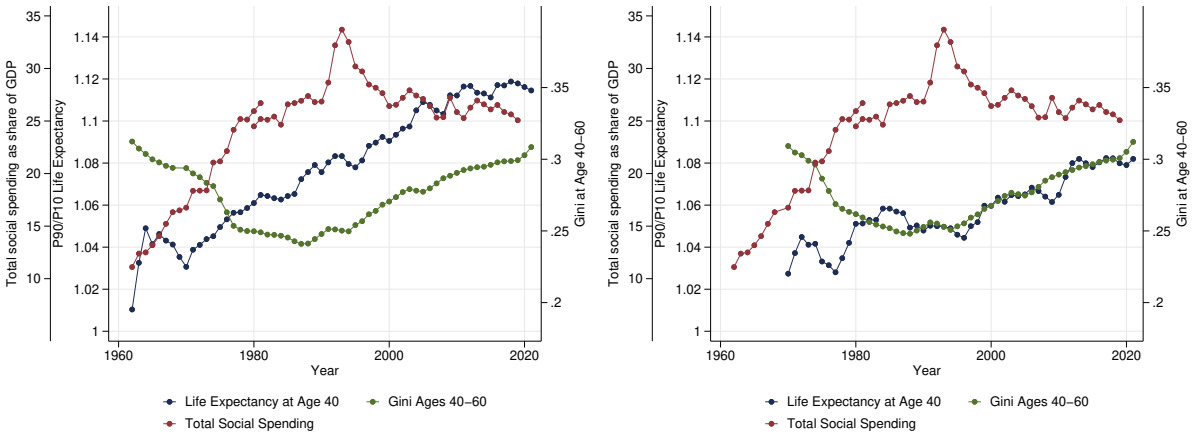
Figure 1: The Relationship Between Life Expectancy and Income Rank in Sweden

Notes: Panels (a) and (b) depict the distributions of life expectancy at age 40 based on percentiles of the income distribution for each decade covered in the study. Income percentiles were based on years 1960–2017 (1968–2017) for men (women), while life-expectancy was calculated using years 1962–2019 (1970–2019). The 2020 decade was excluded as only data for its first two years were available. For the 1960s, Panel (a) displays ventiles instead of percentiles. Panels (c) and (d) display the slope coefficients from an OLS regression of percentile life expectancy at a specific time period on the corresponding percentile in the income distribution. Estimates were based on the total Swedish population aged 40–76, excluding individuals with missing, negative or zero income, and the lowest 3% income.

3.2 The Association between Income Inequality, Social Spending and the Income Gradient in Life Expectancy

Figure 2 shows the development of social spending, income inequality and the income gradient in life expectancy from 1962/70 to 2021. Social spending was measured as a share of GDP, derived from OECD data, including health spending, government transfers and pensions. Income inequality was measured by the Gini coefficient[18] of the gender-specific income distribution, adjusted for cohort size, while the income gradient in life expectancy used P90/P10 ratios. Income data were taken from ages 40–60, where age 40 correlates strongly with lifetime earnings.[19]

Figure 2 shows a very salient result: while the income gradient in life expectancy increased continuously for both males and females during the entire period under study, income inequality decreased markedly for both males and females until the early 1990s and increased only after that. These results provided no empirical support for a positive long-term association between income inequality and the income gradient in longevity. The expansion of the welfare state could be expected to lower health inequalities by redistribution to low income individuals. The association, however, goes in the other direction, with increasing social spending until the 1990s coinciding with an increased income gradient in life expectancy.



(a) Men (b) Women

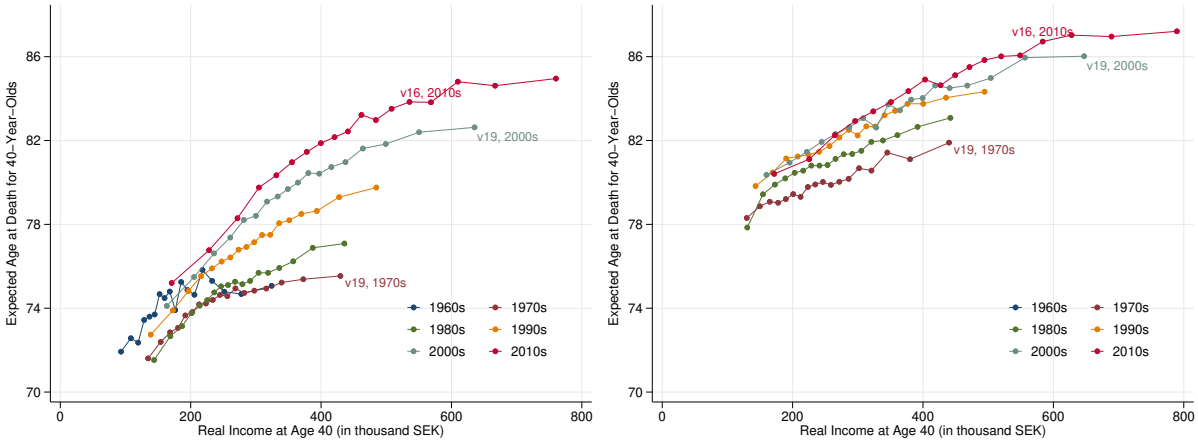
Figure 2: Inequality in Income, Life Expectancy and Social Spending in Sweden, 1962–2021

Notes: The Gini coefficient measures income inequality and the P90/P10 ratio for life expectancy inequality in health by income. 3-year moving averages for both series. Estimates were derived from the total Swedish population aged 40–76, excluding individuals with missing, negative or zero income and the lowest 3% income bracket. Gender-unspecific data from the OECD were added to show concurrent trends in social spending as a percentage of GDP. Until 1981, the data was compiled from OECD sources by Lindert.[20] A different time series from the OECD database was used from 1980.

3.3 The Association between Life Expectancy and Real Income

At the cross-country level, the association between GDP per capita and life expectancy is known as the Preston curve.[21] The Preston curves by life expectancy and CPI-adjusted average income per ventile over six decades in Sweden are illustrated in Figure 3 for both genders. The interpretation of changes in the Preston curves over time is such that movements along the cross-sectional relation correspond to improvements predicted by the cross-sectional association between income and life expectancy, while "shifts" in the curve correspond to changes exogenous to the relation depicted by the curve.

The most salient result revealed in Figure 3 is the "shifts" in the Preston curve in the upper end of the distribution, in particular for males, reflecting the impact of external ("third") factors, such as improvements in medical technology or changes in life-habits related to health. The increasingly concave relationship, particularly flat at higher income levels, suggests diminishing importance of income alone.



(a) Men (b) Women

Figure 3: Life expectancy by income

Notes: Panels (a) and (b) present the average annual real income and life expectancy for each period, broken down by income ventiles and by decade, for men and women, respectively.

3.4 Contributions from Different Causes of Death

3.4.1 Causes of Death by Main ICD Chapter

Figure 4 shows the number of years of gain in life expectancy over the period 1964–2021 from lower mortality in premature deaths (deaths before age 75) by main causes of death. The ICD chapters are defined in Table A2. The method applied to assign the gain in life expectancy is used in previous research[22] and consists of scaling changes in mortality rates by the overall gain in life expectancy from lower mortality in premature deaths. This gain was 1.5 years for males and 0.8 years for females in the first quartile of the income distribution. The corresponding estimates are 3.0 and 1.3, respectively, for the fourth quartile.

The study found that most of the gain in life expectancy from premature deaths was attributed to circulatory and nervous diseases. For males it contributed 1.4 (1.9) years in the lowest (highest) income quartile. For females, the gain from this category was much smaller and more equally distributed between the income groups.

The second-largest improvement came from cancer diseases. The largest gain, 0.6 years, is for males in the fourth quartile. However, it is important to bear in mind that the incidence of dying from cancer increases due to the large gains in life expectancy from decreased circulatory deaths. The estimates of life expectancy gains from cancer are thus underestimating the true improvements in cancer care.[23]

Figure 5 Panels (a)–(d) illustrate the shift in cause-specific mortality rates by gender and income quartile over time. The plots show the significant drop in circulatory disease-related deaths, especially for men. In the highest income quartile, cancer became the main premature death cause for men. Cancer mortality showed stability in the lowest quartile but decreased significantly in Quartile 4 for both genders, halving for men from

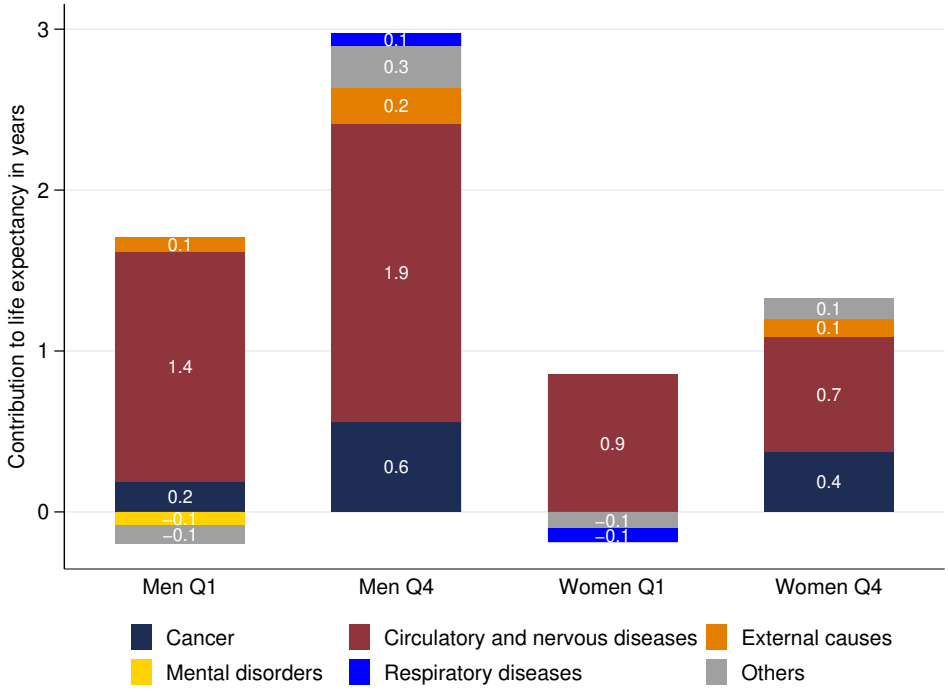
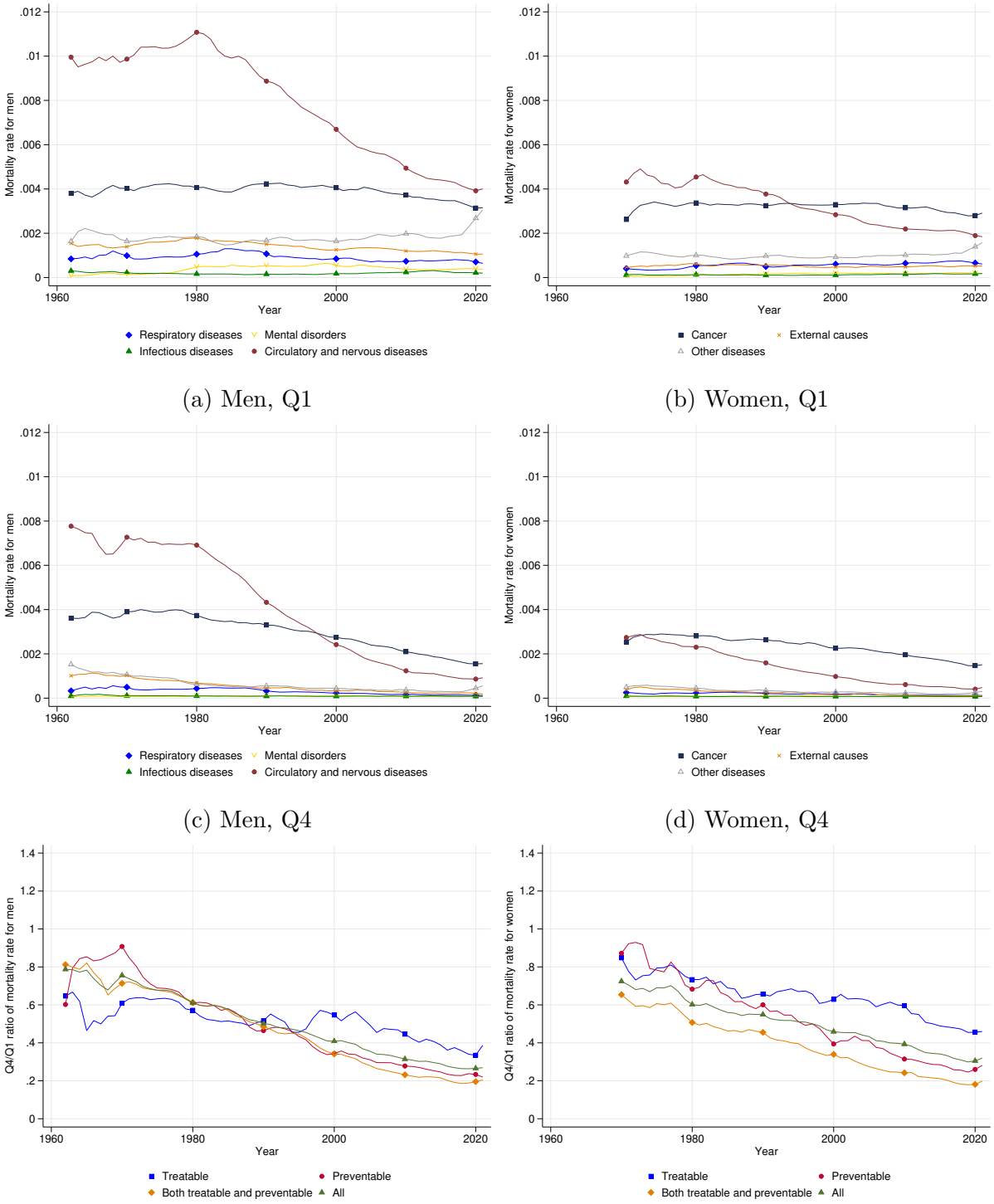


Figure 4: Contribution of each cause of death to the life expectancy increase

Notes: This figure shows the contribution of each cause of death to the life expectancy increase due to reduced premature mortality (deaths before age 575). This was calculated as the difference in mortality rates between 1962/64–2019/21 for men and 1970/72–2019/20 for women by aggregated cause of death, divided by the sum of differences among all causes of death and multiplied by the increase in life expectancy over the period 1962/64–2019/21 and 1970/72–2019/21 between ages 40-74.[22] Values smaller than 0.06 in absolute value were not displayed separately and instead added to "Other" diseases, remaining values were rounded to one decimal place (for exact numbers see Table A1). Mortality rates were based on the total Swedish population aged 40–74, excluding individuals with missing, negative or zero income, and the lowest 3% income.

around 0.4% to 0.2%.



(a) Men, Q1

(b) Women, Q1

(c) Men, Q4

(d) Women, Q4

(e) Men, Q4:Q1 ratio

(f) Women, Q4:Q1 ratio

Figure 5: Mortalities by cause and avoidability inequality, 1960–2021

Notes: Panels (a) and (b) show the mortality rates for the 1st income quartile by different causes of death for men and women, respectively. Panels (c) and (d) show the same for the 4th quartile. Panels (e) and (f) show the ratio between the 1st and 4th quartile for treatable and preventable diseases. 3-year moving averages for all series. Mortality rates were based on the total Swedish population aged 40–74, excluding individuals with missing, negative or zero income, and the lowest 3% income.

3.4.2 Avoidable Mortality

Avoidable mortality consists of deaths occurring before age 75 in treatable and preventable health conditions, respectively. According to 2019 OECD/Eurostat[17] definitions, avoidable deaths are caused by health conditions avoidable by timely and effective healthcare, including treatment and secondary prevention to lower mortality rates after disease onset. Since Sweden had a universal healthcare system providing care at low out-of-pocket cost during the entire period under study, differences in economic resources per se are unlikely to generate inequalities in treatable mortality. Mortality in preventable diseases are primarily attributed to obesity, smoking, alcohol consumption and drug use, which are not primarily linked to economic resources, but to life habits.

For lower-income men, mortality from preventable or both treatable and preventable conditions rose until 1980, driven by circulatory disease deaths (see Figure A.5), then consistently fell. Mortality from purely preventable diseases slightly increased overall. Upper-quartile men saw continuous mortality declines in all categories, with faster reductions post-1980, stabilizing recently. Lower-quartile women experienced steady mortality declines from treatable or both treatable and preventable diseases without the early increase seen in men. Yet, preventable disease mortality slightly rose over time.

Figure 5 Panels (e) and (f) display the evolving inequality in mortality from diseases deemed treatable, preventable, or both, for men (left) and women (right), using the ratio of mortality in the first and fourth income quartile. Ratios close to 1 indicate minor mortality disparities, with declining trends representing increasing inequalities. The ratio for all male (female) deaths decreased from 0.8 (0.7) to 0.3 (0.3) from 1962–2021 (1970–2021), meaning a large increase in inequality over time. Preventable mortality ratios followed a similar or even slightly steeper trend. Treatable mortality ratios showed a more subtle decline, especially for men, indicating a slower widening of disparities in this area.

4 Discussion

The results of this study showed a steady increase in the income gradient over the six decades under study (1962–2021). Additionally, the curvature of both the relative (Figure 1) and absolute (Figure 3) relationships between income and life expectancy has become increasingly concave over time, suggesting that the entire upper part of the income distribution has gained, rather than a continuous change over the entire distribution.

Three key findings suggest that factors correlated with income, rather than income itself, drive the changes in the relationship between income and life expectancy. First, there is no long-term association between income inequality and the income gradient in life expectancy (Figure 2). Had there been a strong link, as suggested by the *absolute income hypothesis*,[3,4] it would have implied a positive correlation between income inequality and the income gradient in life expectancy. Second, the deviation from the cross-sectional relationship between real income and life expectancy over time, particularly in the upper part of the income distribution (Figure 3), suggests a more pronounced shift in life expectancy than can be explained by income alone. Third, our analysis of avoidable

mortality, categorized into preventable and treatable deaths (Figure 5), suggests that this "third factor" comprises both increasing inequality in the adoption of new medical technology and in the adoption of healthy lifestyles.

Specifically, given Sweden's universal healthcare system with medical care at very low out-of-pocket costs, it is likely that the observed widening income gradient in treatable mortality can be attributed to the higher-income earners' better ability to adopt advancements in medical technology. Previous research has shown that more highly educated individuals generally receive better medical care and have higher survival for different conditions.[3,24,25,26] The growing income gradient in treatable mortality indicates that this correlation has strengthened over time with the progression of medical technology.

The overall decline in preventable diseases points to a shift toward healthier lifestyles. The growing income gradient in preventable mortality indicates that high-income individuals are adopting these lifestyle changes to a larger extent. Furthermore, the incidence of most preventable diseases – related to smoking, alcohol, drugs, nutrition, and physical activity – is less a matter of financial resources and more about education and personal characteristics, which are closely associated with income.[24,27]

Smoking is the most common to avoidable deaths. Research suggests that about 50 percent of all smokers die from causes of death related to smoking.[28] An increasing SES gradient in smoking has been documented in several previous studies. Data from the Level of Living Survey[29] show that the odds ratio (*95% CI:*) between smoking in the first and fifth quintiles in the distribution of household income was 0.81 (0.726, 0.894) for men and 0.32 (0.242, 0.398) for women in 1968. The corresponding figure in 2017 was 4.62 (3.189, 6.051) for men and 2.85 (2.046, 3.654) for women.[28]

From a policy perspective, the lack of a long-term link between income inequality and the income gradient in life expectancy suggests that reducing income inequality alone may not effectively address life expectancy disparities. Instead, policies should promote healthy lifestyles and actively promote the use of novel medical technologies, especially for lower-income groups. However, as highlighted in a recent study,[30] policies aimed at improving health among the elderly may paradoxically have a regressive effect on life expectancy, even if they benefit the poor. This is because the benefits of such policies depend on surviving to a certain age, which the poor are less likely to achieve. Additionally, even if they reach this age, the poor generally have shorter lifespans, limiting their benefit from these improvements.

The findings also have implications for pension systems. The rising income gradient in life expectancy suggests that redistribution from low- to high-income earners has increased, counteracting progressive benefit structures.[9,31] Income-based benefit rules or targeted support for lower-income retirees, along with effective health policies, could help mitigate such regressive effects.

A notable strength of this study is the precision of the estimates enabled by high-quality, comprehensive Swedish population data. Its unique six-decade span allowed for exploring the mortality-income relationship across varying income inequality trends, a gap in earlier research, which lacked data on periods of declining income inequality.[1,2] Additionally, it investigated the mortality's income gradient across different death causes and avoidable diseases over these decades.

4.1 Limitations

This study faces several limitations. First, the analysis does not establish a causal relationship between income and life expectancy, nor between specific causes of death or other factors and overall life expectancy. Second, income group misclassification may arise from undeclared earnings or joint income declarations, particularly skewing early data representation for women. Third, ignoring income mobility while using the Gompertz-Makeham model potentially simplifies income level mortality complexities. Fourth, the classification of causes of death into groups can be disputed. Fifth, the distinction between preventable and treatable diseases is not always unambiguous and changes in preventablity/treatability over time have been ignored in the analysis.

5 Conclusions

This paper showed that the income gradient in mortality continuously increased between 1962 and 2021 in Sweden, despite decreasing income inequality until 1990. Notably, life expectancy gains in Sweden's higher income half surpassed expectations from the cross-sectional income-life expectancy link, with a growing gradient in avoidable disease mortality. These outcomes suggest a rising impact of a "third factor" related to both income and life expectancy. The trend towards greater gains in treatable and preventable condition-related deaths among higher income groups may be partly due to their faster adoption of healthier lifestyles and new medical treatments.

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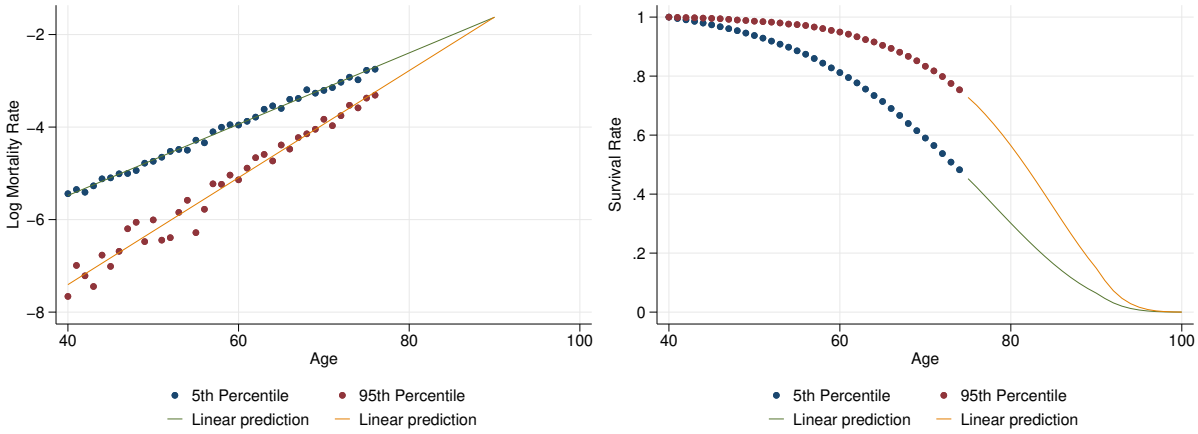
A Appendix

A.1 Data

List of data sources:

1. Population data: The population data list everyone registered in Sweden during the years of interest with information of birth year, birth country etc.
2. Income and tax register (*Inkomst- och taxeringsregistret (IoT)*)
    - Inkomster 1960–1966: This dataset contains data on income, marital status, occupation, and spousal income. Including everyone born on the 5th, 15th and 25th of each month results in a 10% random sample for male tax filers. Due to joint taxation of couples until 1971, many women are missing and the sample is not representative for them.
    - National Tax Register for the years 1968–2021: This database contains many income measures, along with personal information like marital status and household affiliation.
3. Longitudinal Database for Health, Insurance and Labour Market Studies (LISA): This register consists of data from tax registers, the National Social Insurance Board and the National Education Register for the period 1990–2019. It contains household identifiers.
4. National Cause of Death Register: This register contains the date of death for all permanently in Sweden living individuals back to 1961, with details on the cause of death by ICD chapter and treatable and preventable indicators.
5. Aggregate age-specific mortality rates from Statistic Sweden.

A.2 Method



(a) Log Mortality, 1962–2021

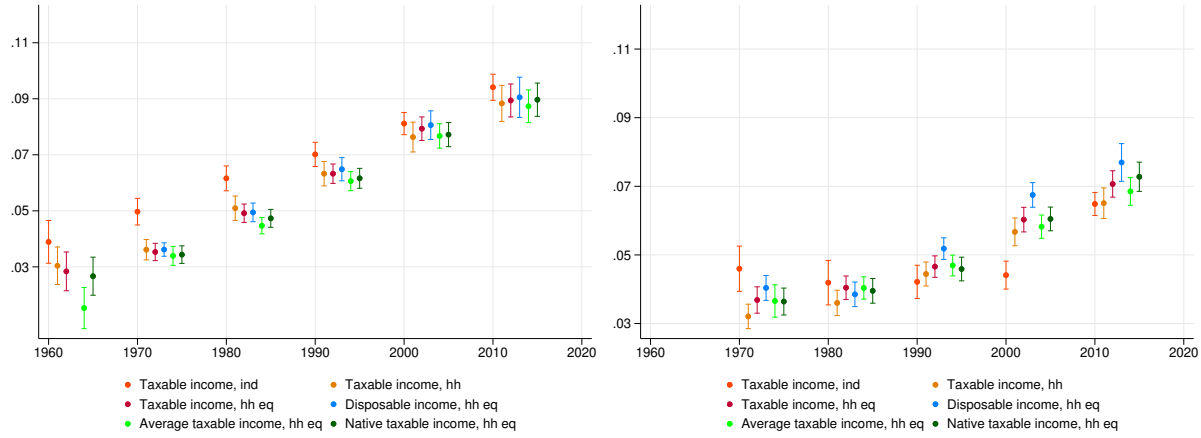
(b) Survival rate, 1962–2021

Figure A.1: Mortality Rates and Expected Age at Death in Sweden

Notes: Panel (a) presents the log-linear mortality approximation by age for the 5th and 95th percentiles in the income distribution. Panel (b) illustrates the resulting survival functions for each of the two groups based on real data up to age 76 and predictions beyond that age. Estimates were derived from the total Swedish population aged 40–76, excluding individuals with zero, negative or missing income and the lowest 3% income bracket.

A.3 Income Measures

Figure A.2 shows the income gradients when using different income measures. All measures show a clear increase for men, with the individual measures being slightly higher than the rest. The increase of the gradient only started after 1980 for women.



(a) Men (b) Women

Figure A.2: Comparison of Income Gradients for Different Income Measures

Notes: This figure compares income gradients between a variety of income measures for men (a) and women (b). These income measures include taxable income on individual level ("ind"), household level ("hh"), and equivalized household level ("hh eq"), as well as disposable income on equivalized household level ("Disposable income, hh eq"), average equivalized household income during the past 5 years ("Average taxable income, hh eq") and household equivalized taxable income excluding immigrants ("Native taxable income, hh eq").

A.3.1 Gains in Life Expectancy

A.4 International Comparison

In this section, we compare the mortality gradient in Sweden to estimates for the US in Chetty et al[1] and the comparative estimates for Norway in Kinge et al[2] and for Canada in Milligan and Schirle[12].

Some methodological adjustments were necessary for consistency with Chetty et al[1] and Kinge et al[2]. Most importantly, a different income measure was used, including all earnings from labour and work-related benefits such as unemployment, parental leave and sickness benefits, but excluding disability insurance and early retirement benefits. The same sample restrictions as in Chetty at al[1] were applied, meaning dropping zero income persons and the bottom 2%. Using the new income measure, which resulted in dropping more individuals with disability insurance benefits or pensions as their main source of income compared to our main analysis. The sample selection by Chetty et al[1] essentially implies the exclusion of non-labor force participants. During the 2001–2014 period, the average LFP rate in ages 20–65 was around 78 percent in the US, 82 percent in Norway and 84 percent in Sweden. Moreover, household income was not adjusted for household size. Income ranks were assigned similarly, but for those over 63, ranks from age 63 were kept, which did not pose an issue when limiting the analysis to the 2001–2014.

Chetty et al[1] noted a 14.6-year gain in life expectancy at age 40 for US men (10.1 years for women) from the first to the 100th percentile in the income distribution during 2001–2014. Using the same time period and consistent income concepts and methodologies, Norway's

Cause of death	Quartile 1	Quartile 4
Men 1962/64–2019/21		
Cancer	0.2	0.6
Circulatory and nervous diseases	1.4	1.9
External causes	0.1	0.2
Infectious diseases	0.0	0.0
Mental disorders	-0.1	-0.0
Respiratory diseases	0.0	0.1
Other	-0.2	0.2
Total	1.5	3.0
Women 1970/72–2019/21		
Cancer	0.1	0.4
Circulatory and nervous diseases	0.9	0.7
External causes	-0.0	0.1
Infectious diseases	-0.0	0.0
Mental disorders	-0.0	-0.0
Respiratory diseases	-0.1	0.0
Other	-0.1	0.1
Total	0.7	1.3

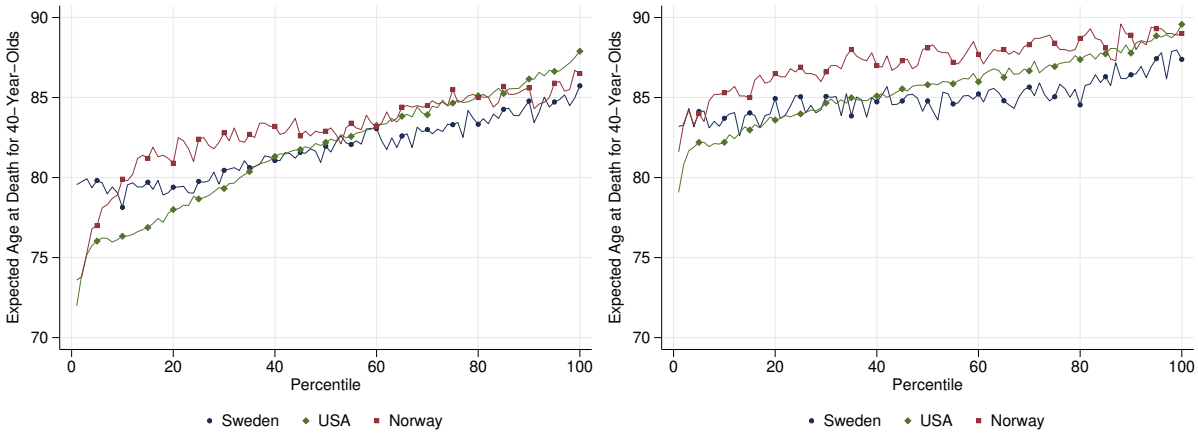
Table A1: Contribution of each cause of death to the overall life expectancy increase for men and women (in years)

Notes: Data from the total Swedish population aged 40–74, excluding individuals with missing, negative or zero income and the lowest 3% income. The table shows the difference in mortality rates between 1962/64–2019/21 for men and 1970/72–2019/20 for women by aggregated cause of death, divided by the sum of differences among all causes of death and multiplied by the increase in life expectancy over the period 1962/64–2019/21 and 1970/72–2019/21 between ages 40-74.

data showed a 12.9-year increase for men and 7.4 for women. The corresponding figures for Sweden were 6.17 for men and 4.2 for women (see Figure A.3).[2]

These gaps were significantly smaller than those observed in the US and Norway, mainly due to higher life expectancies in Sweden among the lowest 10 percentiles. However, the results were sensitive to the precise definition of the income measure used. While the income measure employed in the main part of the study indicated larger gaps in life expectancy, the income measure in this comparison produced a more linear gradient, as seen in Figure A.3 compared to Figure 1, Panels (a) and (b). As pointed out in a note by Cutler,[32] the challenges of aligning income concepts and sample restrictions across countries underline the importance of caution when making international comparisons of income gradients in life expectancy and their implications for the relationship between income and health.

Canadian estimates in ventiles by Milligan and Schirle,[12] on the other hand, seen in Figure A.4, closely mirrored Sweden's when methods were aligned.



(a) Men (b) Women

Figure A.3: Comparison to US and Norway, 2001–2014

Notes: This figure presents the comparison between the Swedish, US and Norwegian and estimates for men (a) and women (b).

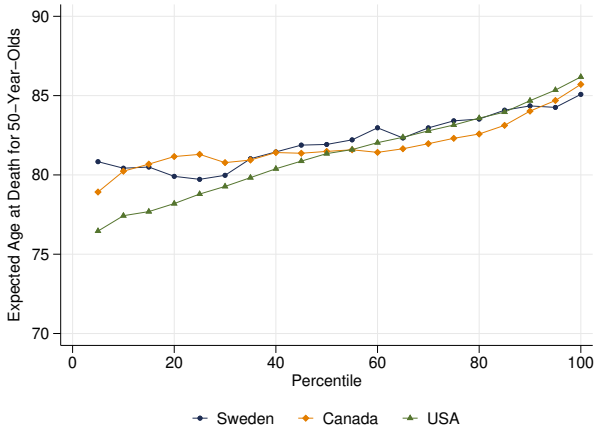


Figure A.4: Comparison to US and Canada in ventiles, 2001–2014

A.5 Cause of Death

Table A2 shows the aggregation of ICD-codes into chapters. Circulatory diseases and nervous system disorders had to be aggregated into one category, because there was an important reclassification when the system changed from ICD7 to ICD8. *Vascular lesions affecting central nervous system* (330-334), classified as nervous system disorders in ICD7, was moved to the subsection *Cerebrovascular disease* (430-438) in the chapter on circulatory diseases in ICD8. This resulted in a sharp drop in deaths from nervous system disorders from approximately 11% to 1% and a sharp increase in deaths from circulatory diseases from approximately 39% to 49%. Counting this category as a circulatory condition, it follows that roughly 2% of deaths in the aggregated category in the 1970s and 1980s stem from other nervous system disorders, while circulatory diseases account for the remaining 80%. In the 1990s, deaths from circulatory diseases started to decrease rapidly and deaths from nervous system disorders increased, such that the share of nervous diseases in the aggregated category rose to 15% in the 2010s.

Cause of death	**ICD-10**	**ICD-9**	**ICD-8**	**ICD-7 & -6**
Infectious diseases	A00–B99	001–139	000–136	001–138
Cancer	C00–D49	140–239	140–239	140–239
Mental disorders	F00–F99	290–319	290–315	300–326
Circulatory and nervous system disorders	G00–G99, I00–I99	320–459	320–458	330–468
Respiratory diseases	J00–J99	460–519	460–519	470–527
External causes	V01–Y99	800–999	E800–E999	E800–E999
Other diseases	D50–E89, H00–H95, K00–R99	240–289, 520–799	240–289, 520–796	240–299, 530–795

Table A2: Cause of Death Aggregation by Chapter

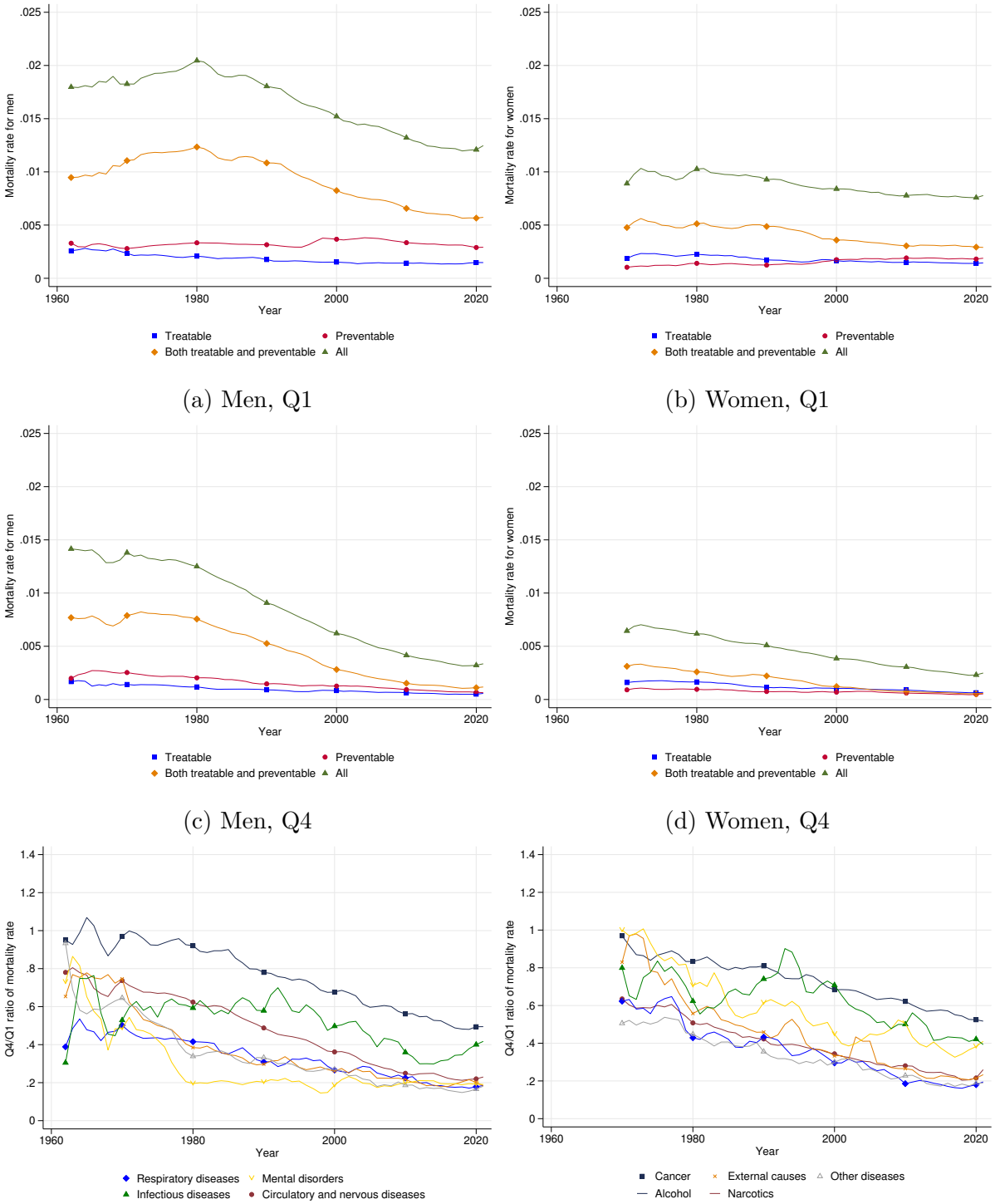
Tables A3 and A4 rely on the OECD list of treatable and preventable diseases.[17] The mapping across ICD-9–ICD-6 was done by the authors and is an approximation, due to difficulties to perfectly match the codes across time. Using these tables, Socialstyrelsen coded up indicators for preventable and treatable diseases from the National Cause of Death Register. A death was classified as preventable/treatable if at least one cause of death (primary or secondary) was preventable/treatable.

Deaths	ICD-10	ICD-9	ICD-8	ICD-7 & -6
Preventable	A00–A09 A15–A19 A33–A37 A39 A403 A413 A492 A50–A60 A63–A64 A80 B01 B05–B06 B15–B24 B50–B54 B90 C00–C16 C22 C33–C34 C43 C45 C53 C67 D50–D53 E10–E14 E244 F10–F16 F18– F19 G000–G001 G312 G621 G721 I10–I13 I15 I20–I25 I60–I71 I739 J09–J11 J13–J14 J40–J44 J60–J70 J82 J92 K292 K70 K73 K740–K742 K746 K852 K860 Q00–Q01 Q05 Q860 R780 V01–Y34	001–018 032–033 036–037 0380 03841 0415 042–045 052 055–056 070 7811 084 090–099 137 140–151 155 162–163 172 180 188 2262 249–250 280–281 3200–3201 3204 401– 405 410–414 430–438 440–441 481 4822 4823 487 490–492 500–508 5183 7713 740– 741 7420 800–999	001–019 032–033 036 03800 040–043 052 055–056 070 07399 084 090–099 140–151 155–156 162–163 172 180 188 250 280–281 3200–3201 400–404 410–414 430–438 440– 441 470–474 4821–4822 490–492 500–508 740–741 E800–E999	001–019 020–039 040–049 051 05300 055–057 061 064 080–081 085–087 092 110–117 140–148 150–151 155–156 162 163 171 181 190 260 291–293 307 322–323 330–334 340 420 440–447 450–451 453 480–483 501–502 523–525 527 753 E800–E999

Table A3: Mapping of preventable conditions across ICD versions 6 through 10

Deaths	ICD-10	ICD-9	ICD-8	ICD-7 & -6
Treatable	A15–A19 A38 A400–A402 A404–A409 A410–A412 A414–A419 A46 A481 A491 B90 C18–C21 C50 C53–C55 C62 C73 C81 C910–C911 D10–D36 E00–E07 E10–E14 E240–E243 E248–E249 E27 G002–G003 G008–G009 G03 G40–G41 I00–I13 I15 I20–I26 I60–I69 I70–I71 I739 I80 I829 J00–J06 J12 J15–J18 J20–J22 J30–J39 J45–J47 J65 J80 J81 J85–J86 J90 J93–J94 K25–K28 K35–K38 K40– K46 K80–K83 K850–K851 K853–K859 K860–K861 K863– K869 L03 N00–N07 N13 N17–N21 N23 N25–N27 N341 N35 N40 N70– N73 N750–N751 N764 N766 O00–P96 Q20–Q28 Y40–Y84	010–018 0341 035 0381–0383 03840 03842–03849 0388–0389 0479 137 180 153–154 174 179 182 186 193 201 204 210–229 240–246 249–250 255 320–322 345 390–398 401–405 410–415 430–438 440–441 451 4539 460–466 470–478 480 4820–4821 4823–4824 4828–4829 483–486 493–494 51882 510–514 53084 531–534 540–543 550–553 574–577 580–589 591–592 59780 598 600 614–616 630–679 681–682 745–747 760–779 7880 9940 99591 99709 E860–E879 E930–E949	010–019 0340–0341 0381–0389 035 045–046 153–154 174 180 182– 183 186 193 201 204 210–229 240–256 320 345 390–398 400–404 410–414 426 430–438 440–441 451 4539 460–466 480–481 48201 4822 48230 483–486 493 500–508 510–514 518 531 534 540–543 550– 553 573–574 576–577 580–586 591–592 597–598 600 612–613 616 620 622 625 630–678 681–682 745–747 760–779 78602 E850–E859 E930–E936 E947 E949	001–019 050–052 05310–05349 154 170–173 178 194 201 20400 20455 210–229 241 250–254 260 274 330–334 340–341 353 400– 416 420 440–447 450–451 453–454 463–466 470–475 490–493 500 510–522 526 540–545 550–553 560–561 584–585 587 590–594 600–604 608 610 622–624 626 630 63711 640–689 691–693 754 78550 E940–E959

Table A4: Mapping of treatable conditions across ICD versions 6 through 10



(a) Men, Q1

(b) Women, Q1

(c) Men, Q4

(d) Women, Q4

(e) Men, Q4:Q1 ratio

(f) Women, Q4:Q1 ratio

Figure A.5: Mortalities by treatability and preventability, 1960–2021

Notes: Panels (a) and (b) show the mortality rates for the 1st income quartile by treatable and preventable types of death for men and women, respectively. Panels (c) and (d) show the same for the 4th quartile. Panels (e) and (f) show the ratio between the 1st and 4th quartile for different causes of death. 3-year moving averages for all series. Mortality rates were based on the total Swedish population aged 40–75, excluding individuals with missing, negative or zero income, and the lowest 3% income.

For men in the lower income quartile, mortality rates for conditions classified as preventable, or both treatable and preventable, increased until 1980, likely influenced by circulatory disease mortality (see Figure A.5). Post-1980, there was a consistent decline in mortality from these categories. However, mortality from purely preventable diseases rose slightly throughout the period.

In contrast, for men in the upper quartile, mortality rates from all categories of treatable and preventable diseases declined, with the pace of decrease accelerating post-1980 and stabilizing in the last two decades. For women in the lower quartile, there was no similar increase in early decades; instead, mortality rates from treatable diseases or those that are both treatable and preventable steadily declined. However, mortality from purely preventable causes increased slightly over this time period.

The bottom panels of Figure A.5 display mortality ratios by cause for men (e) and women (f). Ratios near 1 suggest minor mortality differences, while declining trends indicate growing inequalities. The cancer mortality ratio fell from about 1 to below 0.5 for men and to 0.6 for women, marking increased inequality. Circulatory disease mortality also showed rising income-related disparities. Trends for infectious diseases were less marked, and mortality from mental disorders and alcohol remained stable for men in recent decades.