The evolution of cause- and age- specific contributions to educational gaps in life expectancy in 14 European countries (1990-2019)

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Motivation and justification:

Socio-economic status (SES) constitutes a fundamental determinant of mortality and life expectancy: individuals with higher levels of SES live longer compared to those in more disadvantaged social groups (Mackenbach et al., 2018). This association appears to be universal and it has been documented across all European countries analysed, albeit with variation in the magnitude of inequalities: SES inequalities in mortality are smaller in the South and more pronounced in Eastern Europe (Mackenbach et al., 2008), as documented in Italy and Spain (South) (Trias-Llimós et al., 2023), or Poland, Lithuania and Estonia (Eastern) (Mackenbach, et al., 2019; OECD, 2022).

Two main approaches have been used to study the evolution of SES inequalities in mortality. The first focuses on mortality rates, initially relying on rate-ratios and rate-differences between the mortality rates of the highest and lowest SES groups, and later incorporated the Relative Index of Inequality (RII) and Slope Index of Inequality (SII), which allow intermediate educational categories to be included through Poisson regression models (Moreno-Betancur et al., 2015). Overall, these studies reported increases in relative SES inequalities in all-cause mortality and declines in absolute SES inequalities in all-cause mortality, which reflect larger percentual declines in mortality among higher-educated groups while smaller absolute reductions compared to those with lower education (de Gelder et al., 2017; Mackenbach et al., 2016, 2018). The second approach examines differences in life expectancy between SES/educational groups and have reported overall increases in SES inequalities in life expectancy with important heterogeneity across countries: Educational inequalities in life expectancy have increased in the Nordic countries (Enroth et al., 2022; Zazueta-Borboa et al., 2023), Belgium (Deboosere et al., 2009; Renard et al., 2019), Spain (Permanyer et al., 2018), England & Wales and among males in Italy (Turín) (Zazueta-Borboa et al., 2023). In contrast, declines in educational inequalities in life expectancy have been documented in Austria (Klotz, 2010). Overall, these studies suggest that educational inequalities in life expectancy have evolved heterogeneously across European countries. However, cross-national comparability remains challenging due to differences in previous studies in mortality indicators, age and educational groupings, and the time periods analyzed.

Furthermore, the evolution of educational inequalities in life expectancy is shaped by age- and cause of death- specific mortality dynamics. While these dynamics vary across countries, regularities may reveal shared mechanisms driving the evolution of educational inequalities in life expectancy. Country- specific evidence has shown that the educational gap in life expectancy is primarily explained by the contribution of middle-age groups (± 40-60) (Jasilionis et al., 2007; Trias-Llimós et al., 2023). Given that a substantial share of deaths at these premature ages is avoidable, meaning that they can be averted by prevention or treatment, inequalities in mortality at these ages reflect unequal access to effective health care (Nolte & McKee, 2004), yielding important implications for health policies. As a result, when health care improvements reach lower educational groups, the younger age-groups play a crucial role in the evolution of educational inequalities in life expectancy (Zazueta-Borboa et al., 2023).

Regarding the role of specific causes of death, educational inequalities have been found in Europe in most major causes of death, including cancers (Vaccarella et al., 2023), cardiovascular diseases (CVDs) (Girolamo et al., 2020), diabetes (Espelt et al., 2013), COPD (Kulik et al., 2014). Regarding its evolution, mortality rates from cancer and CVDs have experienced decreases in across all educational groups. However, these have been more pronounced among higher educated groups, reducing absolute while widening relative educational inequalities in mortality (Girolamo et al., 2020; Vaccarella et al., 2023). Although patterns vary across European countries, comparative research has pointed out at ischemic heart disease and amenable causes as key drivers of reductions in absolute inequalities in mortality from 1990-2013, while certain cancers (such as breast cancer for females) have led to widening absolute inequalities (Mackenbach et al., 2019).

While previous research has focused on the role of main causes of death on educational all-cause mortality inequalities over time using annualized mortality rates (Mackenbach et al. 2019), evidence on absolute cause-specific contributions across time periods remains limited. Understanding these contributions is crucial for uncovering the age- and cause-specific mechanisms underlying inequalities, since the causes driving the gap may shift over time even when the overall magnitude of the gap remains unchanged. In this study, we focus on a single indicator, the gap in partial life expectancy (40-84) between the highest and lowest educational groups. To extend previous work, we analyse the contribution of detailed causes-of-death and age-groups at several points in time using decomposition methods, while also expanding the temporal coverage (1990-2019).

This approach enables us to address the following research questions: 1) How do age-groups and causes of death contribute to the educational gap in partial life expectancy (40-84) in 2019?, 2) How have educational inequalities in partial life expectancy (40-84) in European countries evolved since 1990?, 3) Which age-groups have contributed to these changes over time?, and 4) Which causes have played a role in shaping these dynamics?

Data and Methods

We used harmonized cause-specific mortality data by educational attainment spanning from the 1990s (or the first time point available) to 2019 (or the last time point available) for 14 European populations (12 countries, 2 cities), representing different regions in Europe (North: Finland, Denmark, Norway, Sweden; West: Austria, Belgium, England and Wales, Switzerland; East: Poland, Lithuania, Estonia, Slovenia; South: Spain (Barcelona), Italy (Turin)). Most data were obtained from longitudinal mortality follow-up after a census with the exceptions of Spain (Barcelona) and Poland, which stem from cross-sectional studies.

Educational attainment was measured by the highest level of education attained by a person, coded according to the International Standard Classification of Education (ISCED) in three categories: Low (ISCED 0-2), medium (ISCED 3-4) and high (ISCED 5+).

Mortality rates were estimated using 5-year age-groups and data pooled for several years. The periods covered and country-level availability are detailed in Table 1. Partial life expectancy was estimated from ages 40-44 to 80-84 using standard demographic approaches (Preston et al., 2001). The gap in partial life expectancy resulted from the difference in life expectancy between the highest and lowest educational groups. This gap was decomposed by age-group and cause-of-death using the decomposition method developed by Arriaga (1984).

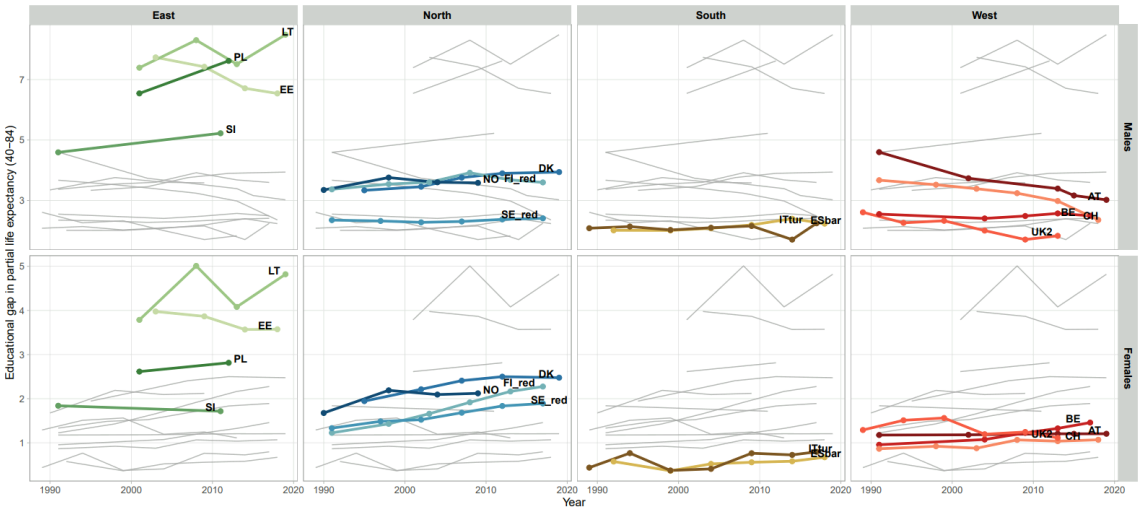
Table 1. Data sources used and years included by country

Region	Country	Design	Inclusion	Years Included					
East	Estonia	Longitudinal	All			2000-05	2006-10	2012-15	2016-19
	Lithuania	Longitudinal	All			2001-05	2006-09	2011-14	2015-19
	Poland	Cross-Sectional	All			2001-03		2010-12	
	Slovenia	Longitudinal	All	1991-95		2002-06			
North	Denmark	Longitudinal	All		1995-99	2000-04	2005-09	2010-14	2015-19
	Finland	Longitudinal	All	1991-95	1996-00	2001-05	2006-10	2011-15	2016-19
	Norway	Longitudinal	All	1990-95	1995-00	2001-06	2006-09		
	Sweden	Longitudinal	All	1990-94	1995-99	2000-04	2005-09	2010-14	2015-17
South	Barcelona (Spain)	Cross-Sectional	All	1992-96	1997-01	2002-06	2007-11	2012-16	2017-18
	Turin (Italy)	Longitudinal	All	1991-96	1999-01	2001-06	2006-10	2011-15	2015-18
West	Austria	Longitudinal	All	1991-92	2001-02		2011-13	2013-15	2015-19
	Belgium	Longitudinal	All	1991-97		2001-06	2006-11	2011-15	2016-17
	Switzerland	Longitudinal	Swiss nationals	1990-95	1995-00	2001-05	2006-10	2011-14	2016-18
	England &Wales	Longitudinal	1% sample	1991-96	1996-01	2001-06	2006-11	2011-13	

Preliminary results

Figure 1 shows the evolution of the educational gap in partial life expectancy (ages 40-84) from the 1990s to 2019. The educational gap in life expectancy has evolved differently across countries, although some regional patterns can be observed. Eastern European countries exhibited the largest educational gaps in partial life expectancy. In Lithuania, Poland and Slovenia (males), the gap has widened since the 1990s, whereas it has narrowed in Estonia and remained stable in Slovenia (females). In the Nordic countries, the gap has widened among females, as observed in all countries of the region. Among males, the gap has widened in Denmark, while stability has been observed in Finland, Norway, and Sweden. Southern European populations exhibited the narrowest educational gaps compared with the other regions, particularly among females. Over time, these gaps have remained stable at low levels, with only minor increases since the beginning of the period (specially Turin). Lastly, in Western European countries, educational gaps among males have generally narrowed, except for Belgium where the gap has remained stable. Among females, the gap has widened in Belgium and Czech Republic, remained stable in Austria, and narrowed in the United Kingdom and Wales.

Figure 1. Evolution of the educational gap in partial life expectancy by sex and country (ages 40-84)



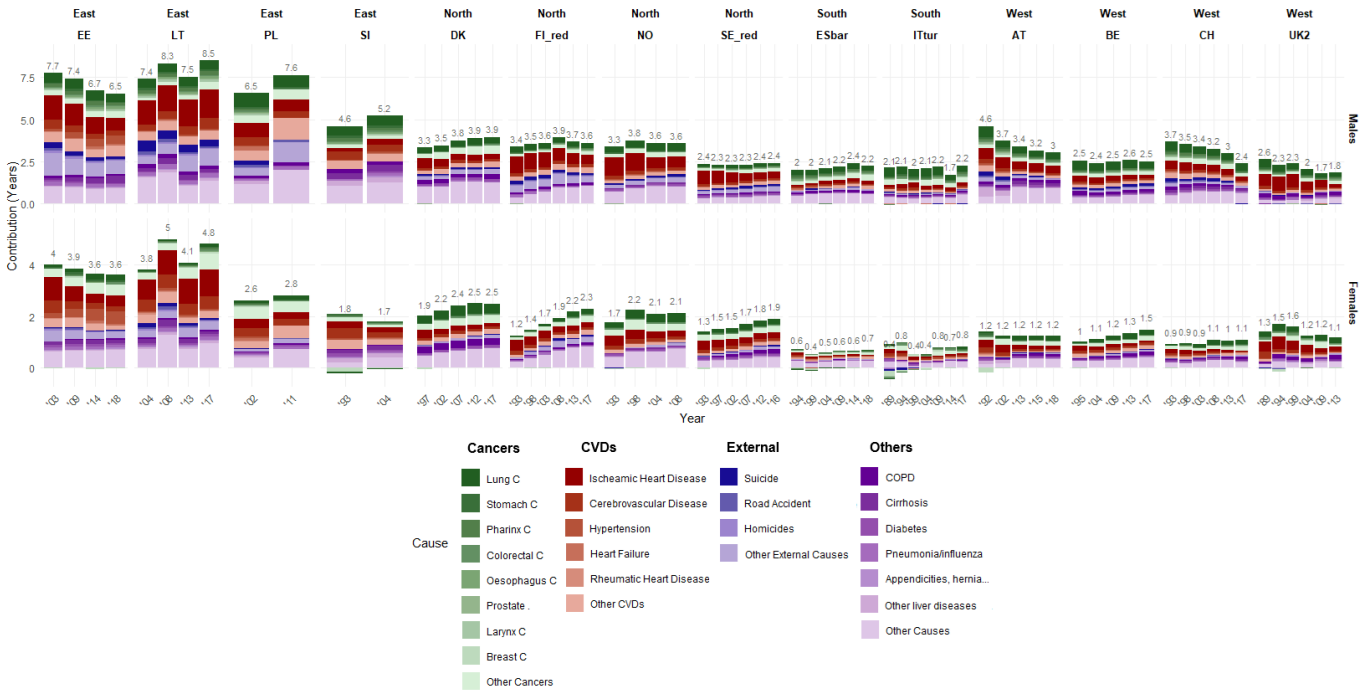
Regarding the contribution of age-groups to the educational gap in partial life expectancy, two general patterns can be observed across countries: First, the lowest contribution to the educational gap in life expectancy is consistently given by the oldest age group (70-84), a pattern that holds across countries, years, and sexes (except for minor deviations among females in Barcelona, Turín and England & Wales). Consequently, changes in the educational gap are primarily driven by changes in the contribution of the age-groups 40-49, 50-59 and 60-69, with heterogeneity across countries. Second, even in the absence of changes in the educational gap over the years, the contribution to the educational gap has shifted towards younger ages, as it is the case for females in Austria, Slovenia, Switzerland or Barcelona (Spain).

Figure 2. Evolution of the contribution of age-groups to the gap in partial life expectancy (40-84) between the highest and lowest educated group by country and sex.

Regarding the contribution of causes of death, we also observed certain patterns: First, the contribution of cardiovascular causes to the educational gap in partial life expectancy has

decreased over time, regardless of the overall trend of the gap. This pattern is constant across countries and between sexes. The decline is largely driven by the declining contribution of ischaemic heart disease mortality, which remains the most important contributor to the educational gap among cardiovascular causes for most countries. Second, the contribution of cancers exhibits a pronounced sex difference. For males, the total contribution of cancers stays relatively stable over time, with minor fluctuations that generally followed the overall trend. For females, however, the contribution of cancers has increased in nearly all countries. Among cancers, lung cancer is the major contributor to these dynamics, showing the same sex-specific pattern over time. Further analyses by detailed causes of death are forthcoming.

Figure 3. Evolution of the contribution of causes of death to the gap in partial life expectancy (40-84) between the highest and lowest educated group by country and sex



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