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Educational Disparities in Disability-Free Life Expectancy across Europe: A Focus on the East-West Gaps from a Gender Perspective

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Abstract

Education plays a crucial role in shaping the health outcomes of adults. This study examines the relationship between educational attainment and health across Europe. Using data from the Survey of Health, Ageing and Retirement in Europe, we estimate educational inequalities in disability-free life expectancy (DFLE) by gender in seven Western European (2004-2019) and three Central and Eastern European (CEE) (2010-2019) countries. We exploit a novel approach that combines the Sullivan method and multivariate life tables to calculate DFLE using SHARE data. We find that educational differences in DFLE favoring the better-educated exist in both CEE and Western European countries, but also that the differences across countries are more pronounced among the low-educated. While the absolute gaps in DFLE between low- and high-educated individuals in CEE and Western European countries are similar, the educational disparities in DFLE impose a more significant burden on the CEE populations due to their overall lower life expectancy. Educational inequalities are larger among women than among men in CEE countries, while the results for Western European countries are mixed. Our findings further highlight the important role of the institutional context in mitigating or exacerbating educational inequalities in health.

Keywords: Disability-Free Life Expectancy, European East-West health divide, educational inequalities.

1. Introduction

Health outcomes have been shown to vary widely across states in the United States and across countries in Europe, with this heterogeneity likely reflecting differences not only in demographic and epidemiological profiles, but also in contextual settings (Jagger et al., 2020; Mackenbach, 2017; Montez et al., 2019). However, studies on health outcomes in Europe typically focus on Western European countries, while neglecting the substantial variation in health across all European regions. One of the most striking health disparities in Europe is the East-West divide, with Central and Eastern European countries having markedly lower life expectancy than the rest of the subcontinent, with a gap of almost 10 years (Eurostat, 2022). However, life expectancy alone is an insufficient measure of population health. Health expectancy estimates, which consider both mortality and morbidity information, indicate that CEE populations not only have shorter lifespans, but also spend fewer years in good health (Eikemo et al., 2008).

While CEE countries have worse health outcomes than other European countries, there are also substantial health disparities within these populations, particularly by gender and education (OECD, 2019). Women have lower mortality rates across all ages, but report poorer health and higher use of health services (Oksuzyan et al., 2008; Van Oyen et al., 2013). At the same time, low education is associated with higher morbidity and mortality (Ross et al., 2012). The intersection of gender and education is also important, as educational returns to health are gendered (Ross et al., 2012).

Both gender- and education-based inequalities in life expectancy seem to be more pronounced in CEE countries than in other European regions (Mackenbach, 2017; Pinho-Gomes et al., 2022). Distinctive causal mechanisms that relate gender and education to health outcomes could be of particular importance in explaining European East-West health disparities (Geyer et al., 2006). However, studies on inequalities in health expectancies by both gender and educational attainment levels in CEE are still scarce.

Therefore, this study aims to determine the extent of gender-specific educational disparities in the duration of healthy life across European countries. More specifically, we estimate disability-free life expectancy (DFLE) at age 50 by gender and education for 10 European countries. The study also attempts to identify any emerging patterns by comparing a number of CEE countries with their Western European counterparts.

Several aspects of this paper contribute to the existing literature. First, we combine two well-established estimation methods, the multivariate life table (Brown et al., 2012; Teachman & Hayward, 1993) and the Sullivan method (Sullivan, 1971), to provide an innovative approach that exploits the information available in SHARE to estimate gender- and education-specific life tables and healthy life years for each country. To the best of our knowledge, this is the first paper using SHARE to estimate life tables by gender and education. In addition, estimating differential mortality and health from a single data source enables us to study countries that are traditionally overlooked in the literature: namely, the CEE countries. Thus, we also contribute to the discussion on how educational inequalities in health influence the European East-West divide.

Background

The differential impact of gender on mortality has been widely recognized, with women exhibiting lower mortality rates than men across all age groups (Oksuzyan et al., 2008). However, despite having a longer life expectancy than men, women also live a smaller share of their life without health problems than their male counterparts (Author 2020; 2022). This phenomenon may be due, at least in part, to the tendency of women to report poorer health, a greater burden of morbidity and disability, and more frequent use of health services (Nusselder et al., 2010). The observation that women have both a mortality advantage and a health disadvantage, which is also referred to as the female-male health-survival paradox, is often explained by citing intricate connections between gender-related social, behavioral, and biological factors (Oksuzyan et al., 2008). Although gender is of such fundamental importance to health that it has become a norm to study health outcomes separately for men and women, health disparities are not limited to differences by gender.

Socioeconomic factors are also considered key determinants of health differences within populations. There is ample evidence that having a certain position in society mitigates or aggravates an individual's chances of enjoying good health, and that this pattern is hierarchical in nature (Siegrist & Marmot, 2004). Researchers have identified several important socioeconomic determinants of health, including income, occupation, and education. However, there are several reasons for focusing on education as an indicator of an individual's socioeconomic status. First, education is a reliable and easily accessible indicator that tends to remain relatively stable after individuals complete their formal education. Moreover, education is fundamental in establishing both income and occupation. Furthermore, research has shown that the impact of education on health outcomes persists even after adjusting for factors such as wealth and occupation (Cutler & Lleras-Muney, 2010; Winkleby et al., 1992). While these are important empirical reasons for taking education into account when studying health disparities, there is also theoretical support for the assumption that education plays a significant role in health.

Higher levels of education directly contribute to better health, beyond a simple correlation. Ross and Mirowsky (2010) argued that the effects of education are embedded in the nexus between two main pathways: commodity and human capital. Commodity theories posit that having a higher level of education provides individuals with advantages, such as access to better employment, higher income, and health insurance. Human capital theories posit that beyond the financial gains, education promotes health by equipping individuals with the knowledge and resources they need to adopt health-promoting behaviors. However, it is essential to recognize that as well as fostering favorable conditions for good health, education also plays a pivotal role as a social determinant of inequalities (ibid.).

While the pathways through which gender and education act upon health are distinct, it is also crucial to consider the intersection between the two. Examining the intersection between education and gender inequalities in European countries requires a multi-dimensional understanding of the various social, economic, and cultural factors that shape health opportunities and outcomes for individuals of different genders and educational levels. Social reproduction theory suggests that educational systems reinforce gender inequalities by perpetuating societal attitudes and gender norms (Bourdieu & Passeron, 1990). Moreover, even as gender intersects with education in shaping health, there are country-specific differences in health inequalities by both gender and education (Mackenbach, 2017; Romero-Ortuno et al., 2014).

Gender differences in health indicators vary across countries (Crimmins et al., 2011). In addition, while the differences in life expectancy between men and women are large in many Western and Southern countries, they are relatively small compared to those in Eastern European countries (Author 2020). The gender gap in life expectancy ranges from approximately three years in the Netherlands and Sweden to about nine years in the Baltic states (Pinho-Gomes et al., 2022). Other studies have also reported a substantial European North-South gradient (Romero-Ortuno et al., 2014). Due to their significant mortality disadvantage, men in Central and Eastern European countries are, on average, expected not only to have shorter lifespans, but also to experience fewer healthy years of life than women (Van Oyen et al., 2013).

Research has indicated that educational returns to health differ across Europe (Mackenbach et al., 2018; Valverde et al., 2021), with the disparities being largest in Central and Eastern European countries and smallest in Southern European countries (Mackenbach, 2017). For instance, the life expectancy difference between men with high and low education is more than 10 years in CEE countries, while it is only about four years in Sweden, Italy, and the Netherlands (OECD, 2019). Although the existing literature has primarily focused on the mortality domain, recent studies have observed a more pronounced educational gradient in transitioning to both poor health and recovery among CEE populations (Solé-Auró & Gumà, 2022). In addition, CEE countries have been consistently shown to have the lowest health expectancies in Europe (Jagger et al., 2008; Jagger et al., 2011), which has led to the concept of the European East-West health divide (Carlson, 2004).

Both the health of the general population and disparities by gender and education are associated with country-specific macro-level indicators (Eikemo et al., 2008; Van Oyen et al., 2010). Therefore, the persistent health divide between East and West might reflect the role of social structures, as conceptualized by the institutional theory of health inequalities (Beckfield et al., 2015). The theoretical framework outlining the effects of welfare states on social health inequalities has suggested that sociohistorical and policy contexts may configure a scenario in which health gains follow educational attainment (ibid.). CEE is a particularly interesting region to focus on when studying this association due to its history of state socialism, early educational expansion, historically high levels of female employment, and atypical relationship between education and income (Haggard & Kaufman, 2009). However, these positive factors may be undermined by the lack of progress in the region across many health indicators, such as mortality from preventable causes (Mackenbach et al., 2015).

Despite the evidence of substantial gender and educational health disparities within CEE countries, the current research on this topic is fragmented, and shares several limitations. First, the existing studies have primarily been population-level analyses focused on the period immediately following the fall of communism (Carlson, 1998; Shkolnikov et al., 2006), and thus failed to account for more recent developments. Furthermore, the previous research has mainly focused on mortality outcomes, which provide only limited insight into the overall health status of the population (Minagawa, 2013). Recently, there has been increasing interest in applying measures that extend beyond mortality to provide a more comprehensive understanding of population health status (Robine et al., 2003). One such measure is disability-free life expectancy (DFLE), which is defined as the average duration of a person's life without health limitations within a given population (Robine et al., 1999). DFLE is derived from disability indicators such as the Global Activity Limitation Indicator (GALI), and when calculated on this basis, it is known as healthy life years. Although disparities in DFLE by gender and education have been widely reported (Mäki et al., 2013; Solé-Auró et al., 2015), limited research has been conducted on differential health expectancy for CEE countries. Thus, whether gender and educational gaps in disability-free life expectancy display a consistent pattern across European countries, as has been observed for overall life expectancy, remains an open question.

The unavailability of the data needed to use traditional methods for estimating health expectancies is a challenge (Avendano et al., 2009; Jagger et al., 2020). Health expectancy measures rely on access to vital statistics, registries, censuses, and health prevalence data. Data on deaths by age and sex are provided by national statistical offices, which are then harmonized and distributed by institutions such as the European Union's statistical office and databases like the Human Mortality Database (HMD). However, multivariate life tables by education are scarce, except for a few countries like the Nordic European countries and Spain (Klotz et al., 2017). This is because mortality records linked to population databases are not broken down by educational level, and have different time periods and stratification variables.

This study seeks to address the deficits in the literature by estimating gender- and education-specific disability-free life expectancy (DFLE) for a number of European countries. The added value of this study is twofold. First, we combine two established estimation methods –the multivariate life table (Brown et al., 2012; Teachman & Hayward, 1993) and the Sullivan method (Sullivan, 1971)– to obtain DFLE estimates. This approach allows us to use the Survey of Health, Ageing and Retirement in Europe (SHARE) as a single data source. To support this approach, we also generate gender-specific life tables to use for comparisons with the HMD and European Health and Life Expectancy Information System (www.eurohex.eu), and to identify any discrepancies. Second, our study contributes to the literature on health disparities across Europe, specifically between CEE and Western European countries, in two ways. First, we analyze health disparities in CEE countries, which have been under-represented in prior research. Second, we shift our focus from mortality to health expectancy, estimating remaining disability-free life expectancy at age 50.

2. Data and Methods

2.1. Data

This study used data from the Survey of Health, Ageing and Retirement in Europe (SHARE), a biannual survey conducted since 2004 that provides cross-national longitudinal information on demographic, socioeconomic, and health measures, as well as vital status data. The survey covers private households with members aged 50 or older, and includes end-of-life interviews to gather accurate information on deaths. Depending on when each country initially participated in the survey, we combined data from either the first (2004) or the fourth wave (2010) to the eighth (2019) wave of SHARE. We excluded the third wave, which is called SHARELIFE, because it focuses on people's life histories, rather than relying on a regular questionnaire.

We studied 10 countries, including three from Central and Eastern Europe (CEE). The term CEE refers to the Baltic countries, Central and Eastern European countries of the former Soviet Union, and Southeast European countries that are known for having a shared sociohistorical context and welfare regime (Eikemo & Bambra, 2008). The remaining analyzed countries were classified as Western European countries.

We aimed to maximize the number of countries included in our study. However, some countries, particularly in the CEE region, participated in fewer waves. To ensure consistency, we included only those CEE countries that have participated in the survey since at least wave 4, and that have not missed more than one consecutive round of participation. We also selected other European countries based on the same criteria for comparative purposes. We dropped individuals with missing data on the variables of interest or with a baseline age below 50. Additional restrictions were applied to individual parts of the statistical analysis.

2.2. Indicators

In this study, we used SHARE’s single-question measure of functional limitation or disability (GALI) as our health indicator. Specifically, this indicator refers to the observed prevalence of any long-standing activity limitations, which could denote general health problems or limitations in engaging in activities people usually perform (Robine et al., 2003; Van Oyen et al., 2006).
This study uses data from the Harmonized SHARE dataset developed by the Gateway to Global Aging Data. In the harmonized dataset, the responses were re-coded by identifying individuals as healthy if they reported no limitations in usual activities, and as limited if they reported any level of limitation.

GALI is a reliable and valid tool for measuring function and disability, and can be used for cross-country comparisons. However, caution is advised when comparing GALI levels over time and across EU countries due to translation revisions in 2008 and cultural differences. These concerns were addressed in a sensitivity analysis.

The level of educational attainment was determined using a harmonized measure based on the International Standard Classification of Education (Statistics UIS, 2012). This measure categorized individuals into three groups: 1. lower secondary education or less (ISCED 0-2); 2. upper secondary or vocational training (ISCED 3-4); and 3. tertiary education (ISCED 5-6). Sample characteristics are presented in Table 1.

2.3. Analysis

In this study, we used a multivariate life table approach (Teachman & Hayward, 1993) to create gender- and education-specific life tables. Following an approach similar to that used in Brown et al. (2012), we employed a set of discrete-time regression models for each country, stratified by gender, to estimate the probability of death by age, gender, and education. To estimate this probability, survival information was needed for at least two consecutive time points for each individual. The approach assumed that individuals are alive at age *t* and may die at age *t+1*. This implied that age was the time scale we used in the models. The population discrete-time hazard was defined as the probability of death occurring in the current or future time period, represented by $h(t_{ij}) = \Pr(T_i = j \mid T_i \geq j)$, where T_i is a random variable indicating the time period *j* when individual *i* dies.

The models were as follows:

$$\ln\left[-\ln\left(1 - h(t_j|x_i)\right)\right] = \alpha_j + x'_i\beta \qquad (1)$$

where t_j is the time interval, α_j is the complementary log-log transformation of the baseline hazard and $\boldsymbol{x'_i}$ are a set of covariates: namely, age, age-squared, and educational level, specific to the individual *i*. Age was added with a second-degree polynomial; the quadratic term accounted for nonlinearities in the age pattern of deaths. The models were run separately for men and women, and for each country.

To predict death probabilities by country, gender, education, and age, we used two-year intervals to reflect the biannual panel data structure. We obtained gender- and education-specific life tables from estimated survival probabilities by simulating the death of a synthetic cohort of 500,000 individuals. In the simulation, each person in the age interval x survives to $x+n$ if the predicted probability of death is lower than a random draw from a uniform distribution. We repeated this procedure iteratively from ages x to $x+n$ for age intervals [50-52), [52-54), ..., 110, and obtained life table quantities, such as the number of survivors at the corresponding ages. The period life table was constructed following standard steps (Preston et al., 2001). Life tables were closed at age 90+ due to limited observations at the oldest ages.

Finally, remaining DFLE at age 50 was estimated using the Sullivan method (Sullivan, 1971), following that:

$$e_{50}^{DF} = \frac{1}{l_{50}} \sum_{x=50}^{x=90+} (1 - {}_n\pi_x) \cdot {}_n L_x , \quad (2)$$

where n is the length of the age interval, ${}_n\pi_x$ is a proportion of individuals with health limitations between ages x and $x + n$, l_{50} is a number of survivors at age 50 and ${}_nL_x$ is a number of person-years lived between ages x and $x + n$. The idea underlying our use of the method was to apply age-specific proportions of a population in an unhealthy state to the age-specific person-years lived from the life table. In this way, we assumed that years lived are partitioned into those spent in good health and those spent with disability. Summing up only the disability-free person-years lived across all ages yielded the DFLE. The difference between residual LE and DFLE represents the remaining years of life individuals can expect to live with a disability. The age-specific proportion of people with health limitations within sub-groups was determined using a sample of individuals who were still alive. Confidence intervals for LE and DFLE were obtained using a nonparametric bootstrap approach (Cameron & Trivedi, 2005) by resampling the data 1,000 times. All the analyses were conducted using R language (version 4.1.1).

We utilized a distinctive approach that capitalized on the availability of mortality data within the SHARE dataset. However, the quality of the individual country samples is often questioned when mortality is analyzed using survey data. In some countries, life tables calculated from survey data may differ considerably from those generated using high-quality data sources. To support our findings, we compared life expectancy estimates at the population level with HMD and EurOhex data, with the aim of identifying any substantial differences. More details on how we approached the construction of comparative life tables using HMD data can be found in the supplementary material.

3. Results

Table 1 shows characteristics of the working sample, categorized by educational level and country for men and women. The sample included 184,240 person-wave observations of individuals aged 50+ across 10 countries. It should be noted that the data for Central and Eastern Europe countries cover the years 2010 to 2019, whereas the data for Western European countries cover the years 2004 to 2019.

Table 1. Sample characteristics and educational composition for men and women aged 50+

				Proportion across educational levels					
				Women			Men		
	Years	Sample size	Proportion of men	Low	Medium	High	Low	Medium	High
Central and Eastern Europe									
Estonia	2010-2019	21 514	0.40	0.27	0.49	0.23	0.30	0.47	0.22
Czechia	2010-2019	18 141	0.41	0.44	0.46	0.11	0.39	0.44	0.17
Slovenia	2010-2019	12 111	0.43	0.42	0.43	0.15	0.25	0.58	0.17
Western Europe									
Austria	2004-2019	16 371	0.42	0.34	0.45	0.21	0.15	0.55	0.31
Belgium	2004-2019	24 572	0.45	0.44	0.27	0.29	0.39	0.26	0.35
Denmark	2004-2019	15 016	0.47	0.24	0.33	0.43	0.14	0.48	0.39
France	2004-2019	18 906	0.43	0.49	0.31	0.20	0.38	0.39	0.23
Italy	2004-2019	19 174	0.46	0.74	0.20	0.06	0.70	0.22	0.08
Spain	2004-2019	21 771	0.45	0.84	0.08	0.08	0.78	0.11	0.11
Sweden	2004-2019	16 664	0.46	0.39	0.30	0.31	0.43	0.30	0.27

Source: Own calculations, using pooled data from SHARE.

Although CEE countries joined SHARE later, the number of observations from CEE countries was not substantially lower than that from Western European countries, except for Slovenia, which had the smallest number of observations.

The distribution of individuals across educational levels varied by country and gender. Most CEE countries had a large share of individuals with upper secondary or vocational training, while Western European countries were more heterogeneous, with some having a large share of individuals with low education (e.g., Spain and Italy), and others having an evenly distributed educational composition across all three levels (e.g., Denmark and Sweden). Finally, as expected, most countries had a larger proportion of women than of men in the lowest education category.

Table 2 displays data on the proportions of individuals experiencing long-term limitations in usual activities due to health problems (indicated by the GALI indicator), categorized by education and country for men and women. Women, and especially those with low education, were more likely than men to report limitations. Significant gender gaps were observed among individuals with medium education in Denmark and Sweden, with a 9 to 10% difference in the prevalence of health limitations. Our results showed a consistent educational pattern across all analyzed countries, with a lower proportion of individuals in the high education group reporting limitations. With the exception of Slovenia, CEE countries had the highest prevalence of health limitations. For example, up to 76% of low-educated women in Estonia reported limitations, while the. Southern European countries, and particularly Spain and Italy, had the lowest prevalence of health limitations.

Table 2. Proportions of women and men aged 50+ experiencing long-term limitations in usual activities due to a health problem by educational level

	Women			Men		
	Low	Medium	High	Low	Medium	High
Estonia	0.76	0.61	0.50	0.69	0.59	0.50
Czechia	0.66	0.50	0.46	0.62	0.55	0.48
Slovenia	0.63	0.46	0.37	0.63	0.47	0.37
Austria	0.62	0.48	0.43	0.63	0.47	0.43
Belgium	0.56	0.48	0.44	0.49	0.43	0.38
Denmark	0.55	0.46	0.33	0.48	0.36	0.32
France	0.55	0.40	0.36	0.52	0.40	0.31
Italy	0.51	0.32	0.25	0.44	0.30	0.26
Spain	0.50	0.24	0.25	0.41	0.27	0.24
Sweden	0.53	0.46	0.40	0.47	0.37	0.34

Note: The data used for the calculations were pooled from country-specific waves of SHARE from either 2004-2019 or 2010-2019, based on country-specific data availability.

3.1. Life and Health Expectancies at the Population Level

Fig. 1 shows estimates of remaining life expectancy at age 50 for men and women for all the analyzed countries compared with the HMD and EurOhex data. While population-level estimates were not the main focus of this study, we included them because they not only provided an overview of the health status of the population, they also allowed for comparisons with data from other reliable sources. In most cases, the HMD and EurOhex estimates fell within the 95% confidence intervals of our estimates or were within the two-year difference, except for Danish and Slovenian women.

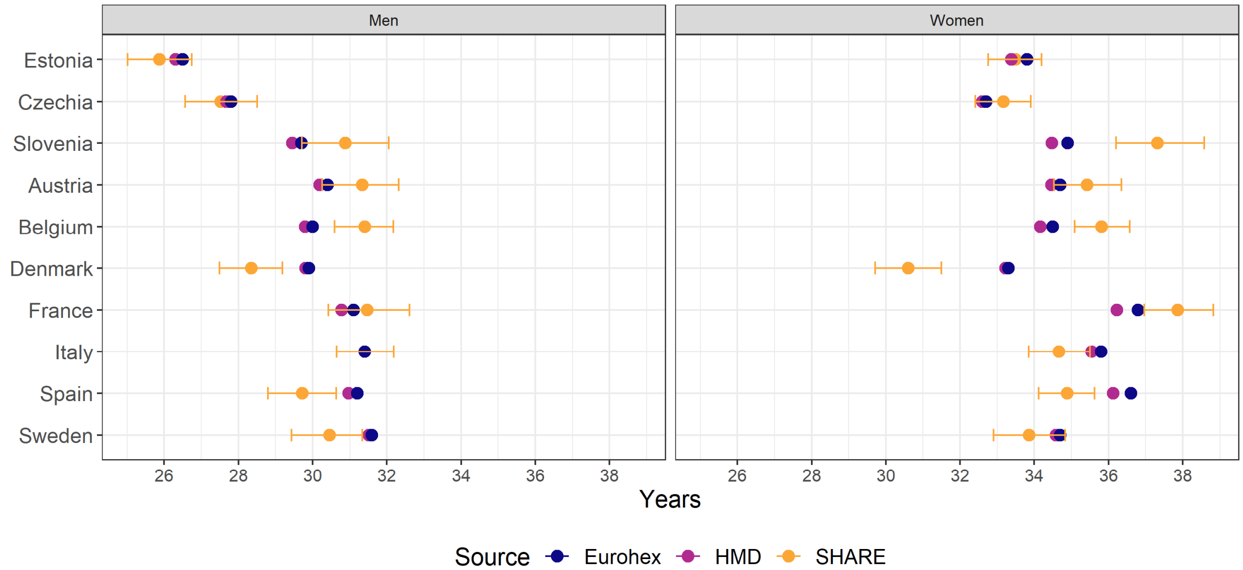

Fig. 1. Remaining life expectancy at age 50 and their 95% confidence intervals obtained from SHARE, compared to estimates obtained from HMD and EurOhex

Note: HMD estimates are based on the calendar year that represented the midpoint population given the period of the country's participation in the survey. For Austria, Belgium, Denmark, France, Italy, Spain, and Sweden, we used life tables from 2012. For Czechia, Estonia, and Slovenia, we used life tables from 2015. In addition, we used EurOhex estimates from 2012, as it is the latest year available in the database for all countries.

In addition, estimates at the population level revealed some important patterns. First, we did not observe greater between-country disparities in disability-free life expectancy (DFLE) than in overall life expectancy at age 50. Second, we found that individuals in CEE countries, and particularly men, spent a much smaller share of their life disability-free than their Western European counterparts. Complete information on estimates at the population level can be found in the supplementary material **Table A.1**.

3.2. Life and Health Expectancies by Gender and Education

Our findings indicated that women in all educational groups could expect to live longer than their male counterparts across all of the countries studied. The differences were striking: in most of the studied countries, the highest-educated men could expect to live fewer than or the same number of years as the least-educated women. The full set of estimates by gender and education is provided in supplementary materials **Table A.2**.

When considering life expectancy free of disability, we found that women retained their advantage compared to men in the majority of countries, except for Belgium and Sweden. Central and Eastern

European (CEE) countries generally had a wider gender gap in life expectancy without disability, especially among individuals with medium education. Women in CEE countries with medium education could expect to live 2-3 years longer without disability than their male counterparts.

Fig. 2 displays DFLE estimates by gender and education for the studied countries. Higher educational levels were associated with a longer disability-free life, but the differences between the highest and the lowest educational levels varied greatly by gender and across countries. Among women, Belgium had the smallest educational gap in DFLE (3.7 years), while Slovenia and Italy had the largest differences (10 years). Among men, Belgium had the smallest educational gap in DFLE (3.6 years), while Slovenia and Austria had the largest differences (9.2 and 8.4 years, respectively). For Southern European and CEE countries (except for Spanish and Czech women), the health benefits of higher education were particularly noteworthy, as there was a marked increase in the differences in DFLE between individuals with medium and with high educational levels compared to the differences in DFLE between individuals with low and medium educational levels.

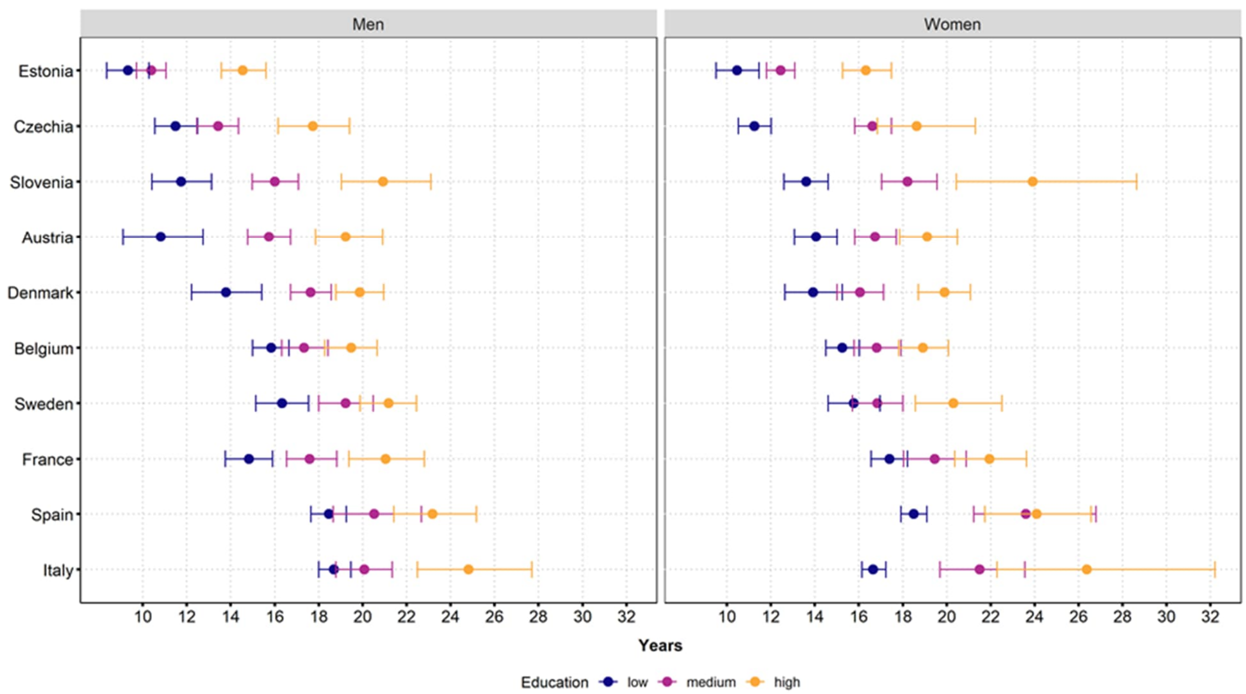

Fig. 2. Remaining disability-free life expectancy at age 50 by gender and education.

Although the gaps in DFLE between individuals with low and high educational levels were significant, the absolute disparities within CEE countries were not greater than those found in Western European countries. To illustrate, the difference in DFLE between men with low and high educational levels was approximately six years in Denmark, Italy, and France, which was comparable to the gap in Czechia. Furthermore, among men in Estonia, this gap was narrower by one year. However, it is important to interpret these results in relative terms; specifically, in terms of the proportion of the overall life expectancy that an individual could expect to live disability-free.

Higher education was associated with a greater proportion of disability-free life, but the size of this advantage varied by gender and by country. The estimates indicated that individuals in Italy and Spain had the highest shares of disability-free life at age 50 across all educational groups. Notably, the estimates showed that high-educated men in Italy and Spain could expect to live 72-73% of their remaining years of life at age 50 disability-free. In contrast, the shares of disability-free life at age 50 were smallest for individuals in CEE countries (with the exception of medium- and high-educated women in Slovenia) and Austria. Across all educational groups and irrespective of gender, individuals living in CEE countries and Austria could expect to live less than 50% of their remaining years of life at age 50 free of disability. Generally, women could expect to spend a smaller share of their life without health limitations. For example, while low-educated Italian women could expect to live 60% (18.7 years) of their remaining years of life at age 50 disability-free, high-educated Estonian women could expect to live less than half (46%; 14.5 years) of their remaining years of life at age 50 free of disability.

The estimates indicated that Danish, Italian, and French men had a remaining DFLE at age 50 of 17.4-19.4 years. By contrast, Czech and Estonian men could expect to live 12.8 and 11.0 years, respectively, of their remaining life at age 50 disability-free. These findings imply that the six-year difference in DFLE between low and high educational groups mentioned earlier was proportionally smaller in Western European countries, and that the educational disparities in DFLE imposed a more significant burden on the populations in the CEE countries.

4. Discussion

Health disparities based on gender and education in Europe have been widely studied, but limited data has made it challenging to estimate these disparities in some countries. To address this issue, researchers have been compelled to adapt existing methodological approaches, and to develop new and original approaches. Our study emphasized the potential of using SHARE as a single source of data for differential life and health expectancy estimation, in particular for countries for which no information is available from other sources. We combined two established estimation techniques – discrete-time modeling and simulation – to estimate multivariate life tables, and the Sullivan method to estimate disability-free life expectancy.

The results of this paper first point to important gender differences, in line with prior research (Pinho-Gomes et al., 2022). Across all educational groups, women were shown to live longer than men, with the highest-educated men living fewer or the same number of years as the least-educated women in their respective countries. However, the differences narrowed in the DFLE estimates, which is consistent with the female-male health-survival paradox (Oksuzyan et al., 2008). Women's health disadvantage may be due to limited access to resources such as income, education, and health care (Tawiah et al., 2021). On the other hand, women exhibit higher levels of compliance with treatments (Christensen et al., 2009), and greater resilience when living with chronic diseases (Kiely et al., 2019).

Our findings, consistent with previous research, uncovered an educational gradient in health outcomes. The advantage associated with high education was first reflected in the prevalence of health limitations, as the findings indicated that individuals with higher educational levels tended to report fewer limitations than those with lower educational levels. Health disparities by education were also observed in the estimates of DFLE, but the extent of these disparities was not exclusively driven by the disadvantage associated with low education.

In certain countries, particularly in Southern European and Central and Eastern European countries, the differences in DFLE between individuals with medium and high educational levels were found to be much greater than the differences in DFLE between individuals with low and medium educational levels. Previous research has suggested that national contexts might be able to modify patterns of uneven health returns (Cambois et al., 2016). In Southern European countries, the proportion of high-educated individuals was still relatively small among the oldest members of the studied cohorts. This is likely because educational expansion occurred later in these countries than in the other European countries studied, resulting in a sub-population of high-educated individuals, and particularly of men, that is more selective. Meanwhile, in CEE countries, where education is more evenly distributed, institutional differences may have been more important for the more affluent. Given the sociohistorical context, individuals with low educational attainment in the CEE countries tended to have consistently lower DFLE than their Western European counterparts. This could be due to the cumulative effects of exposures tied to social disadvantages, such as low education, across the life course. However, the degree to which additional levels of education were associated with health appeared to differ across countries. This finding is supported by the institutional theory of health inequalities (Beckfield et al., 2015) and empirical evidence of differential educational returns to health from other geographical contexts (Montez et al., 2019). The empirical findings of this study are also consistent with this theoretical contextualization, as the education-specific differences observed across the studied countries were more pronounced among the low-educated.

A particular interest of this study was investigating the differences between CEE and Western European countries. Additional insights into the East-West divide in Europe, consistent with prior research, emerged from our examination of gender-specific educational disparities in DFLE across European countries. First, a substantial gender gap in DFLE favoring women was observed in CEE countries, particularly among individuals with medium levels of education. Second, with a few exceptions (in particular Slovenia), the three CEE countries were shown to have lower levels of disability-free life expectancy (DFLE). Thus, the findings indicated that regardless of their educational level or gender, individuals in these CEE countries spent a smaller percentage of their remaining life disability-free than their counterparts in the seven analyzed Western European countries. However, differences across countries could be observed among the low-educated. Third, although the differences in DFLE between high and low educational groups were not necessarily larger in CEE countries than in Western European countries, the relative disparities by educational attainment were more significant in CEE countries due to their generally lower level of life expectancy. These findings are consistent with those of other studies reporting that populations in CEE countries tend to have poorer health indicators and higher inequality levels than populations in other regions (e.g., Solé-Auró and Gumà (2022)). Finally, an examination of the intersection of gender and education also produced a distinctive pattern, with women in CEE countries exhibiting greater educational disparities in DFLE than their male counterparts. Meanwhile, the findings for Western European countries were more mixed.

It is important to note that substantial heterogeneity was observed within both CEE and Western European countries. For instance, Slovenia was shown to have exceptionally high DFLE, particularly among medium- and high-educated men and women, which distinguished it from other CEE countries. However, due to the small sample size for this country, the wide and overlapping confidence intervals indicate a degree of uncertainty regarding this favorable profile. These estimates should therefore be interpreted with caution. By contrast, Austria was found to have one of the widest educational disparities among the studied countries, and underperformed in DFLE at every educational level. In line with our findings, recent reports have also indicated a high prevalence of limitations in daily activities and chronic conditions (European Commission, 2022; OECD, 2019), as well as a large proportion of life spent in an unhealthy state in Austria (Welsh et al., 2021). Denmark was also shown to have low DFLE values, particularly among women, which could be attributed to an exceptionally high prevalence of smoking among the interwar cohort in that country (Lindahl-Jacobsen et al., 2016).

4.1. Methodological strengths and limitations

Our study proposed combining two estimation approaches: discrete-time modeling and simulation for estimating multivariate life tables, and the Sullivan method for estimating health expectancies using SHARE data. Using SHARE as a sole data source in estimating educational gradient in DFLE is not only an original alternative to the existing methods, it can also offer insights into DFLE trends for countries that currently cannot provide differential mortality statistics, which is a crucial component of DFLE estimation. We also estimated health and life expectancies for countries that are otherwise under-represented in the literature, which is especially relevant in light of the persisting European East-West health divide.

Furthermore, unlike vital statistics, the SHARE survey provides comprehensive information on the health and demographic and socioeconomic characteristics of individuals. Thus, SHARE data can be used to investigate dimensions other than education, which can help to advance our understanding of health disparities across and between CEE and Western European countries. At the same time, we acknowledge several data-related limitations. Klotz et al. (2017) have extensively discussed the validity concerns associated with survey data, such as the under-representation of institutionalized populations and the possible misrepresentation of differential mortality between subgroups. Indeed, household surveys like SHARE usually do not cover institutionalized populations, which might result in a selectively healthier sample. The proportion of institutionalized individuals varies across countries, adding complexity to cross-country comparisons (Author 2020). Additionally, education could serve as a factor for attrition, but Muszynska-Spielauer and Spielauer (2022) found only negligible differences in the effects of panel attrition on the education-specific prevalence of disability and DFLE estimates.

The use of the Global Activity Limitation Indicator (GALI) as a measure of health has limitations due to potential differences across cultures in self-reported disability (Author 2020). Additionally, in 2008, the translations of the question into different languages was revised. To address this issue, sensitivity analyses were conducted using only waves 4-8 and an alternative health indicator (limitations in at least one basic activity of daily living) (see supplementary material **Fig. A.1-A.3**).

Albeit with some exceptions, the SHARE data produced population-level life expectancy estimates that were similar to the Human Mortality Database estimates. The biannual nature of the panel and the exclusion of institutionalized populations should be considered when evaluating the quality of these estimates. Furthermore, our findings on the association between education and health were consistent with the results of previous research showing that longevity and health tend to be positively associated with education (Montez & Friedman, 2014). Although the measurement of disability, the study period, and the age range for reporting remaining years of disability-free life vary across studies, the relative differences in disability-free life expectancy by gender and education we observed are in line with the previous literature.

5. Conclusions

The study found substantial health disparities by education in both Central and Eastern European and Western European countries, with the largest cross-country differences being observed among the low-educated. Although the differences in disability-free life expectancy between the high and the low educational groups were not necessarily larger in CEE countries, the relative disparities by educational attainment were more significant due to the generally lower level of life expectancy in these countries. In addition, the educational inequalities in CEE countries were found to be more pronounced for women than for men, whereas the results for Western European countries were inconclusive. These findings underline the need for further research on how individual factors impact health that also considers the contextual environment in which people live their lives. The results of this study may advance our understanding of the factors that drive educational health inequalities, and the effectiveness of national policies designed to address them.

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Author(s) 2020

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Supplementary Material

Table A.1. Disability-free life expectancy (DFLE), overall life expectancy (LE), and the share of remaining life spent disability-free for men and women at age 50

Country	DFLE	95% CI	LE	95% CI	Share of DFLE
			Women		
Estonia	13.0	(12.6 - 13.5)	33.5	(32.8 - 34.2)	39%
Czechia	14.1	(13.6 - 14.6)	33.2	(32.4 - 33.9)	43%
Slovenia	17.2	(16.5 - 18.0)	37.3	(36.2 - 38.6)	46%
Austria	16.4	(15.8 - 16.9)	35.4	(34.5 - 36.3)	46%
Belgium	16.8	(16.2 - 17.3)	35.8	(35.1 - 36.6)	47%
Denmark	17.3	(16.6 - 18.0)	30.6	(29.7 - 31.5)	56%
France	18.9	(18.3 - 19.4)	37.9	(37.0 - 38.8)	50%
Italy	17.8	(17.3 - 18.3)	34.7	(33.9 - 35.5)	51%
Spain	19.3	(18.8 - 19.9)	34.9	(34.1 - 35.6)	55%
Sweden	17.6	(17.0 - 18.3)	33.9	(32.9 - 34.8)	52%
			Men		
Estonia	11.0	(10.5 - 11.5)	25.9	(25.0 - 26.7)	42%
Czechia	12.8	(12.1 - 13.5)	27.5	(26.6 - 28.5)	46%
Slovenia	15.7	(15.0 - 16.5)	30.9	(29.7 - 32.0)	51%
Austria	16.1	(15.4 - 16.9)	31.3	(30.3 - 32.3)	51%
Belgium	17.4	(16.8 - 18.0)	31.4	(30.6 - 32.2)	55%
Denmark	18.0	(17.3 - 18.7)	28.4	(27.5 - 29.2)	63%
France	17.4	(16.7 18.1)	31.5	(30.4 - 32.6)	55%
Italy	19.4	(18.8 -20.0)	31.4	(30.6 - 32.2)	62%
Spain	19.3	(18.5 - 20.0)	29.7	(28.8 - 30.6)	65%
Sweden	18.5	(17.7 - 19.2)	30.5	(29.4 - 31.3)	61%

Note: The data used for the calculations were pooled from country-specific waves of SHARE for either 2004-2019 (Austria, Belgium, Denmark, France, Italy, Spain, and Sweden) or 2010-2019 (Estonia, Czechia, Slovenia), based on country-specific data availability.

Table A.2. Educational differences in disability-free life expectancy (DFLE), overall life expectancy (LE), and the share of life spent disability-free at age 50 for men and women

		Women			Men		
		Low	Medium	High	Low	Medium	High
Czechia							
	DFLE	11.3	16.6	18.6	11.5	13.4	17.7
		(10.5 - 12.0)	(15.8 - 17.5)	(16.9 - 21.3)	(10.5 - 12.5)	(12.5 - 14.3)	(16.2 - 19.4)
	LE	32.5	35.6	36.8	28.7	28.0	33.0
		(31.4 - 33.6)	(34.4 - 37.0)	(34.1 - 40.1)	(27.3 - 30.0)	(26.7 - 29.3)	(31.0 - 35.1)
	% DFLE	35%	47%	51%	40%	48%	54%
Estonia							
	DFLE	10.5	12.4	16.3	9.3	10.4	14.5
		(9.5 - 11.5)	(11.8 - 13.1)	(15.3 - 17.5)	(8.4 - 10.3)	(9.7 - 11.1)	(13.6 - 15.6)
	LE	33.0	32.9	35.4	24.1	25.5	29.3
		(32.0 - 34.1)	(31.9 - 33.8)	(33.8 - 37.0)	(22.8 - 25.4)	(24.4 - 26.7)	(27.7 - 30.9)
	% DFLE	32%	38%	46%	39%	41%	50%
Slovenia							
	DFLE	13.6	18.2	23.9	11.7	16.0	20.9
		(12.6 - 14.6)	(17.0 - 19.6)	(20.4 - 28.6)	(10.4 - 13.1)	(15.0 - 17.1)	(19.0 - 23.1)
	LE	36.1	36.9	42.0	29.1	30.3	35.5
		(34.7 - 37.4)	(35.1 - 38.7)	(37.8 - 47.0)	(27.4 - 31.0)	(28.9 - 31.7)	(32.8 - 35.8)
	% DFLE	38%	49%	57%	40%	53%	59%
Austria							
	DFLE	14.0	16.7	19.1	10.8	15.7	19.2
		(13.1 - 15.0)	(15.8 - 17.7)	(17.9 - 20.5)	(9.1 - 12.7)	(14.8 - 16.7)	(17.9 - 20.9)
	LE	34.7	35.2	37.2	29.3	30.3	34.2
		(33.5 - 35.9)	(33.8 - 36.7)	(35.2 - 39.4)	(27.3 - 31.4)	(29.0 - 31.7)	(32.3 - 36.4)
	% DFLE	41%	48%	51%	37%	52%	56%
Belgium							
	DFLE	15.2	16.8	18.9	15.8	17.3	19.5
		(14.5 - 16.0)	(15.8 - 17.9)	(17.8 - 20.1)	(15.0 - 16.7)	(16.3 - 18.4)	(18.3 - 20.7)
	LE	34.4	35.8	38.0	30.6	31.2	32.4
		(33.5 - 35.4)	(34.3 - 37.2)	(36.5 - 39.6)	(29.6 - 31.7)	(29.9 - 32.6)	(31.0 - 34.0)
	% DFLE	44%	47%	50%	52%	55%	60%
Denmark							
	DFLE	13.9	16.0	19.9	13.8	17.6	19.9
		(12.6 - 15.3)	(15.0 - 17.1)	(18.7 - 21.1)	(12.2 - 15.4)	(16.7 - 18.6)	(18.8 - 21.0)
	LE	28.5	30.1	32.3	26.1	27.6	30.2
		(26.9 - 30.0)	(28.7 - 31.6)	(30.7 - 34.0)	(24.5 - 27.8)	(26.4 - 28.7)	(28.9 - 31.4)
	% DFLE	49%	53%	62%	53%	64%	66%
Italy							
	DFLE	16.7	21.5	26.4	18.7	20.1	24.8
		(16.1 - 17.2)	(19.7 - 23.6)	(22.3 - 32.2)	(18.0 - 19.5)	(18.8 - 21.3)	(22.5 - 27.7)
	LE	34.2	35.6	37.9	31.4	30.7	33.8
		(33.3 - 35.0)	(33.3 - 38.1)	(33.2 - 44.9)	(30.5 - 32.3)	(29.0 - 32.6)	(31.3 - 37.1)
	% DFLE	49%	60%	70%	60%	65%	73%
France							
	DFLE	17.4	19.5	21.9	14.8	17.6	21.0
		(16.6 - 18.2)	(18.0 - 20.9)	(20.4 - 23.6)	(13.8 - 15.9)	(16.5 - 18.8)	(19.4 - 22.8)
	LE	36.1	38.2	41.7	28.8	32.6	34.1
		(35.0 - 37.2)	(36.3 - 40.5)	(38.9 - 44.8)	(27.3 - 30.4)	(30.8 - 34.6)	(31.9 - 36.7)
	% DFLE	48%	51%	53%	51%	54%	62%
Spain							
	DFLE	18.5	23.6	24.1	18.5	20.5	23.2
		(17.9 - 19.1)	(21.2 - 26.8)	(21.7 - 26.6)	(17.6 - 19.3)	(18.7 - 22.7)	(21.4 - 25.2)
	LE	34.7	35.8	35.5	29.5	29.3	32.1
		(33.9 - 35.5)	(32.4 - 40.1)	(32.5 - 39.1)	(28.4 - 30.5)	(26.8 - 32.0)	(29. 7 -34.8)
	% DFLE	53%	66%	68%	63%	70%	72%
Sweden							
	DFLE	15.8	16.8	20.3	16.3	19.2	21.2
		(14.6 - 17.0)	(15.7 - 18.0)	(18.6 - 22.5)	(15.1 - 17.5)	(18.0 - 20.5	(19.9 - 22.5)
	LE	32.1	33.0	37.3	28.8	31.0	32.7
		(30.8 - 33.3)	(31.3 - 34.6)	(35.3 - 39.7)	(27.5 - 30.1)	(29.4 - 32.4)	(31.2 - 34.4)
	% DFLE	49%	51%	54%		57%	62%

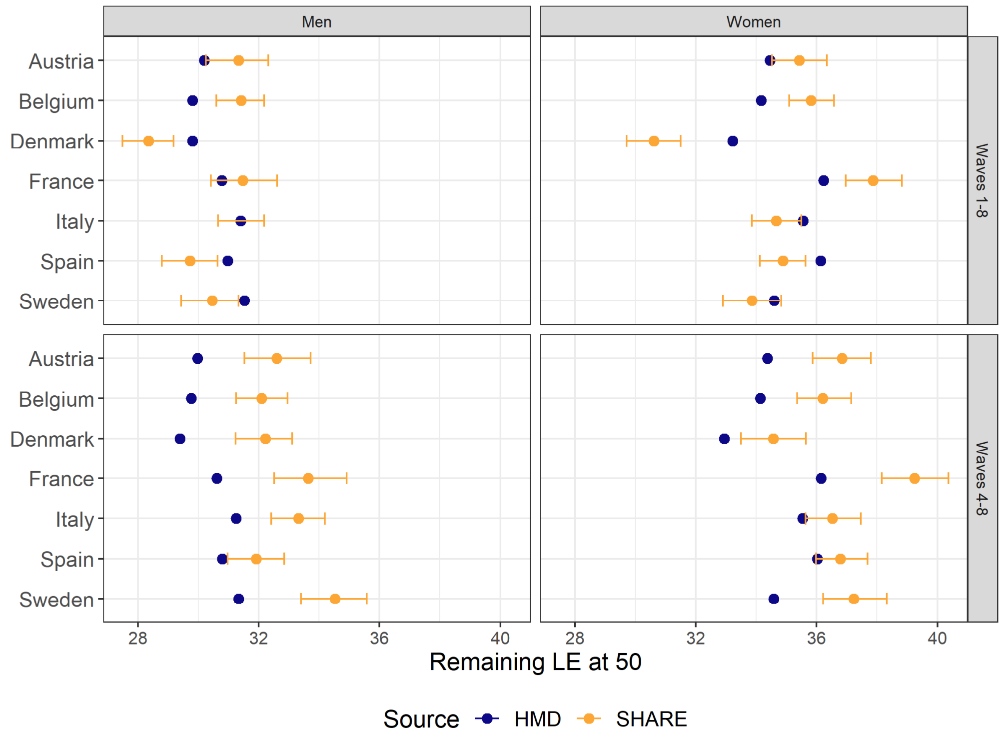

Fig. A.1. Life expectancy estimates from SHARE data compared to HMD estimates
Note: We selected single-year complete life tables for the calendar year that represented the midpoint population, based on the period when the country was participating in the survey. Specifically, we utilized life tables from the year 2012 for countries covered by SHARE data from 2004 to 2019, and used life tables from the year 2015 for countries covered by SHARE data from 2010 to 2019. It is important to note that the life tables in the HMD are provided by either single-year or five-year age groups. However, as we needed to utilize two-year age groups for our estimates, we employed single-year HMD data to calculate life tables in two-year age intervals.

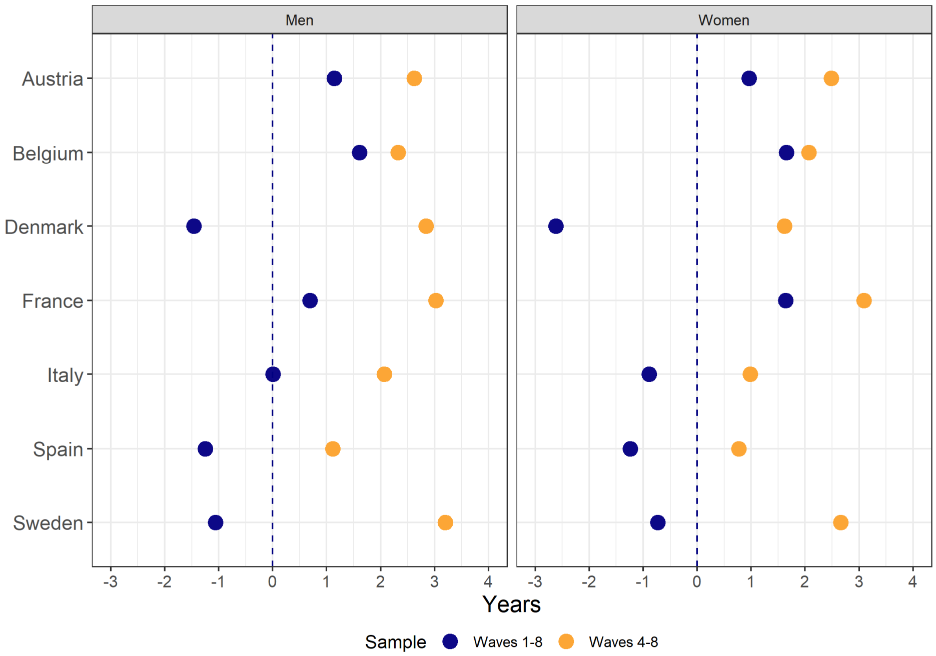

Fig. A.2. The differences in life expectancy estimates (in years) obtained from the Human Mortality Database (HMD) for a specific period using two different sample groups: a restricted sample from SHARE waves 4-8, and a full sample for countries for which such data are available

The points on the graph represent the differences between the two samples, with the x-axis showing the degree of over- or underestimation in the SHARE estimates compared to that in the HMD estimates. A value of zero on the x-axis indicates that the SHARE estimates do not differ from the HMD estimates. We decided to use a full sample, as it derived estimates closer to those of the HMD estimates.

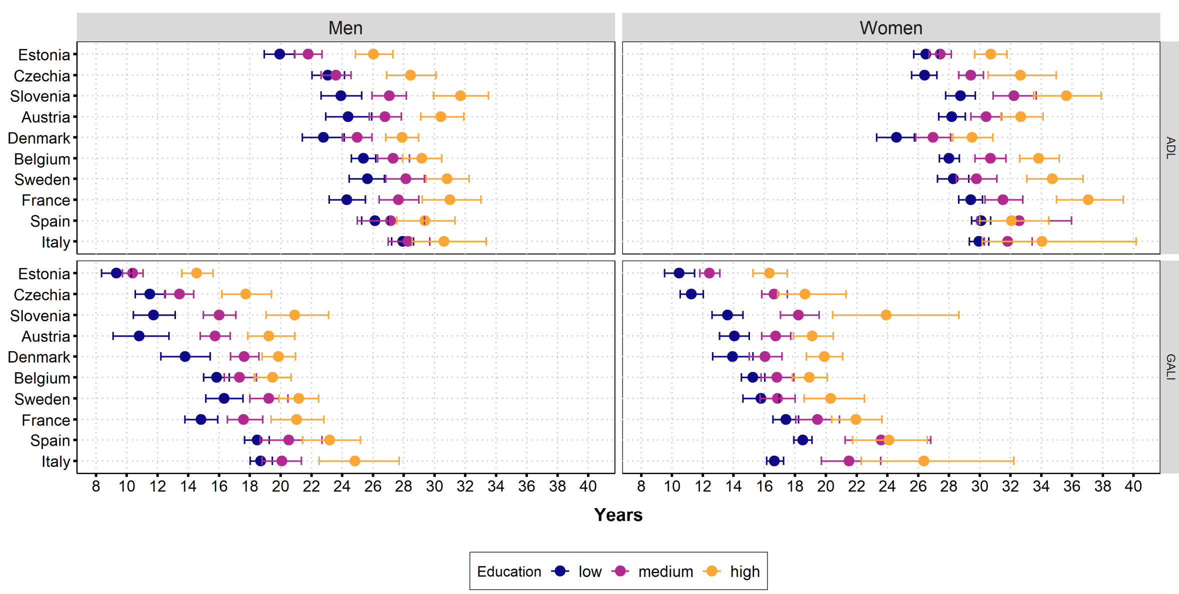

Fig. A.3. Comparison of remaining healthy life years at age 50 estimates by gender and education using two different health indicators: limitations in at least one basic activity of daily living (ADL) and the global activity limitations indicator (GALI).

The scale of the estimates differs given that the indicators capture different aspects of health. However, the observed pattern in educational differences across countries supports the robustness of our findings.