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How Does Mortality Contribute to Lifetime Pension Inequality? Evidence From Five Decades of Swedish Taxation Data

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ABSTRACT As with many social transfer schemes, pension systems around the world are often progressive: individuals with lower incomes receive a higher percentage of their income as a subsequent pension. On the other hand, those with lower earnings have higher mortality and thus accumulate fewer years of pension income. Both of these opposing factors influence the progressiveness of pension systems. Empirical efforts to disentangle the effects of mortality inequality on lifetime pension inequality have been scarce. Using Swedish taxation data linked with death registers for 1970–2018, we study how education and preretirement earnings relate to lifetime pensions from age 60 onward and how mortality inequalities contribute to overall inequalities in lifetime pensions. The results show that a progressive replacement structure and mortality differences contribute to the overall distribution of pension payments over the life course. Up to one quarter of lifetime pension inequality is attributable to the greater longevity of socially advantaged groups—particularly among men. Hence, mortality inequalities are an important determinant of the overall degree of between-group income transfers in a pension system, but they are not as important as inequalities in prior earnings.

KEYWORDS Pension progressivity • Retirement • Mortality inequality • Life expectancy • Education

Introduction

A large body of literature has considered the substantial and persistent socioeconomic gradient in mortality risks and longevity. One implication of such gradients is their effects on redistribution through state-regulated programs, such as health care and pension systems. Demographers interested in mortality gradients have examined population aging differences by socioeconomic status (SES) (Kitagawa and Hauser 1973; Majer et al. 2011; Pamuk 1985), but the effects of differential mortality on pension benefits have not received as much attention. Thus, whether individuals with lower SES benefit less from pension programs because of their higher mortality risks remains an open question.

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Three factors determine an individual's accumulated pension over the life course. First, given the mortality gradient, individuals with higher SES live more years and accumulate higher pensions. Second, preretirement earnings determine contributions to the pension system, which is further translated into flows of pension benefits. Third, because of the explicit progressivity of many pension programs (i.e., redistributing toward lower earners), proportional benefits become lower at increasingly higher levels of preretirement earning. Whereas the first two factors predict greater benefits to those with higher SES, the third does the same for those with lower SES. The relative importance of these three factors is far from self-evident.

Researchers have often studied pension progressivity by comparing measures such as the replacement rate across earnings groups (e.g., Dudel and Schmied 2019; Whitehouse 2006). The replacement rate is the proportion of labor earnings translated into retirement pension income. Higher replacement rates mean more benefits with respect to prior earnings-based contributions. In contrast, a cohort-based life course analysis using measures such as the lifetime benefits/tax ratio (e.g., Smith et al. 2003) may modify the association between SES and annual benefits because it introduces the additional factor of mortality, which counteracts progressivity defined annually. Recent research has highlighted the detrimental effects of SES mortality differences using various methods. This research has concluded that SES mortality differences increase lifetime pension inequalities and impede the progressivity that is usually conceptualized annually without considering SES-specific mortality patterns (Sánchez-Romero and Prskawetz 2020).

Understanding lifetime pension inequality is relevant from a policy-making perspective: the progressivity of pension systems is often a policy goal. Yet, progressive replacement rates do not afford the same level of progressivity for the entire cohort over the life course if the system considers replacement only among *living* retirees compared with their previous incomes. Thus, an interesting question is, who benefits (more) from pension systems when longevity varies? The answer depends on both replacement and mortality inequalities between cohort members across such characteristics as gender, income levels, and education.

In this study, we use high-quality Swedish national taxation records on earnings and pension payments from 1970 to 2018 to examine how lifetime pensions are structured across socioeconomic groups. We disentangle inequalities in lifetime pensions between social groups based on gender, education, and preretirement earnings into age-specific components attributable to differences in annual pension income and mortality.

We expand the literature in several ways. Prior research has not used individual-level data over the complete life course, largely because of the unusually long span of data required for this kind of lifetime analysis. We measure values of lifetime pensions of real birth cohorts with high-quality register data that—unlike survey data, which often suffer from missing values and reporting bias—provide an accurate picture of an entire population. Researchers have mainly examined the role of mortality on lifetime pension inequality by using counterfactual analysis—that is, by recalculating lifetime pensions based on hypothetical mortality rates (e.g., Organisation for Economic Co-operation and Development (OECD) 2017; Sánchez-Romero et al. 2020)—rather than decomposition techniques that yield additive terms summing to total lifetime pension inequality. Our life table–based decomposition is a novel approach that presents not only age-specific mortality effects but also additive effects of preretirement earnings and the redistributive role of the pension system. We also explore the potential impacts of policy changes, such as raising pensionable ages.

Substantively, our results can inform policymakers attempting to balance the goals of social equity and (demographic) actuarial fairness. We also shed new light on the literature on later-life income stratification. Given that the share of older adults in the population is rising almost worldwide and that pension income is the main source of income for most older people, reducing old-age poverty is becoming ever more important. The share of state budgets allocated to pensions is rising throughout the aging world; meanwhile, inequalities in pension payments are becoming an increasingly important aspect of economic inequality over the life course.

Background

What Is the Function of Pension Systems?

Pension systems in contemporary high-income countries serve many goals, including (1) helping individuals redistribute resources from working to old ages; (2) protecting individuals from poverty in old age; (3) providing insurance and reducing variance in monthly old-age income, regardless of longevity; and (4) transferring money from higher income individuals to lower income individuals as an integrated part of larger tax-funded and mandatory government welfare systems, thus helping achieve the first three goals. In traditional typologies of pension systems in OECD countries, systems described as "Bismarckian" are oriented toward income replacement (meeting the first and third goals), whereas "Beveridgean" systems focus on poverty protection (the second goal) with less emphasis on relating pensions to previous earnings (Ebbinghaus 2021).

All but the first goal of life course transfers involve varying degrees of redistribution between individuals. For instance, the third goal, also known as risk pooling (Ayuso et al. 2017), may counteract the other goals of a pension system if individuals with unusually long life spans are concentrated among high-income individuals.

In theory, everyone at working ages could buy private pension insurance that, in retirement, would be translated into annuities from their savings through an open market, thereby fulfilling the first and third goals. Yet, this practice has never occurred at the societal level. Instead, lower income countries have relied mostly on family care, gradually replacing it with public pension systems as they become richer. For privately funded pension systems, creating actuarially fairly funded pension insurances is challenging because of mortality differences by gender and socioeconomic group, difficulties in forecasting future mortality, the great efforts required to maintain a pension scheme over decades, and the risks involved in providing such insurances. Thus, all OECD countries (with the partial exception of Chile) fund public pension systems through taxes on working-age individuals that are transferred to pensioners (the so-called pay-as-you-go system), through mandated (and often tax-favored) pension savings for individuals (Whitehouse 2006), or both.

Reducing inequality at older ages is intrinsic in most pension systems. Indeed, the initial motivation for all pension systems (particularly those of the Beveridgean tradition) was to eliminate poverty among older adults and ensure an adequate standard of living for them. Pension systems thus protect against socially unacceptable social deprivation among the very old who can no longer work. With individuals living longer beyond retirement ages, however, saving adequate resources during working years to fund retirement has become less realistic for some. This point is particularly relevant for low earners, who are more heavily reliant on public pension schemes than high earners (U.S. Government Accountability Office 2019). Because public pension systems are equalizers, old-age inequality in total income from all sources is smaller in countries where public pension benefits represent a larger share of pensioners' total income (Brown and Prus 2004).

Types of Redistributions and Inequalities

Different types of redistributions are involved in achieving each of the aforementioned goals of pension systems. Accordingly, redistribution and inequality can be assessed for different comparison groups. In systems where working-age individuals fund the currently retired population, total contributions and total benefits within any given generation tend not to be equal. Thus, *intergenerational* redistribution is inevitable, further stimulating discussions about pension fairness across generations. Many studies have focused on this aspect, particularly on whether the overall system is sustainable with an aging population following declining fertility and mortality (Howse 2007; Lee and Mason 2011). Other research has focused on pension reforms and differences between funded and nonfunded systems (Sinn 2000). We do not elaborate on either of these aspects in this study. We focus instead on the redistribution between individuals of the same cohort: *within-generation, interpersonal* redistribution and inequality. The sources of such inequality are prior labor income, the extent to which labor income is translated into pension income, and life span. Life span is crucial because it determines the length of pension accumulation. Although our focus is on interpersonal redistribution and inequality, understanding *intrapersonal* redistribution (i.e., individuals redistributing their income from working age to old age) is also integral to our lifetime analysis.

Here, we summarize the three determinants of within-generation inequality. First, preretirement labor earnings are closely linked to annual pension income. Men tend to have higher labor earnings than women and thus tend to have higher annual pension incomes. Second, the extent to which the system intends to redistribute incomes from the rich to the poor is often reflected in differential replacement rates. Such redistributive effects of public pension programs, like other government programs, tend to be measured yearly (Nelissen 1998), which ignore between-individual differences in mortality risks and thus in the number of years they can receive a pension. Third, the longer individuals live, the more years they can benefit from the pension system. This feature reflects that pension systems pool risks, protecting individuals against uncertainty regarding how long they will live. Individuals therefore do not risk using up their money long before they die or having unintentional property left upon their death (Ayuso et al. 2017). Consequently, a pension system redistributes money from the shorter-lived to the longer-lived.

Studies have found that people with higher SES tend to live longer than those with lower SES even in today's low-mortality regimes (e.g., Brønnum-Hansen and

Baadsgaard 2012; Mackenbach et al. 2018). The exact magnitude of this SES gradient varies between countries. In the United States in 2001–2014, men in the top 1% of the income distribution lived an average of 14.6 years longer than those in the bottom 1% (Chetty et al. 2016). In many OECD countries, the SES gap in longevity has been growing (Kravdal 2017; Meara et al. 2008; Östergren 2015; Permanyer et al. 2018).

Research on How Mortality Affects Pension Inequality

Research beginning with Aaron (1977) has demonstrated mortality's regressive effects on the overall redistribution of pension systems in many contexts. Many studies have focused on the role of mortality inequalities by (lifetime) earnings (e.g., Bishnu et al. 2019; Garrett 1995), probably because public pension income is solely based on prior earnings-related contributions. Other researchers have examined differences across social factors such as class, education, gender, and race/ethnicity (Brown 2003, 2007; Jijiie et al. 2019; Tan and Koedel 2019; Vidal-Meliá et al. 2019).

Most studies have focused on the U.S. context. One such study simulated individual life histories for two cohorts (1930 and 1960), finding that the gap in lifetime Social Security benefits between men in the top and bottom income quintiles increased from US$103,000 to US$173,000 across the two cohorts (National Academies of Science, Engineering, and Medicine (NASEM) 2015). This increase was attributed to growing inequality in life expectancy: projected life expectancy at age 50 increased for the top quintile (from 31.7 to 38.8 years) but decreased for the bottom quintile (from 26.6 to 26.1 years) across the two cohorts (NASEM 2015). Focusing on cohorts born in 1962–1980, Tan and Koedel (2019) found that the U.S. retirement system is still modestly progressive and that mortality inequalities reduce its progressivity.

Studies in other countries with distinct pension systems have confirmed mortality's regressive role. Research found that pension systems in Germany and Italy, unlike in the United States, are regressive, transferring money from low to high earners (Caselli et al. 2003; Haan et al. 2020; Mazzaferro et al. 2012). The OECD (2017) examined lifetime pensions across its member countries, assuming a three-year difference in life expectancy between low and high earners and an arbitrary ratio of earnings between them (50% and 200% of average earnings, respectively). The study found that the differences in lifetime pensions between low and high earners vary between 10.6% and 16.6% across OECD countries. The true magnitude of life expectancy differences between these income groups may not be three years. Nevertheless, fixing the differences at three years is useful to show that the impact of life expectancy gaps is widespread and suggests that the magnitude of lifetime pension inequality depends on the context.

Research has also examined the potential impact of pension reforms, given that many countries have moved from defined benefits to (notional) defined-contribution pension systems. Using simulation, Lee and Sánchez-Romero (2019) found that a notional defined-contribution (NDC) system using cohort- and income-specific life tables leads to the lowest level of lifetime pension inequality in the U.S. context; a defined-benefit (DB) system with progressive replacement or an NDC system with cohort-specific but not income-specific life tables shows slightly higher lifetime pension inequality levels; and a DB system with a flat replacement rate shows the highest inequality. Thus, the authors concluded that an NDC system should use income-specific life tables to reduce lifetime pension inequality, and a DB system should move toward more progressive replacement rates. A theoretical analysis based on life cycle hypotheses incorporating individual behavioral responses (e.g., timing of retirement) yielded similar conclusions (Sánchez-Romero et al. 2020).

Some studies have used mathematical models to understand the variations of lifetime pension inequality under different pension systems (Pestieau and Ponthiere 2016; Sánchez-Romero et al. 2020). Others have analytically calculated SES-specific lifetime pensions based on SES-specific life tables and pension formulae (e.g., OECD 2017; Olivera 2019). Inputs are often not from data linked at the individual level but instead are aggregated from different sources or arbitrary SES-specific inputs. This approach is useful for international comparisons in which harmonized microdata are unavailable. Another approach is to use microsimulation to construct hypothetical cohorts, often with data from different sources and mortality forecasts (Goldman and Orszag 2014; Hurd and Shoven 1985; NASEM 2015; Nelissen 1998). The simulation approach is useful to parse the effects of different pension systems (Lee and Sánchez-Romero 2019) and changes in individual-level inputs (e.g., earnings trajectory, retirement age, life span) on population-level lifetime pension inequality. Another advantage of simulation is that it can help address right-censoring, particularly in analyses of future trends in pension inequality. Only a few studies (e.g., Haan et al. 2020) have been able to directly calculate lifetime pension inequality from individual-level microdata with rich information. We impute pensions and mortality at very old ages, but the imputed person-years represent only a trivial share of the total person-years.

Research Gaps and Our Contributions

No study has analyzed lifetime pension inequality based on birth cohorts' experiences because of data limitations. The long series of individual-level linked administrative data are not subject to the problems typically affecting surveys, such as missing values and reporting bias, especially for income variables. Hence, one contribution of this study is to provide precise, empirical evidence of the regressive role of the mortality gradient.

Methodologically, our combination of the life table approach with the decomposition technique is a novel addition to research on lifetime pension inequality. This analytical framework can answer research questions that have not been thoroughly answered. First, we can answer questions about the size of the contributions of mortality and preretirement earnings to lifetime pension inequality. In most government pension systems, whether based on mandatory savings or a DB or NDC system, pension income is highly correlated with preretirement labor income; therefore, a large proportion of lifetime pension inequality results from inequality in preretirement labor income. Our decomposition method disentangles total lifetime pension inequality into additive components due to mortality differences, preretirement earnings differences, and the intended redistributive effects of the system. We also examine how (hypothetical) changes to the entire pension system—such as overall generosity, pension timing, and life expectancy changes—impact SES differences between groups. Second, we can address questions of how mortality differences at a given age affect lifetime pension inequality. Research has shown that mortality inequality between SES groups becomes smaller with age (Hoffmann 2011; Rehnberg 2020), suggesting that mortality inequality at older ages may contribute less to total lifetime pension inequality than mortality inequality at younger ages. Whether this is true also depends on the age-specific pension variable. Empirical evidence of the age pattern of mortality's contribution is lacking: research has shown only the total mortality contribution, partly because of methodological constraints.

Given that most of the relevant research refers to the U.S. context, less is known about countries with contrasting pension systems, such as Sweden. Our study also differs conceptually from previous research in that we capture all sources of pensions (income-related government pensions, guaranteed pensions, collective-agreement pensions, disability pensions, and widowhood benefits) and provide a holistic view of the entire Swedish pension system, rather than evaluating individual components of a (government) pension system (e.g., U.S. Social Security old-age insurance). The drawback of this feature is that our study is not useful for evaluating subcomponents of a given pension system; the advantage is that we can assess the pension system's overall societal redistribution.

The Swedish Context and Pension System

For most of the twentieth century, life expectancy in Sweden ranked among the world's highest, although data in recent decades indicate that this is no longer the case (Drefahl et al. 2014). Male mortality remains low from an international perspective, whereas female mortality is at average OECD levels (Drefahl et al. 2014). Inequality in life expectancy by income levels at age 35 increased over 1970–2007 for Swedish men and women (Hederos et al. 2018). In particular, poor and low-educated men were the most vulnerable to premature deaths (Hartman and Sjögren 2018). An increasing gap in life expectancy at age 65 was also observed over 2006–2015 (Fors et al. 2021).

Sweden is often described as a universalistic welfare state and as an exemplar of the social democratic regime in Esping-Andersen's (1990) typology of welfare states. At the time of our study, Sweden offered a generous public pension system (first pillar), but occupational pension systems (second pillar) linked to collective agreements covering the majority of the population were also important (Palme 2005). Thus, the Swedish pension system could broadly be described as Bismarckian. An overview of the Swedish pension systems for our cohorts is provided in the online appendix.

The statutory retirement age was 65 for our cohorts, although individuals could (and commonly did) access many of their retirement benefits beginning at age 60 (Hagen 2013). Our pension variable covers a wide selection of first- and second-pillar pensions (Whitehouse 2006), including other pensions targeted at individuals with special needs (e.g., survivor's pension). However, the variable does not cover sickness and disability pension schemes targeted at ages before the statutory retirement age. For the cohorts analyzed, individuals could save in private annuities (i.e., "pension insurance") with different tax rates, depending on the saver's circumstances. Private pensions (paid out as a normal pension) are included in our pension variable, but they are rare.

Data and Methods

Data

Our analyses draw on two data sets—tax and death registers—linked with a unique personal ID number. The initial sample includes 209,491 individuals born in 1920 (55.6%) or 1925 (44.4%). The use of two cohorts helps test the robustness of the results. No important institutional change occurred between the two cohorts, so differences in results would reflect cohort differences in mortality schedules and earnings inequality, with the latter partly explained by cohort differences in labor force participation, particularly for women. (See Tables A1 and A2; these and all tables and figures designated with an "A" are available in the online appendix.) We exclude 1,628 individuals who had international migration records after age 50; 17,050 individuals who died before age 60; and 5,027 individuals with missing values for key variables (mainly education). Hence, the analytic sample contains 103,712 individuals born in 1920 and 82,074 individuals born in 1925.

Individuals' yearly labor earnings and pension income are derived from taxation registers. The main outcome variable lifetime pension income includes state pensions, employer-financed pensions, and private pensions (private pensions being a very small share; see the online appendix). We focus on pension income at ages 60 and older; lifetime pensions are conditional on surviving to age 60.[1]

We examine two socioeconomic factors: education and preretirement labor earnings. The education variable is obtained from education registers and has three levels: primary, secondary, and tertiary (or more). We group individuals into earnings quintiles based on (pretax) labor earnings over ages 50–59, separately by gender.[2] Ideally, we would include earnings at younger ages for grouping, but earlier data are not available. Grouping based on lifetime earnings (i.e., earnings over the entire work history) may lead to different results. However, the most important part of the Swedish pension system for our cohorts, the Allmän Tillägspension, is based on income during the highest-earning 15 years (in practice, often around ages 50–59), not lifetime earnings. The average annual earnings over these 10 years include years with zero earnings, but excluding years with zero earnings when calculating average annual earnings produces very similar results. A large share of women were (mostly) outside the labor force because female labor force participation was far from universal in Sweden at the time. Therefore, the lowest quintile mostly includes women outside the labor market. Women in the second quintile had some labor force attachment. For the third and higher quintiles, the variable reflects different income levels among working women (see Table A2). Earnings and pension income are shown in 1,000 Swedish krona (SEK). The exchange rate of SEK to U.S. dollars varied over the period, with an average of approximately SEK 8 to US$1.

[1] After conditioning on surviving to age 50, we find that 5.8% (11,418) did not reach age 60. Men, the less educated, and those with less income were more likely to die before age 60 than women, the more educated, and those with more income, respectively (see Table A3, online appendix).

[2] The online appendix shows the proportion of individuals with years of zero earnings over ages 50–59 (Tables A1 and A2) and the mean and standard deviation of the earnings variable (Table A4).

Death records are available until 2019. In total, 1,658 (1.6%) individuals from the 1920 cohort survived to 2020 (age 99), and 8,387 (10.2%) individuals from the 1925 cohort survived to 2020 (age 94). For individuals who survived to 2020, we assume that their pension income is constant with the last three years' average over subsequent years and that their mortality follows Statistics Sweden's (2020) forecasts.[3]

Lifetime Pension Income

Our analyses are based on cohort life tables. For each subgroup, we construct a life table from age 60 to age 105+. Then, we add a column of age-specific pension income, pen_x, to the life table. Lifetime pensions conditional on surviving to age 60, LP_{60}, are a function of inputs: the total number of individuals surviving to age 60 (l_{60}), person-years lived in the age interval $\left[x, x+1\right)$, L_x, and pen_x:

$$LP_{60} = f\left(l_{60}, L_x, pen_x\right) = \frac{1}{l_{60}} \sum_{x=60}^{\omega} L_x \times pen_x, \tag{1}$$

where ω is the terminal age 105+, and the radix l_{60} is 1. This equation is analogous to Sullivan's (1971) method of healthy life expectancy, a widely used technique in population health research. The difference is that we replace the proportion of individuals without morbidity with pen_x. Applying life table equations that Chiang (1960, 1972) suggested, we can write L_x in the form of age-specific mortality rates (m_x) and average person-years lived in the age interval $\left[x, x+1\right)$ for persons dying in this interval (a_x):

$$L_x = L_{x-1} \times \frac{1 - m_{x-1} a_{x-1}}{1 + m_x - m_x a_x}. \tag{2}$$

We assume a_x to be 0.5. This assumption works well and is widely used for calculating life tables. Hence, LP_{60} is a function of m_x and pen_x:

$$LP_{60} = f\left(m_x, pen_x\right). \tag{3}$$

For earnings and pension income, we adjust for inflation, with 2018 as the base year.

Some studies used a discount rate when calculating lifetime pensions because they focused on the actuarial sustainability of pension systems (e.g., NASEM 2015; Whitehouse 2006; Whitehouse and Zaidi 2008). This calculation adds less weight to pensions at older ages. We do not include a discount rate in our main analyses, given that our primary interest is in the received money flows in the pension system. Also, accumulating nondiscounted values is standard in research on social stratification.

[3] This assumption is reasonable because inflation-adjusted pension income is relatively invariable over time (see Figures A1 and A2). We use Statistics Sweden's (2020) mortality forecasts for ages that were not observable (ages 100+ for the 1920 cohort and 95+ for the 1925 cohort). Within gender, we calculate mortality rates for SES groups by assuming relative mortality differences (i.e., mortality ratios) between SES groups in future years to be the same as those observed in 2015–2019 while matching total gender-specific mortality rates to those forecasted by Statistics Sweden. The potential bias in our assumption should be minor for our estimates of lifetime pensions at age 60, given that only a small proportion of individuals from the two cohorts survived to 2020.

For comparability with other studies focusing on pension sustainability, we present results derived from using a discount rate of 2% in the online appendix. This discount rate approximates the GDP per capita growth and wage growth over the period, and overall income growth determines the long-term financial sustainability of a pay-as-you-go system (Samuelson 1958).

Using the life table approach, we aggregate individuals by their life span and then calculate the average lifetime pension. This approach essentially yields the same result as directly averaging individuals' lifetime accumulated pension (i.e., without aggregating by life span first). Variation across individuals of the entire population calculated from a life table approach (e.g., Olivera 2019) differs from direct individual calculations because aggregating individuals to the midpoint of one-year age-groups reduces the variation to some extent.

Decomposition

Decomposition techniques are widely applied to explain the difference in an aggregate measure between two (sub)populations by differences in its input covariates. As described earlier, lifetime pensions are a function of covariates m_x and pen_x, and our aim is to explain the difference in lifetime pension between SES groups by differences in m_x and pen_x. We apply the Horiuchi et al. (2008) decomposition method. Specifically, LP_{60} can be seen as a differentiable function of the covariates m_x and pen_x. We assume continuous changes between the two groups of interest (e.g., low and high SES). Lifetime pensions of low- and high-SES groups are denoted as LP_{60}^1 and LP_{60}^2, respectively, and the difference between them can be written as follows:

$$LP_{60}^2 - LP_{60}^1 = \sum_{x=60}^{\omega} \left(\int_{m_x^1}^{m_x^2} \frac{\partial f\left(m_x, pen_x\right)}{\partial m_x} dm_x + \int_{pen_x^1}^{pen_x^2} \frac{\partial f\left(m_x, pen_x\right)}{\partial pen_x} dpen_x \right). \quad (4)$$

This way, the total difference between LP_{60}^1 and LP_{60}^2 is split into components attributable to differences in m_x and pen_x. Numeric integration is used for the estimation (Horiuchi et al. 2008). This decomposition method has been widely used to decompose health expectancies (van Raalte and Nepomuceno 2020).

We apply a second decomposition by further splitting the pen_x into two components: *earn* and $diff_x$. Here, *earn* is the average yearly labor earnings between ages 50 and 59, and $diff_x$ is the difference between pension income at each age and the average earnings at ages 50–590 (i.e., $pen_x = earn + diff_x$).[4] The covariates are m_x,

[4] Alternatively, the relationship between prior earnings and yearly pension income can be specified as a ratio. Our pension variable is the sum of pension incomes from various programs, and many of them are not earnings-related. Thus, theoretically, the relationship between yearly pension income and prior earnings is neither additive nor relative. Empirically, the relationship between earnings and yearly pension income depends on the location of the earnings distribution. Particularly at the lower end of the earnings distribution, yearly pension income is unlikely to be related to earnings on a ratio basis. For instance, for women with zero earnings (more than 40% of the lowest income quintile for the 1920 cohort), the ratio would be positive infinity. A small increase in earnings does not lead to a big increase in pension income because of the guarantee pension. The ratio between average yearly pension and average earnings for the lowest female quintile in 1920 is 15.14, whereas the usual replacement rate of occupational pension is smaller

$diff_x$, and $earn$. This reformulation is motivated by the large proportion of inequalities in yearly pension income attributable to inequalities in preretirement labor earnings. Generally, $diff_x$ takes negative values because individuals' pension income tends to be lower than their previous labor earnings. A $diff_x$ closer to zero means pension income more closely matches labor earnings. Therefore, comparing $diff_x$ across SES indicates the redistribution effect (measured yearly). If $diff_x$ is smaller in absolute value among low-SES groups than among high-SES groups, the system is progressive. The total contributions of $earn$ and $diff_x$ sum to the total contributions of pen_x in the first decomposition. The decomposition method is implemented using the R package *DemoDecomp* (Riffe 2018).

We also analyze the impacts of several scenarios of policy and mortality changes. Changes in retirement ages are examined by shifting pen_x along age x.[5] Changes in the pension system generosity are assessed by recalculating pen_x. Mortality scenarios are evaluated by modifying the m_x.[6]

Results

Table 1 shows that life expectancy at age 60 increases by education and earnings quintile for both men and women (see also the survival curves in Figures A3 and A4). For the 1920 cohort, men aged 60 in the highest earnings quintile were expected to live 4.5 more years than their peers in the lowest quintile (22.0 vs. 17.5 years). Similarly, for the 1920 cohort, life expectancy was 2.6 years lower for men with primary education than for men with tertiary education; the corresponding gap for men in the 1925 cohort was 3.4 years. We found similar patterns for women, albeit to a lesser extent. Overall, mortality differences by earnings were smaller for women than for men. Interestingly, unlike men, women in the lowest earnings quintile did not have the lowest life expectancy. Table 1 also shows that men and women who were more educated and who earned higher incomes had higher pension incomes at age 70, reflecting an income-based pension system. Overall, pensions increased rapidly up to age 66 and remained stable for all groups thereafter (see age-specific pension income in Figures A3 and A4).

We find substantial gaps in lifetime pensions between education and earnings groups.[7] Lifetime pension income of men with tertiary education was more than twice

than 1. Thus, the specification of using ratios is empirically less meaningful than the specification of using absolute differences.

[5] When examining the impact of raising the retirement age by one year, we replace pen_x with pen_{x-1} for ages 61–105 and set pen_{60} to 0. When examining the impact of lowering retirement age by one year, we replace pen_x with pen_{x+1} for ages 60–104 and leave pen_{105} unchanged. This approach might not perfectly reflect reality because individuals' retirement patterns may change as a result of changes in statutory retirement age, but it is a good starting point for the analysis of such policies.

[6] We examine simple scenarios in which mortality rates across all ages experience the same proportional reduction.

[7] See Figures A5 and A6 for boxplots of observed (i.e., truncated) accumulated pensions income until the end of 2018. Lifetime pensions are defined here as the expected value of accumulated pension from age 60 to death, but they can also be calculated from age 60 to a specific age, analogous to temporary life expectancy (i.e., expected years of life within the specified age interval). These results are presented in Figures A7 and A8.

Table 1 Descriptive statistics for remaining life expectancy at age 60, average pension at age 70, and lifetime pension: Means, with percentages shown in parentheses

	Number		LE_{60} (years)		Mean Pension at 70 (in SEK 1,000)[a]		Lifetime Pension (in SEK 1,000)[a]	
	1920 Cohort	1925 Cohort	1920 Cohort	1925 Cohort	1920 Cohort	1925 Cohort	1920 Cohort	1925 Cohort
Men Total	51,088 (100)	40,368 (100)	20.0	21.0	192.2	197.6	3,173.5	3,589.2
Men by Education								
Primary	34,757 (68)	25,486 (63)	19.5	20.2	168.5	169.3	2,705.7	2,992.8
Secondary	13,086 (26)	11,328 (28)	20.8	21.7	222.3	221.0	3,795.6	4,128.6
Tertiary	3,245 (6)	3,554 (9)	22.1	23.6	311.4	311.9	5,650.4	6,138.8
Men by Earnings								
Lowest	10,218 (20)	8,074 (20)	17.5	18.6	105.8	113.6	1,606.6	1,913.6
Second	10,217 (20)	8,073 (20)	19.3	20.2	158.4	161.4	2,465.2	2,802.0
Third	10,218 (20)	8,074 (20)	20.2	21.0	178.0	178.6	2,932.9	3,273.3
Fourth	10,217 (20)	8,073 (20)	20.9	21.8	204.6	209.8	3,507.8	3,930.9
Highest	10,218 (20)	8,074 (20)	22.0	23.2	298.3	309.6	5,334.9	6,014.1
Women Total	52,624 (100)	41,706 (100)	24.5	25.1	109.4	118.8	2,405.8	2,725.6
Women by Education								
Primary	41,128 (78)	31,049 (74)	24.2	24.7	99.8	107.3	2,178.0	2,443.5

Table 1 (continued)

	Number		LE_{60} (years)		Mean Pension at 70 (in SEK 1,000)[a]		Lifetime Pension (in SEK 1,000)[a]	
	1920 Cohort	1925 Cohort	1920 Cohort	1925 Cohort	1920 Cohort	1925 Cohort	1920 Cohort	1925 Cohort
Secondary	9,363 (18)	8,300 (20)	25.3	26.0	131.6	136.6	2,925.3	3,169.1
Tertiary	2,133 (4)	2,357 (6)	27.1	27.3	192.8	203.3	4,503.0	4,888.5
Women by Earnings								
Lowest	10,525 (20)	8,341 (20)	24.6	24.9	65.6	63.5	1,481.0	1,621.4
Second	10,525 (20)	8,341 (20)	23.2	23.8	72.2	79.6	1,618.6	1,871.8
Third	10,524 (20)	8,341 (20)	24.7	25.6	93.2	109.0	2,117.8	2,526.0
Fourth	10,525 (20%)	8,341 (20)	24.7	25.2	127.9	141.0	2,761.8	3,134.1
Highest	10,525 (20)	8,342 (20)	25.4	26.1	185.9	198.0	4,044.4	4,475.2

Note: See summary statistics for the earnings variable in Table A4.

Source: Authors' calculation based on linked administrative data from Statistics Sweden.

[a] We adjusted inflation to the 2018 level when computing the average pension at age 70 and lifetime pensions. SEK 1,000 ≈ US$125.

that of men with primary education. The absolute difference was about SEK 3 million (approximately US$375,000) for both cohorts. Differences for women with primary versus tertiary education were SEK 2.3–2.4 million for both cohorts. Additionally, lifetime pensions increased by earnings quintile for men and women, with the largest difference observed between the fourth and highest quintiles for both genders and both cohorts.

We also find large differences by gender: men had shorter life expectancies but higher lifetime pensions than women. For any given quintile from the second onward, women had lifetime pensions that were approximately similar to those of men of the preceding quintile. Additional analysis (Figure A9) shows that women had an advantage because of their lower mortality, but a disadvantage in yearly pension income more than offset the mortality component and led to an overall male advantage in lifetime pensions.

Education and earnings differences in life expectancy are larger among men than among women. The literature has long documented gendered differences in the association between SES and mortality (Pappas et al. 1993). On the other hand, differences in yearly pension income were smaller (in absolute terms) between women's SES groups than between men's SES groups because of a more homogeneous income distribution among working-age women than working-age men. Both mortality and yearly pension levels resulted in larger gaps in lifetime pension income between men's SES groups.

Decomposition results for the comparison between primary and tertiary education groups by gender and cohort are shown in Figure 1, where the sum of all red and black bars in each panel equals the total difference in lifetime pension. Mortality differences accounted for an important part of the total differences in lifetime pension. For men born in 1920, differences in mortality rates of all ages above 60 resulted in a difference of SEK 636,000 in lifetime pension income, constituting 22% of the total difference (SEK 2,945,000); corresponding figures for men in the 1925 cohort were SEK 852,000 and 27%, respectively. However, lifetime pension differences due to yearly pension income showed almost no change across the cohorts for men.

As shown in Table 1, women had lower annual and lifetime pensions than men. Overall, the SES gradient in annual pension levels was similar for men and women. In absolute terms but not relative terms, we find a larger difference in lifetime pensions across SES groups for men than for women. Women had a less marked SES gradient for mortality, particularly for earnings groups.

Among men, the importance of mortality differences between the two cohorts increased slightly, in line with the increasing gap in remaining life expectancy (from 2.6 to 3.4 years). Contributions of mortality were smaller for women's educational groups than men's (in absolute and relative terms), which is reasonable given that mortality differences between women's education groups were also smaller. The magnitude of contributions of mortality differences decreased only at advanced ages (around age 85); before this point, age-specific mortality contributions were relatively stable. This finding could be explained by the decline in SES differences in mortality with increasing age and the steeper slope above age 85 (Figure A10). Indeed, the age patterns of mortality in Figure 1 resemble the age patterns of mortality when

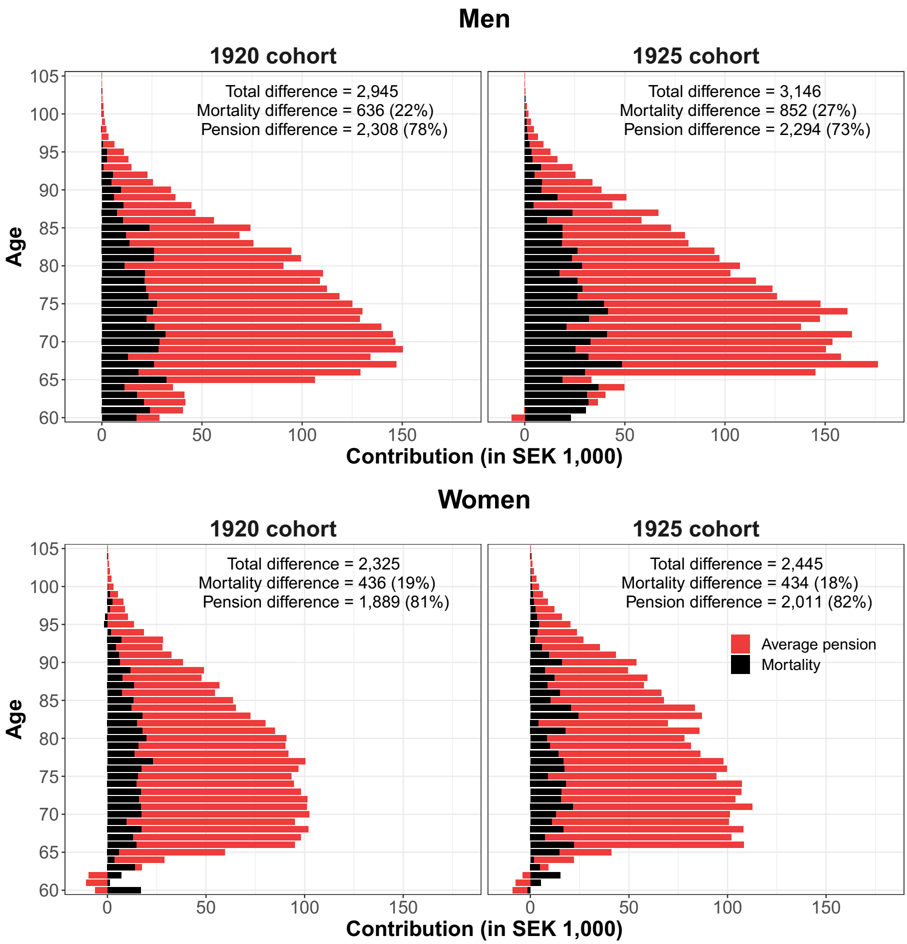

Fig. 1 Decomposition of total lifetime pension differences between primary and tertiary education groups into differences explained by mortality and yearly pension. SEK 1,000 ≈ US$125. *Source:* Authors' calculation based on linked administrative data from Statistics Sweden.

life expectancy differences are decomposed (Figure A11). The contributions of age-specific pension and mortality were much lower at older ages because many fewer people survived to these ages.

Meanwhile, age-specific differences in pension income contributed significantly only beginning at the typical retirement age of 65 for men and women in both cohorts. Before age 65, contributions to yearly pension income were minor and even reversed among women because lower educated women retired earlier much more frequently and had higher average pension income at these ages. Men's and women's contributions of yearly pension differences were consistently high beginning at age 66 and started decreasing rapidly at approximately age 80.

Figure 2 shows the decomposition results for comparisons of the lowest and highest earnings quintiles. For men, we largely find the same patterns as for education.

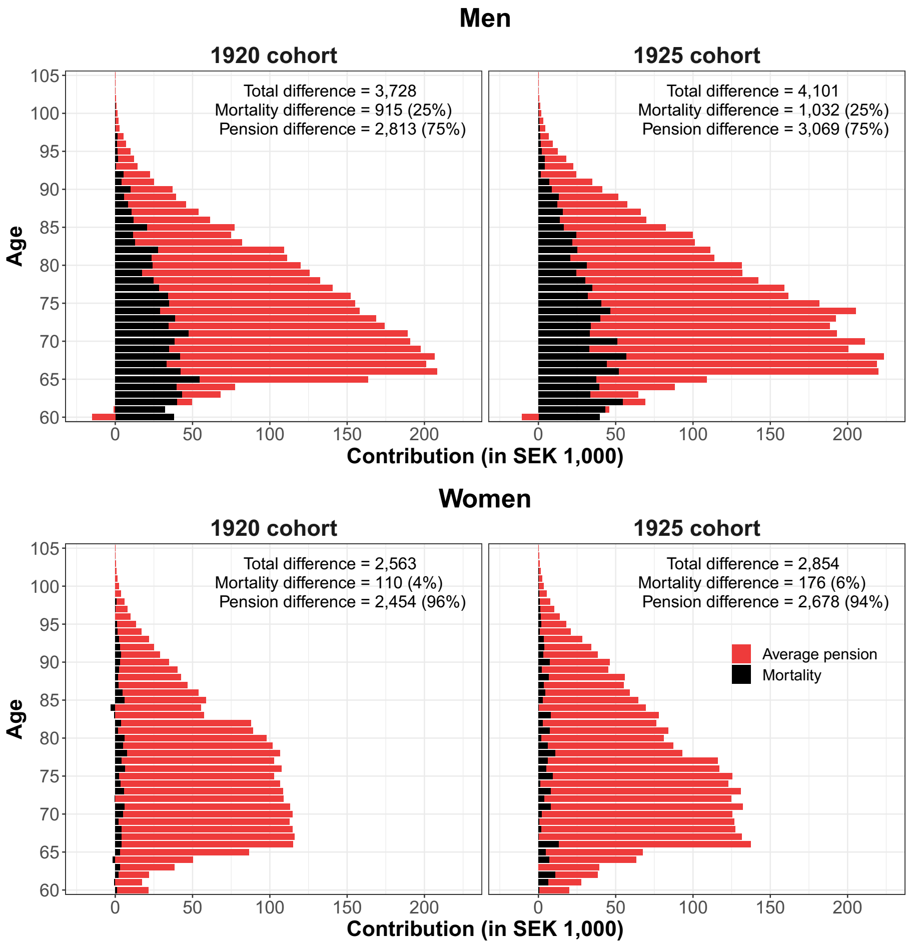

Fig. 2 Decomposition of total lifetime pension differences between the bottom and the top earnings quintile groups into differences explained by mortality and yearly pension. SEK 1,000 ≈ US$125. *Source:* Authors' calculation based on linked administrative data from Statistics Sweden.

The differences in lifetime pension were larger in the 1925 cohort. For women, the earnings results differ from the education findings: the contributions of mortality differences were much smaller, accounting for only 4% and 6% of lifetime pension differences between the lowest and highest quintiles for the 1920 and 1925 cohorts, respectively. As noted earlier, women's life expectancy at age 60 was not the lowest among the lowest earnings quintile, and mortality was only slightly higher among women in the lowest quintile than among those in the highest quintile.

Figures 1 and 2 show that most lifetime pension inequalities were explained by differences in yearly pension income, which was largely determined by preretirement labor earnings. On the other hand, most pension systems are progressive and aim to provide higher replacements for low-SES groups. Thus, the differences in lifetime pensions between SES groups explained by average yearly pensions (red bars) observed in Figures 1 and 2 are a function of both labor earnings and the pension system's redistribution effect. We further explored this aspect by splitting age-specific pension income into two components: preretirement labor earnings and the difference between pension income and labor earnings. Hence, we estimated the extent to which preretirement labor earnings and the pension system's redistribution function (perceived yearly) contributed. Before showing these results, we show how pension income is attached to labor earnings by education and earnings group. We calculated the difference and ratio between individuals' average yearly pension income at ages 66–75 and average yearly earnings at ages 50–59. This calculation, though, does not reflect any formula for how earnings were translated into pensions in the pension system, which was not possible because our pension variable included divergent pension programs.

Table 2 shows that the difference and the ratio declined with education and earnings quintile, indicating progressivity in the pension system. Whereas women in the highest earnings quintile born in 1920 received approximately three fourths of their labor earnings, their peers in the lowest quintile received pensions more than 15 times their labor earnings. The large ratio for women in the lowest quintile reflects a guarantee pension, which benefits individuals with very low earnings, such as homemakers. However, from the second to the fourth quintiles, the ratio and the difference decreased little for men and moderately for women. In the 1925 cohort, the ratio decreased from 0.78 to 0.74 for men and from 0.94 to 0.77 for women. Thus, the pension system translated earnings into pensions at nearly constant rates for individuals who had medium earnings, with only modest progressivity. The relatively weak link between women's earnings and pension partly reflects that women received a comparatively large share of their income as widowhood pensions (which was independent of their own earnings) because many of them married older husbands (Kolk 2015) and outlived their husbands.

Table 3 shows the results of an extended three-way decomposition. For simplicity, we refer to the three components attributable to mortality, differences between pension income and preretirement labor earnings, and labor earnings as *mortality effect*, *redistribution effect*, and *earnings effect*, respectively. The results show that most of the total lifetime pension difference was due to the earnings effect. Differences in lifetime pensions would have been considerably larger without a progressive pension system. If there had been no redistribution between groups, SES differences would have been approximately twice as large. It is noteworthy that the decompositions were based on comparisons between the lowest and highest SES groups. We expect to see a much smaller redistribution when comparing groups in the middle of the SES distribution, as suggested by the results in Table 2. The overall patterns in Table 3 are similar across different comparisons, except for the comparison between women's lowest and highest earnings quintiles. Compared with women in the lowest quintile, women in the highest quintile had much higher earnings, but they (as shown in Table 2) received only 72% of their labor earnings as their pension (at age 70) versus more than 1,500% for women in the lowest quintile. Such substantial differences resulted in huge earnings and redistribution effects, driving lifetime pension inequality in opposite directions. The differences explained by mortality are of lower magnitude than SES differences in earnings and the progressive redistribution of the pension system.

Table 2 Absolute and relative differences between average yearly pension income (at ages 66–75) and average yearly labor earnings (at ages 50–59) across educational groups and earnings quintiles

	Men				Women			
	1920 Cohort		1925 Cohort		1920 Cohort		1925 Cohort	
	Diff. (in SEK 1,000[a])	Ratio	Diff. (in SEK 1,000[a])	Ratio	Diff. (in SEK 1,000[a])	Ratio	Diff. (in SEK 1,000[a])	Ratio
Total	–74.08	0.72	–66.89	0.75	–0.40	1.00	–17.21	0.88
By Education								
Primary	–55.54	0.75	–51.56	0.77	5.30	1.06	–12.78	0.90
Secondary	–95.57	0.70	–80.92	0.74	–13.66	0.91	–25.38	0.85
Tertiary	–200.63	0.60	–148.09	0.68	–58.44	0.77	–52.00	0.80
By Earnings								
Lowest	–12.10	0.90	–12.17	0.90	60.05	15.14	45.62	3.32
Second	–46.28	0.77	–46.45	0.78	28.29	1.65	–4.76	0.94
Third	–63.31	0.74	–62.06	0.75	–3.24	0.97	–21.89	0.84
Fourth	–82.04	0.71	–76.46	0.74	–25.98	0.83	–42.11	0.77
Highest	–183.41	0.62	–154.00	0.67	–63.75	0.74	–65.98	0.75

Source: Authors' calculation based on linked administrative data from Statistics Sweden.

[a] Units are in SEK 1,000 ≈ US$125.

Table 3 Three-way decompositions of differences in lifetime pensions between education and earnings groups

	Men				Women			
	1920 Cohort		1925 Cohort		1920 Cohort		1925 Cohort	
	Lifetime Pension (in SEK 1,000)	%	Lifetime Pension (in SEK 1,000)	%	Lifetime Pension (in SEK 1,000)	%	Lifetime Pension (in SEK 1,000)	%
Primary vs. Tertiary Education								
Mortality effect	636.2	21.6	852.1	27.1	436.1	18.8	433.5	17.7
Redistribution effect	–3,597.8	–122.2	–2,963.6	–94.2	–2,086.4	–89.7	–1,569.4	–64.2
Earnings effect	5,906.2	200.6	5,257.5	167.1	3,975.2	171.0	3,580.9	146.5
Total	2,944.7	100.0	3,146.0	100.0	2,325.0	100.0	2,444.9	100.0
Lowest vs. Highest Earnings Quintiles								
Mortality effect	915.0	24.5	1,032.0	25.2	109.6	4.3	175.8	6.2
Redistribution effect	–4,269.7	–114.5	–4,026.9	–98.2	–3,632.8	–141.7	–3,655.3	–128.1
Earnings effect	7,083.0	190.0	7,095.5	173.0	6,086.5	237.4	6,333.4	221.9
Total	3,728.3	100.0	4,100.6	100.0	2,563.3	100.0	2,853.8	100.0

Notes: Mortality effect, redistribution effect, and earnings effect refer to the parts of total lifetime pension differences that are attributable to differences in mortality, differences in the differences between pension income and labor earnings, and differences in labor earnings, respectively. Units are in SEK 1,000 ≈ US$125.

Source: Authors' calculation based on linked administrative data from Statistics Sweden.

Table 4 Ratios of yearly earnings, yearly pension, lifetime pension, and life expectancy at age 60 between education and earnings groups

	Men		Women	
	1920 Cohort Ratio	1925 Cohort Ratio	1920 Cohort Ratio	1925 Cohort Ratio
Primary vs. Tertiary Education				
Yearly earnings (average over ages 50–59)	2.28	2.08	2.66	2.13
Yearly pension (average over ages 66–75)	1.84	1.84	1.93	1.90
Lifetime pension income (at ages 60+)	2.09	2.05	2.07	2.00
Life expectancy at age 60	1.13	1.17	1.12	1.11
Lowest vs. Highest Earnings Quintiles				
Yearly earnings (average over ages 50–59)	4.10	3.69	58.33	13.63
Yearly pension (average over ages 66–75)	2.82	2.74	2.86	3.10
Lifetime pension income (at ages 60+)	3.32	3.14	2.73	2.76
Life expectancy at age 60	1.25	1.25	1.03	1.05

Source: Authors' calculation based on linked administrative data from Statistics Sweden.

In comparisons of less-divergent SES groups (e.g., primary vs. secondary education, lowest vs. third earnings quintiles), the absolute differences in lifetime pension are unsurprisingly smaller, yet the share explained by mortality differences is more or less constant across comparisons (see Tables A5 and A6 and Figures A12–A16). Our main findings are robust in these comparisons. Among them, the largest differences in lifetime pension are those between secondary and tertiary education groups and the third and highest earnings quintiles, suggesting that the differences between SES groups were particularly large between the most advantaged groups and others. To make our results comparable to previous studies focusing on actuarial aspects and financing of pension systems, we replicated our calculations using a discount rate of 2%, giving more weight to present incomes rather than future pension incomes (see Table A7 and Figures A17 and A18). In these calculations, money received at younger ages is valued more. Hence, we observe that mortality was less explanatory of differences in lifetime pension between SES groups, given that low-SES groups obtained a relatively higher share of their pensions earlier; the longevity advantage of high-SES groups at older ages becomes less important when a discount rate is used.

In Table 4, we show ratios of yearly earnings, yearly pension, lifetime pension income, and life expectancy between low- and high-SES groups. Yearly pension income is the most equal among the three monetary outcomes, and yearly earnings are the most unequal. The inequality level of lifetime pension income falls between the two. One exception is that for women in the lowest versus highest earnings quintiles, yearly pension is more unequal than lifetime pension income. This finding is likely due to the ages used to compare yearly pension income (ages 66–75): yearly pension income for the highest versus lowest female earnings quintiles is more equal at older ages owing to increases in the minimum pension over time (see Figure A2). We also find that differences in life expectancy between SES groups (and between men and women) are much smaller than differences in lifetime pensions.

Lastly, in addition to decompositions based on the 1920 and 1925 cohorts' experiences, we examined how counterfactual scenarios of policy changes and mortality reduction affect lifetime pension differences to understand which factors are important for lifetime pension and how they affect SES differences in life time pensions. Table 5 shows the results for the comparisons between primary and tertiary education for the 1920 cohort. Results for other comparison groups are highly consistent (Tables A8–A10). We examined how changes in retirement timing and pension system generosity will affect SES gradients. A uniform increase in retirement age would have led to a smaller gap in lifetime pensions in absolute terms because more highly educated individuals had higher yearly pension income and thus would have lost more pension benefits in absolute terms. Yet, uniform increases in retirement age would have enlarged lifetime pension inequality in relative terms because lower earners would have lost a higher proportion of lifetime pension. The magnitude of these changes is small, particularly for relative inequalities. If the change in retirement timing had differed by education such that the less educated were to retire earlier than they did or the more educated were to increase their retirement age, lifetime pension inequality would have been reduced in both absolute and relative terms. In the extreme case in which only individuals with tertiary education were to postpone their retirement age by three years, the absolute differences in lifetime pension would have decreased by 30.2% and 25% for men and women, respectively. However, the absolute differences in lifetime pension would have remained high, at more than SEK 2 million for men and SEK 1.7 million for women.

Increasing yearly pension by the same fixed amount for all individuals would have increased lifetime pension inequality in absolute terms because the more educated would have benefited more given their longer life expectancy; however, it would have reduced relative inequality. Increasing the minimum pension, which would have affected mainly those with the least pension, would have reduced both absolute and relative inequality.

Finally, we considered changing mortality rates. If mortality had decreased by 10% across all ages for all groups, absolute inequality in lifetime pension would have been larger, but relative inequality would have been smaller. If mortality rates had been reduced by 10% for the less educated but remained stable for the more educated, lifetime pension inequality would have decreased in both absolute and relative terms. Stagnation of mortality among the less educated and a 10% reduction in mortality among the more educated would have exacerbated lifetime pension inequality. The magnitude of effects of these scenarios is even more limited than in the retirement age scenarios. Overall, even though these scenarios reflect quite large changes in the pension system or behavior, the impact on overall SES differences in lifetime pension is quite small compared with empirically observed differences (see Table 1). This finding underscores the importance of prior earnings inequality in generating old-age inequalities.

Table 5 Lifetime pension inequality between primary and tertiary education under policy and mortality scenarios, 1920 cohort

	Men				Women			
	Absolute Difference		Relative Difference		Absolute Difference		Relative Difference	
	Diff. (in SEK 1,000[a])	% Change	Ratio	% Change	Diff. (in SEK 1,000[a])	% Change	Ratio	% Change
Observed	2,944.7	—	2.09	—	2,325.0	—	2.07	—
Uniform Increase in Retirement Age								
One-year increase	2,803.4	−4.8	2.10	0.6	2,231.4	−4.0	2.07	0.4
Three-year increase	2,525.5	−14.2	2.13	2.0	2,046.5	−12.0	2.09	1.2
Differential Retirement Ages								
Primary education one year earlier	2,815.4	−4.4	1.99	−4.6	2,253.0	−3.1	2.00	−3.2
Primary education three years earlier	2,580.7	−12.4	1.84	−11.9	2,129.8	−8.4	1.90	−8.2
Tertiary education one year later	2,643.0	−10.2	1.98	−5.3	2,129.2	−8.4	1.98	−4.3
Tertiary education three years later	2,055.8	−30.2	1.76	−15.7	1,743.5	−25.0	1.80	−12.9
Pension System More Generous								
Yearly pension SEK 10,000 more to all	2,970.7	0.9	2.02	−3.1	2,353.5	1.2	1.97	−4.6
Yearly pension SEK 20,000 more to all	2,996.7	1.8	1.97	−5.8	2,382.1	2.5	1.89	−8.3
Pension System Less Generous								
Yearly pension SEK 10,000 less to all	2,918.7	−0.9	2.16	3.5	2,296.4	−1.2	2.19	5.7
Yearly pension SEK 20,000 less to all	2,892.7	−1.8	2.25	7.7	2,267.9	−2.5	2.34	13.1
Raising Minimum Pension								
Minimum pension to SEK 80,000	2,934.3	−0.4	2.07	−0.6	2,223.5	−4.4	1.96	−5.4
Minimum pension to SEK 100,000	2,911.4	−1.1	2.05	−1.6	2,081.5	−10.5	1.82	−11.7
Mortality Reduction Scenarios								
10% less for all	3,073.6	4.4	2.08	−0.6	2,394.0	3.0	2.06	−0.5
Primary 10% less, tertiary 0% less	2,792.4	−5.2	1.98	−5.3	2,236.2	−3.8	1.99	−3.9
Primary 0% less, tertiary 10% less	3,225.9	9.5	2.19	5.0	2,482.8	6.8	2.14	3.5

Notes: For the 1920 cohort, the observed average lifetime pensions are SEK 2,705,700 for men with primary education, SEK 5,650,400 for men with tertiary education, SEK 2,178,000 for women with primary education, and SEK 4,503,000 for women with tertiary education. For the scenarios of changing the retirement age, we shift the observed yearly pension income to younger or older ages by one or three years. In the case of earlier retirement by one year, the last year (i.e., age 105) of pension income is assumed to be the same as the pension income in the last observed year (i.e., age 104). In the case of later retirement by one year, the first year (i.e., age 60) of pension income is set to 0. For the mortality reduction scenarios, we reduce mortality rates across all ages by 10%.

Source: Authors' calculation based on linked administrative data from Statistics Sweden.

[a] SEK 1,000 ≈ US$125.

Discussion

This study documents large differences in lifetime pensions across SES groups in Sweden. Three factors determine total lifetime pension inequality. First, higher annual earnings before retirement translate to a higher annual pension income. Second, higher life expectancy among high-SES groups results in more lifetime pensions. These two factors contribute to higher inequalities in lifetime pensions. Third, a higher replacement rate among low-SES groups decreases lifetime pension inequalities through a redistributive pension system. We show that a longevity advantage explains up to one quarter of the higher lifetime pensions among high-SES groups, particularly among men. Thus, over a lifetime, mortality differences between SES groups dampen pension system progressivity. However, the results also indicate that mortality is less important than the underlying earnings inequality in working years that carries over into retirement.

Our findings are generally in line with previous research on the topic, which has used different methodological approaches. Many studies have examined the extent of redistribution and how it is affected by mortality differences. Studies have found that mortality cancels out more than 25% of the redistribution in the French pension system, almost fully offsets the redistribution in the U.S. old-age Social Security system, and makes the German and Italian systems regressive (Bommier et al. 2005; Haan et al. 2020; Mazzaferro et al. 2012; Sánchez-Romero et al. 2020). Taken together, these studies highlight that the role of mortality in a pension system varies across countries. Pension designs, individual work histories, and SES mortality patterns may explain cross-country differences. Comparative studies might elucidate the relative importance of these factors in future work. Such analyses of redistribution involve lifetime contributions. Because of data limitations, we focus only on inequalities in lifetime benefits and do not directly examine redistribution.

Socioeconomic inequalities in health and mortality inequalities in Sweden have been among the lowest in Europe since the 1980s (Mackenbach et al. 2018). In 2011, the gap in life expectancy at age 65 between Swedish men with low versus high education was 2.8 years, lower than the average of 3.6 years among 18 OECD countries; for women, the gap was 2.9 years, higher than the OECD average of 2.6 years (Murtin et al. 2022). Research suggests an increasing SES gap in longevity globally (Brønnum-Hansen and Baadsgaard 2012; Kravdal 2017; Meara et al. 2008; Östergren 2015; Permanyer et al. 2018). An open topic is whether the COVID-19 pandemic will affect the socioeconomic mortality gradient (Clouston et al. 2021; Drefahl et al. 2020) and how the pandemic will affect lifetime pension inequality. Mortality inequality might contribute more to lifetime pension inequality in the future. In this study, we found only small cohort differences, but the direction of change suggested a trend toward larger differences.

The pension system design may help interpret our results. Mortality's contribution to SES differences in lifetime pensions is arguably larger without occupational pensions, which provide more generous replacement rates above the state income pension. In the extreme case in which pension income is unrelated to preretirement earnings, SES differences in lifetime pensions would be solely determined by mortality. Because of generous replacement rates in occupational pensions for higher earners, the overall net replacement rate in the mandatory pension schemes (i.e., public and occupational pensions) appears to be U-shaped across earnings, which is unique among OECD countries (OECD 2021). Given that Sweden has one of the least progressive first- and second-pillar pension systems among OECD countries (OECD 2011), preretirement earnings will be less important and mortality will be more important in other countries. Across cohorts, the share of public pensions has decreased, whereas the share of occupational and private pensions has increased in Sweden (Hagen 2017); thus, preretirement earnings will be more important in generating SES inequalities in lifetime pensions in the future.[8]

Lifetime pensions are more unequally distributed across male SES groups than female SES groups. There are three potential explanations for this finding. First, the SES mortality gradient is usually stronger for men than for women, as found in this study and consistent with prior research (Mackenbach et al. 2018). Among women, the association between low income and high mortality is even reversed in the lowest two quintiles—perhaps because for our cohorts, women in the lowest quintile are often outside the labor market and rely on their husbands with higher incomes, whereas women in the second and third quintiles are more often in the labor market (see Table A2) and live alone (see Table A11) or in households with low income.[9] Second, the redistributive effect is stronger for women. Women in the lowest earnings quintile are protected by the minimum pension and, to some extent, by widowhood pensions (given the much higher ratio between pension income and earnings for women in the lowest quintile vs. higher quintiles). Third, women display smaller inequalities in preretirement earnings than men. Because the majority of lifetime pension inequality is explained by preretirement earnings, gender differences in the magnitude of lifetime pension inequality by SES could also be explained by the more homogeneous earnings distribution across women's SES groups.

The difference between yearly pension income and preretirement labor earnings is similar from the second to the fourth earnings quintiles, suggesting that the redistributive role of the Swedish pension system is limited for most of the population in the earnings distribution's middle range. In contrast, the pension system plays a relatively more significant role in redistributing money from the very rich to the very poor, as illustrated by the comparisons between the highest earnings group (who had a large share of earnings that did not translate to lifetime pensions) and the lowest earnings group (who received a guarantee pension, even in the absence of contributions), particularly for women.

Recent policy discussions on pension reforms often do not consider SES differences in longevity. Because of increasing overall longevity, many low-mortality

[8] Additionally, the reliance on first- and second-pillar pensions differs considerably across subgroups of the labor market, which may help clarify the role of mortality. For instance, the second and fourth quintiles together arguably relied more on the first pillar than the third and highest quintiles combined. Accordingly, we find that for both genders, mortality explained a notably larger share of the gap in lifetime pensions between the second and fourth quintiles than between the third and highest quintiles (see Figures A15 and A16).

[9] Prior research has also shown that the type of income measure (individual vs. household) has large impacts on the results regarding mortality inequalities between income groups. Women's longevity monotonically increases with household income, which is not always found for women's individual income (Shi et al. 2021). Table A11 shows that the share of married women was the largest in the lowest female quintile and that the pattern for men was reversed.

countries (e.g., Denmark, Greece, Italy, the Netherlands, Portugal) link the statutory retirement age to life expectancy, and Sweden has plans to do so (OECD 2021). Implications of such policies on redistribution will be particularly relevant for Bismarckian pension systems, which explicitly aim to redistribute earnings into pensions in an actuarially fair way. Hence, using SES-specific life tables would increase pension fairness in defined-contribution and notional defined-contribution pension systems. Individuals with higher SES and earnings live longer. Differences in longevity by SES would then be reflected in assumptions on life span. Thus, individuals with higher SES and earnings should have lower payout rates, which entails practical challenges, such as how to measure SES and which ages to consider for measuring SES. Further concerns of raising pensionable ages are about who can survive to retirement and inequalities in life span after retirement (Alvarez et al. 2021; Shi et al. 2022).

Our definition of "lifetime" is from age 60 onward, so premature mortality before age 60 is not included. SES differences in lifetime pensions measured at age 50 would have been larger than our estimates because the SES–mortality gradient tends to be higher at ages 40–60 (Rehnberg et al. 2019). Future research may wish to examine lifetime pensions beginning at a younger age to capture such effects.

Our study offers several notable contributions. First, we used an exceptionally long series of high-quality data on observed earnings, mortality, and all pension sources. Prior mathematical models illustrated the importance of differential mortality to lifetime pension progressivity (Auerbach et al. 2017; Sánchez-Romero et al. 2020), and previous empirical studies have modeled mortality rates for cohorts whose complete mortality schedules were still unknown (Haan et al. 2020; Olivera 2019). Unlike previous studies, ours used observed income, mortality, and pension data for cohorts whose life course has been almost entirely observed. Thus, our approach is more data-driven and has the advantage of introducing many fewer assumptions. Second, our decomposition approach is novel in revealing how much money lower SES individuals lose because of their mortality disadvantages at each age. Third, we disentangle three effects: mortality, earnings, and the pension system's redistributive effects. Finally, our hypothetical analysis is a useful way to show the impacts of potential policy changes.

A limitation of our hypothetical scenarios is that they assume that these scenarios would not affect individual behaviors, such as retirement timing (for scenarios of pension generosity and mortality), and do not reflect that later retirement would imply higher contributions. However, the counterfactuals are primarily useful to contrast the effects of different dimensions of a pension system, such as retirement age, mortality, and pension levels.

Another limitation is that our earnings grouping is based on earnings accrued over ages 50–59, ignoring earlier earnings trajectories. Our comparison of average yearly earnings over these 10 years and average yearly pension payments (at ages 66–75) are only illustrative, not strict actuarial calculations of the rate of return on actual pension payments. Our entirely empirical approach is both an advantage and a disadvantage compared with previous research. Thus, our study differs conceptually from previous research: our pension variable is the sum of pensions of all pillars. Because the distribution of pension types differs substantially across SES, our study provides a broad picture of how a national pension system works in practice and the consequences for social stratification (not calculations of the extent of redistribution of specific pension programs). In addition to representing a contribution to the literature, this feature makes comparisons of our results with those of many previous studies somewhat difficult. Future research may wish to disentangle how different pension programs (e.g., guarantee pensions, widowhood pensions, collective agreement pensions, private pensions) explain overall lifetime pension differences between SES groups—a set of distinctions our data did not permit.

A further implication of our approach is that the cohorts for whom we could observe nearly their entire lives were born in the early twentieth century, and we therefore studied the pension system in the 1990s and 2000s. It would be interesting to examine whether pension reforms in Sweden in 1999 have changed the broad patterns we observed. The reform in 1999 introduced a notional defined-contribution system to the public pension with balances for intergenerational redistribution and flexible retirement ages that are actuarially fair. It later became a model for many other OECD countries (Palme 2005). The first cohorts that experienced this new system were born in the mid-1950s. ■

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