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Widening educational inequalities in mortality in more recent birth cohorts: a study of 14 European countries

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► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/jech-2023-220342).

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Received 18 January 2023
Accepted 1 April 2023

ABSTRACT

Background Studies of period changes in educational inequalities in mortality have shown important changes over time. It is unknown whether a birth cohort perspective paints the same picture. We compared changes in inequalities in mortality between a period and cohort perspective and explored mortality trends among low-educated and high-educated birth cohorts.

Data and methods In 14 European countries, we collected and harmonised all-cause and cause-specific mortality data by education for adults aged 30–79 years in the period 1971–2015. Data reordered by birth cohort cover persons born between 1902 and 1976. Using direct standardisation, we calculated comparative mortality figures and resulting absolute and relative inequalities in mortality between low educated and high educated by birth cohort, sex and period.

Results Using a period perspective, absolute educational inequalities in mortality were generally stable or declining, and relative inequalities were mostly increasing. Using a cohort perspective, both absolute and relative inequalities increased in recent birth cohorts in several countries, especially among women. Mortality generally decreased across successive birth cohorts among the high educated, driven by mortality decreases from all causes, with the strongest reductions for cardiovascular disease mortality. Among the low educated, mortality stabilised or increased in cohorts born since the 1930s in particular for mortality from cardiovascular diseases, lung cancer, chronic obstructive pulmonary disease and alcohol-related causes.

Conclusions Trends in mortality inequalities by birth cohort are less favourable than by calendar period. In many European countries, trends among more recently born generations are worrying. If current trends among younger birth cohorts persist, educational inequalities in mortality may further widen.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Previous studies that have examined educational inequalities in mortality used a period perspective and found that relative inequalities have increased over time in almost all European countries, whereas absolute inequalities have followed a more variable course.

WHAT THIS STUDY ADDS

⇒ This study provides insight into the differences in the trends in mortality inequalities viewed from a cohort and period perspective.
⇒ This study provides insight into cohort differences in mortality inequalities by investigating both all-cause and cause-specific mortality.
⇒ The study provides insight into cross-national, sex and age differences in educational trends in mortality across 14 European countries.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ More awareness is needed that the period perspective may yield too optimistic results.
⇒ Practice and policy should be prepared that inequalities in mortality may further widen and that ‘unhealthy homogenisation’ may create an increasingly vulnerable group of lower-educated persons.

INTRODUCTION

Socioeconomic inequalities in mortality have been extensively analysed. Over the past decades, relative inequalities in mortality have increased in almost all European countries, whereas absolute inequalities have followed a more variable course.[1–3]

Most previous studies on health inequalities have adopted a period perspective, in which the unit of time is calendar year. This is useful for monitoring purposes, for instance, to evaluate whether policy targets for reducing health inequalities have been met or to detect interruptions in trends due to major historical events such as the financial crisis in 2008.[4] However, not all changes occurring over time are due to true period effects. Instead, changes may also be due to cohort effects, for example, changes between successive birth cohorts in exposure to health determinants during the life course.[5 6]

Cohort effects have been found for several health outcomes including lung cancer[7] and cardiovascular diseases.[8] In addition, cohort effects have been observed for various health determinants including smoking,[9] alcohol use[10] and physical activity.[11] In turn, these developments may have a consequence

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To cite: Long D, Mackenbach JP, Klokgieters S, *et al*. *J Epidemiol Community Health* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/jech-2023-220342

for trends in educational inequalities in health. While there are several studies focusing on cohort trends in educational inequalities in different health outcomes suggesting growing educational differences in more recent birth cohorts,[12–17] most studies were based on a small number of deaths or focused on one single country. Therefore, the generalisability of these findings might be limited to specific national and historical contexts, thus studies covering both a wider geographical area and a larger number of cases are needed.

Determining whether health inequalities are affected by cohort effects is important for two other reasons. First, it may help to better understand long-term trends occurring over time. For example, changes over time in inequalities in smoking-related mortality are at least partly determined by widening or narrowing inequalities in smoking habits across successive generations.[18] Second, it may help to better understand how educational inequalities in mortality might develop in the future. Strong cohort effects in health outcomes indicate that successive birth cohorts may differ importantly in exposure to the determinants of mortality. If we observe more recently born birth cohorts to have larger inequalities in mortality (at the same ages) than previous generations, we can reasonably hypothesise that when they grow older, they might continue to have larger inequalities in mortality. This is particularly true for risk factors such as smoking which have a long-lasting effect on health. Extrapolations into the future based on cohort patterns may, therefore, usefully supplement extrapolations based on period effects only.[19]

In this study, we, therefore, aimed to (1) explicitly compare inequalities in all-cause mortality between a period and cohort perspective and (2) explore underlying patterns in all-cause and cause-specific mortality among low-educated and high-educated birth cohorts, exploiting a unique dataset with harmonised information on mortality by the level of education, sex, age and cause of death covering several decades and 14 European countries.

DATA AND METHODS

Data

We collected and harmonised data on all-cause and cause-specific mortality by sex, age (in 5-year age groups from 30–34 to 75–79 years), calendar period (various periods between 1971 and 2015) and educational level from 14 European countries. Most data relate to complete national populations, with the exceptions of Italy (Turin only), Spain (Barcelona only), France (a 1% sample of the population), the UK (England and Wales only, and a 1% sample of the population) and Switzerland (Swiss nationals only). Most data are derived from longitudinal mortality follow-ups after a census or based on registries (online appendix 1 table 1). The results are grouped geographically, (3–4 countries per figure) to make the figures easier to read: Northern Europe (Denmark, Finland, Norway and Sweden), Southern Europe (France, Italy and Spain), Western Europe (Austria, Belgium, the UK and Switzerland) and Eastern Europe (Estonia, Hungary and Lithuania).

Socioeconomic position (SEP) was indicated by the highest level of completed education: ‘low’, ‘mid’ and ‘high’ corresponding to International Standard Classification of Education (ISCED) 2011 categories 0–2, 3–4 and 5–8. In the UK, only two groups could be distinguished, namely ‘low’ and ‘high’. Data with missing level of education were excluded. We refer to online appendix 1 tables 2–3 for more information on education. We focused on educational inequalities in mortality because comparable data on educational attainment were available for both men and women in most European populations. In addition, education is the most stable measure of SEP, as it is normally completed early in adulthood,[20] and it is not sensitive to fluctuations in economic conditions.[21]

Birth cohorts were reconstructed using the information on age and period (birth cohort equals period minus age). Birth cohorts were constructed to retain as much detail as possible. Because data were originally collected in 5-year age groups and 1–5 years calendar periods, the birth year intervals of the reconstructed birth cohorts ranged between 6 and 10 years, with overlaps. For example, those of age 30–34 who died during 1980–1984 belong to birth cohort 1946–1954, whereas those of age 35–39 who died during 1980–1984 belong to birth cohort 1941–1949.

To reduce random fluctuations in the number of deaths across birth cohorts, while retaining as many birth cohorts as possible, we excluded combinations of country–sex–age–education that had less than 10 all-cause deaths. We further excluded birth cohorts with data for less than three age groups. In total, 18 birth cohorts containing 595 169 966 person-years were included in the analysis, with birth years ranging from ca. 1902–1910 to ca. 1967–1975 (online appendix 2 table 5). We presented the results by the median birth year of each birth cohort. To allow comparability, the same selection of study populations was used for the period perspective.

In addition to all-cause mortality, we also analysed mortality by four causes-of-death groups (namely neoplasms, cardiovascular diseases, external causes and all other causes of death) and eight specific causes of death (online appendix 3 table 6).

Methods

Comparative mortality figures (CMF) were used to measure mortality difference between calendar periods (CMF) and between birth cohorts (cohort CMF, CCMF), based on direct standardisation[22] (details in online appendix 4).

Simply put, CMFs are calculated for each combination of country, sex, level of education and cause of death as follows:

$$CMF = \sum_{period} \frac{Expected\ deaths\ in\ standard\ population\ at\ period\ rates}{Observed\ deaths\ in\ standard\ population}$$

and

$$CCMF = \sum_{age} \frac{Expected\ deaths\ in\ standard\ population\ at\ cohort\ rates}{Observed\ deaths\ in\ standard\ population}$$

As standard population, we used pooled population of all countries, all educational groups and all calendar periods, separate for men and women. Because mortality rates are on average lower among women than men, using the same standard population for both sexes would yield hard-to-interpret comparisons between educational groups (online appendix 7 figures 3–4).

The CMF and CCMF are index figures, representing differences in mortality between a particular calendar period/birth cohort and the overall average on a relative, dimensionless scale. The approach chosen here is particularly suited for the analyses of this paper because our data had different age ranges and compositions between birth cohorts and this approach can work around it. CCMF has been used in prior research on geographical comparisons.[23–25]

Relative inequalities (rate ratio, RR) between the low educated and high educated were calculated as the ratio of their corresponding mortality figures, CMF (period perspective) and CCMF (cohort perspective). For the cohort perspective, the RRs were further adjusted for the fact that more recent birth cohorts included younger age groups than earlier birth cohorts.

Table 1 Birth cohorts and numbers of deaths included in the analysis

Population	No of birth cohorts	Oldest Birth cohort	Youngest birth cohort	Person-years (in thousands)	No of deaths	Percentage of deaths with low education (%)		Geographical region as presented in the graphs
						Male	Female	
Austria	8	1922–1927	1957–1962	14 108	127 523	35	58	Western Europe
Belgium	7	1927–1936	1957–1966	64 882	462 390	69	72	Western Europe
Denmark	9	1926–1934	1966–1974	52 941	437 378	45	59	Northern Europe
UK (England and Wales)	13	1902–1911	1962–1971	9135	117 110	92	94	Western Europe
Estonia	8	1933–1941	1968–1976	9384	106 976	43	37	Eastern Europe
Finland	14	1902–1910	1967–1975	106 449	1 123 366	73	77	Northern Europe
France	11	1906–1914	1956–1964	4957	54 535	74	84	Southern Europe
Hungary	10	1909–1916	1954–1961	91 017	1 290 345	83	86	Eastern Europe
Italy (Turin)	13	1902–1911	1962–1971	17 452	187 673	82	88	Southern Europe
Lithuania	8	1932–1940	1967–1975	19 381	230 238	42	44	Eastern Europe
Norway	11	1902–1910	1952–1960	53 725	722 272	55	64	Northern Europe
Spain (Barcelona)	10	1923–1931	1968–1976	19 355	120 262	71	80	Southern Europe
Sweden	8	1921–1929	1956–1964	67 135	491 271	53	55	Northern Europe
Switzerland	10	1922–1930	1967–1975	65 250	416 601	29	50	Western Europe

This could cause an overestimation of inequalities in recent birth cohorts as relative inequalities in mortality are substantially larger in younger than in older age groups.[26] This adjustment followed two steps (details in online appendix 5). In the first step, we calculated an expected RR in the standard population based on the age range in each birth cohort. In the second step, we divided each birth cohort's observed RR by the expected RR and multiplied the result by the all ages RR in the standard population to obtain the adjusted RRs as presented in this paper.

Absolute inequalities (rate difference) between the low educated and high educated were also calculated. First, we calculated an age-standardised mortality rate by sex in the standard population. Next, we multiplied these standardised rates with CMFs/CCMFs to obtain absolute mortality rates for the low educated and high educated groups. Rate difference is then calculated by subtracting the absolute rates of the high educated from the low educated.

The 95% CIs were calculated using parametric bootstrapping with Poisson-distributed death counts and 1000 repetitions. Analyses were performed in Stata V.16.0 SE.

RESULTS

Descriptive results

Table 1 and online appendix 1 table 4 present descriptive information about the data included for analysis. For several countries, the analysis covered a wide range of birth years, ranging from 1900s to 1970s. The total number of deaths included in the analysis is 5.9 million. As the analysis covered many older birth cohorts, the proportion of low educated among all deaths was often substantial. Note that the extraordinarily high percentage of low educated in the UK was because the 'low' educated in this country also includes those with some secondary education (ISCED 3).

Educational inequality trends from period and cohort perspectives

Figure 1 shows the absolute and relative inequalities for the period and cohort perspective, for men (figure 1A) and women (figure 1B) separately.

For men, the period perspective showed stable absolute inequalities in Northern and Southern Europe and declining inequalities in Western and Eastern Europe (from 2000s and onwards). The cohort perspective generally showed that absolute inequalities have increased in almost all countries between generations born earlier in the 20th century and those born later, except for Italy (constant) and the UK (decreasing). Both perspectives showed increasing relative inequalities for men in Northern Europe (except for Sweden), Spain and Eastern Europe (except for recent birth cohorts), but these increases in relative inequalities were larger in magnitude in the cohort perspective. The relative inequalities showed no or less clear increases in the other countries. In Belgium and the UK, inequalities decreased among men in the cohort perspective only.

For women, absolute inequalities were stable or reduced in the period perspective, whereas absolute inequalities were higher for the more recent birth cohorts as compared with earlier birth cohorts in several countries, including Eastern European countries, Finland, Denmark, France and Spain. The cohort perspective showed increasing relative inequalities in these countries as well, except for France. The period perspective showed only increases in relative inequalities in Northern Europe, UK and Hungary.

Mortality trends by education across birth cohorts

Figure 2 shows the birth cohort trends in mortality from all-cause and four groups of causes of death among high-educated men (figure 2A), high-educated women (figure 2B), low-educated men (figure 2C) and low-educated women (figure 2D). The mortality trends among high-educated men and women decreased consistently: all-cause mortality and all four cause-of-death groups showed decreasing mortality, with the largest reductions for cardiovascular disease mortality.

For all-cause mortality among low-educated men, a downward trend in successive birth cohorts born in the first decades of the 20th century often slowed down or even reversed in birth cohorts born since the 1930s. In Eastern Europe, mortality increases were seen over all successive birth cohorts. Among low-educated women, the reversals were more pronounced, with mortality generally considerably higher in birth cohorts born in the 1950s and 1960s than in those born in the 1920s and 1930s. The reversals among both men and women were particularly striking in Hungary and Finland. The only countries in

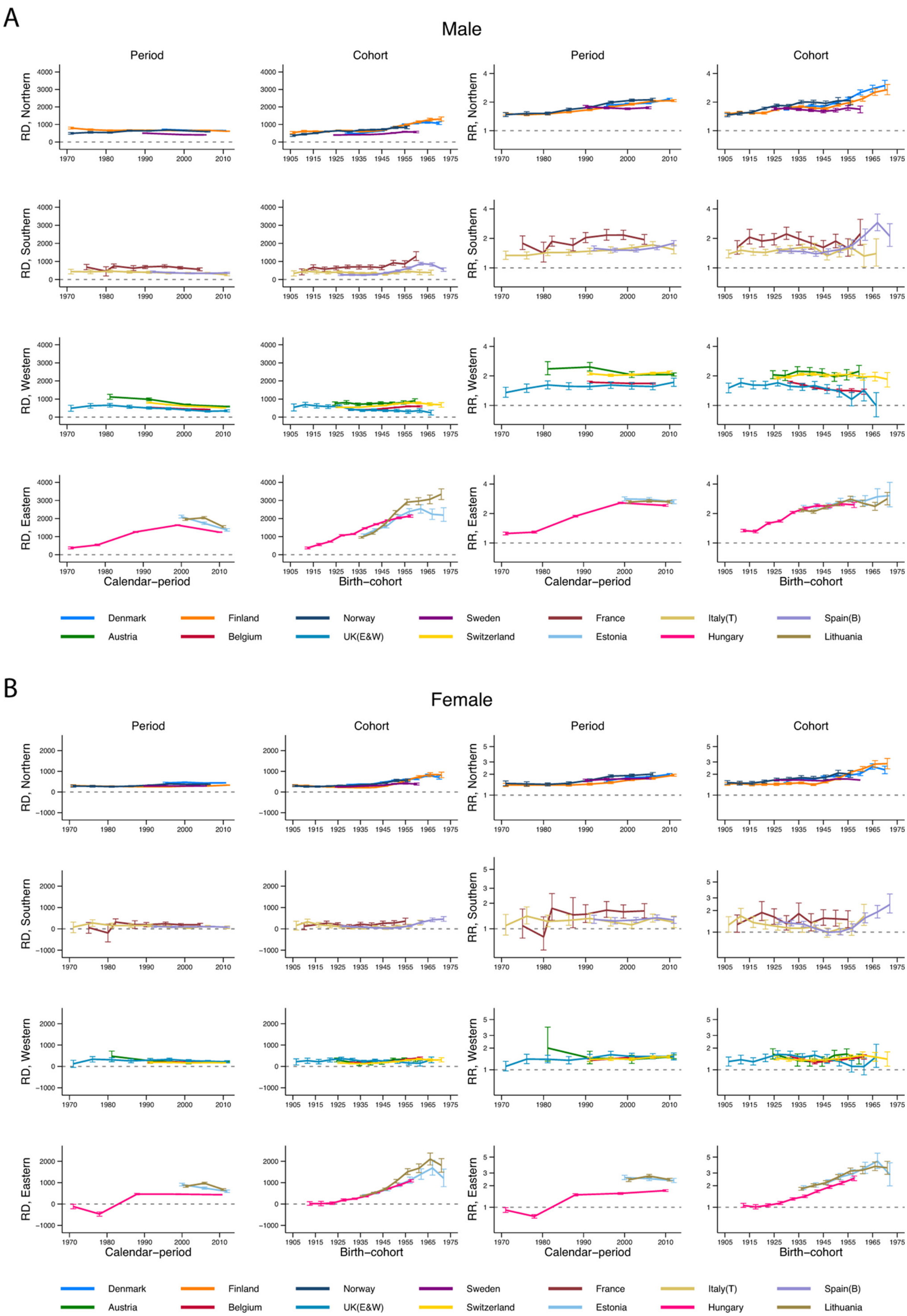

Figure 1 Changes in inequality in all-cause mortality by period and cohort perspectives. RR, (adjusted) rate ratio; RD, rate difference.

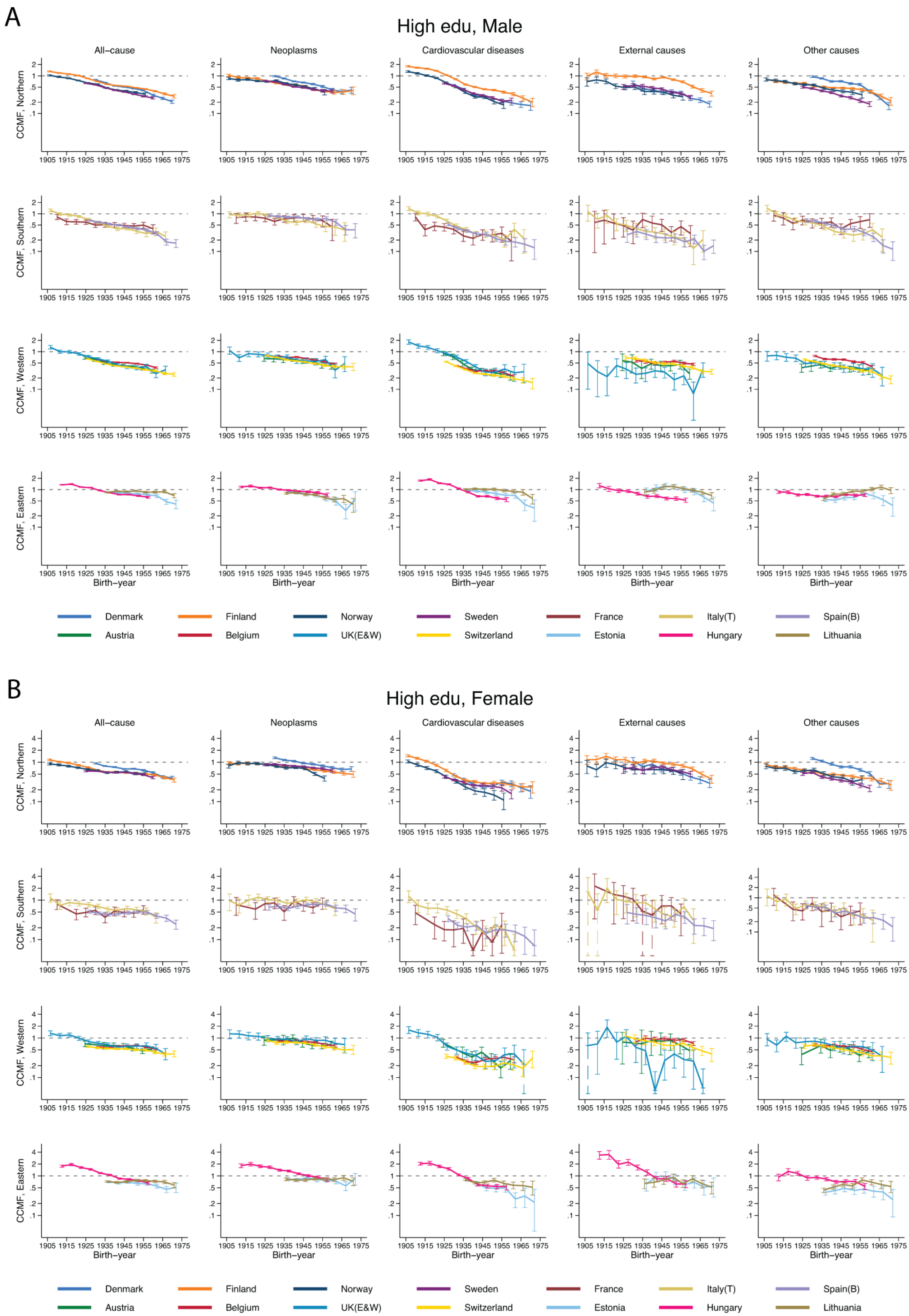

Figure 2 Changes in mortality by birth year among the high educated and the low educated. CCMF, cohort comparative mortality figure.

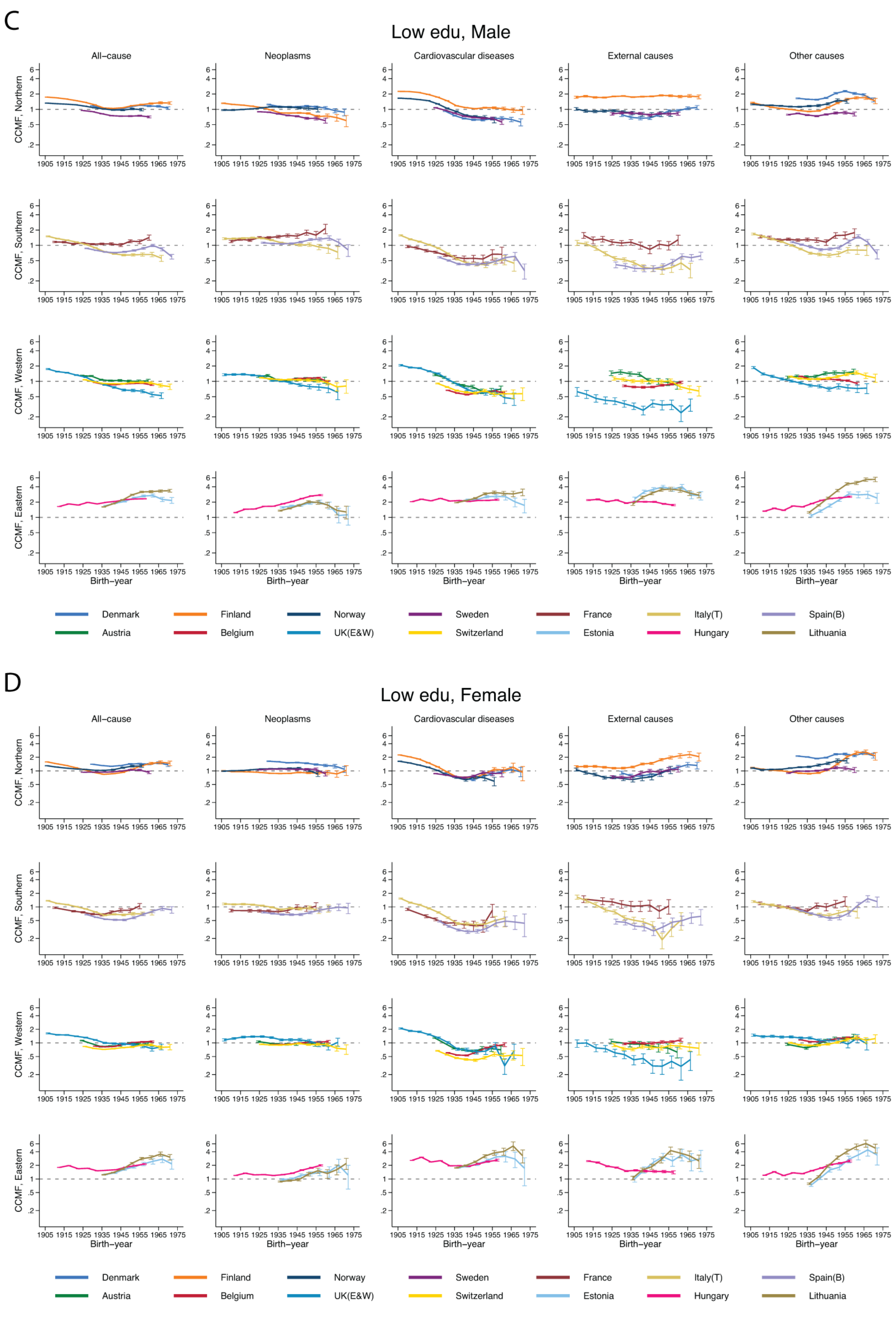

Figure 2 Continued.

which reversals appear to be absent, were the UK and Italy, with continuous declines, particularly in men.

The slow down of decreasing trends or reversals among recent low-educated birth cohorts were found for several cause-of-death groups, among both men and women. Analysis of eight specific causes of deaths (online appendix 6 figure 1-2) provides more insight into causes with initially large mortality reductions that have slowed down or turned into an increase and causes with increased mortality in recent birth cohorts. Declines in mortality from ischaemic heart disease and cerebrovascular disease, and chronic obstructive pulmonary disease have slowed down in recent birth cohorts of low-educated men. Among low-educated women, decreases from these causes have reversed into increases in many countries. Mortality from alcohol-related causes gradually increased across successive birth cohorts, especially among recently born cohorts of low-educated men and women. In addition, mortality from road-traffic injury and suicide stabilised or increased among the low educated in more recently born generations.

DISCUSSION

Summary of main findings

The cohort perspective offers a less favourable picture of changes in educational inequalities in mortality as compared with the period perspective. Educational inequalities in mortality across birth cohorts have widened in many European countries, particularly among recent birth cohorts, women and in Eastern Europe. The widening was mainly driven by the unfavourable trends among the low educated where a mortality decrease was often followed by stabilising or even returning to the initial (high) mortality levels. This pattern is particularly evident for mortality from cardiovascular diseases (ischaemic heart disease, cerebrovascular disease), lung cancer, chronic obstructive pulmonary disease and alcohol-related causes.

Strengths and limitations

This is one of the first studies to apply a cohort perspective on changes in mortality inequalities across Europe using cross-national data. We were not only able to analyse a very large number of deaths (5.9 million) but also to ensure a certain degree of representativeness for Europe as a whole. The range of birth cohorts covered by the analysis is also substantial, including three-quarters of the 20th century.

Besides well-known limitations inherent to international comparisons of mortality by SEP and cause of death,[1–3] we discuss some limitations specific to this study. First, because of data availability, we were not able to compare the complete life course of the cohorts. The approach we have chosen is suited for the explorative purposes of this paper and enables us to include cohorts with different age groups. Nonetheless, we cannot rule out that the parts of the life course outside our observation windows differ in important ways. Confirmations of our results based on longer and more detailed times series that allow formal age-period-cohort modelling is needed to mathematically distinguish between effects that are due to age, cohort or period.[27]

Second, our analysis often included only a limited number of age groups for each birth cohort. Particularly for countries where data were only available for two recent decades, the analysis had to rely on three to four age groups for most birth cohorts. The validity of the results thus depends on whether the empirical pattern can be extrapolated to higher ages and younger birth cohorts. In addition, this study covered data until the year 2015. Thus, more recent global challenges in healthcare and public health systems, with potential impact on mortality patterns, are not covered.

Third and finally, we had to work around the limitations of the data that were not initially aimed at birth cohort analyses. Because data were collected in 5-year age groups and 1–5 years calendar periods, we had to construct and compare sometimes overlapping birth cohorts. We also had to exclude combinations of country–sex–age–education with less than 10 deaths to reduce random fluctuations in recent birth cohorts. Lastly, there were only two levels of education in the data from the UK. Therefore, mortality inequalities in the UK might be underestimated, and the time trends are less comparable to those in other countries.

Interpretation

Our study highlights the importance of analysing educational inequalities in mortality from a birth cohort perspective, in addition to a period perspective. Our analysis by birth cohort shows a less favourable development, with generations born after the 1930s at risk of developing larger mortality inequalities in mortality than their parents. This is mainly due to the unfavourable mortality trends among the low educated for more recent birth cohorts. Our analyses suggest that, in many European countries, low-educated men and women born after the 1930s no longer benefit from the continuous decreases in mortality seen among most previous generations. This applies particularly to mortality from ischaemic heart disease and cerebrovascular disease, and smoking-related and alcohol-related causes. The results may suggest stagnation—or reversal—of improvement in many cardiovascular risk factors, such as smoking and harmful alcohol use.[28 29]

One possible explanation for this unfavourable picture for the low educated is that in successive generations the low-educated group has become much smaller. The share of high educated in the population has increased noticeably because of the rapid expansion of education opportunities in most European countries. Thus, the low educated may have become a more adversely selected subgroup of their generation with fewer opportunities for cognitive advancement and more adverse behavioural or personality profiles, and in turn, have less opportunity for socioeconomic advancement, creating an 'unhealthy homogenisation'.[30]

A second explanation is that social factors have become increasingly important, particularly for disease categories where humans have the capacity to prevent or treat disease.[31 32] The high-educated individuals are more likely to adopt and maintain healthy practices or profit from new technologies and knowledge as they have the money, power and prestige to do so, while the low educated are more often laggards.[33] It is also worth noticing that there is an increasing diversity in population composition due to immigration, which may also impact the magnitude of health inequalities, although the effect may depend on how (im) migrants are distributed over socioeconomic groups and their (dis)advantage compared with natives.[34]

The upswing in mortality among recent-born birth cohorts, particularly among low-educated women, may be explained by, first, healthy homogenisatio since women have increased their educational level more than men during educational expansion. Second, the processes of diffusion of uptake and regress of (un) healthy practices differ by sex, SEP, region and risk factor(s). Women followed men with some delay in the uptake and regress several originally 'male dominant' risk factors for so-called 'diseases of affluence' (eg, cardiovascular disease, some cancers and injuries).[35] This is well documented for smoking in the literature on the stages of the cigarette epidemic.[36] For obesity, a similar stage model with opposite sex patterns is described in the literature.[37] Over time, both of these risk factors show a reversal of the socioeconomic gradient from higher prevalence in higher SEP groups to higher prevalence in lower SEP groups. But for obesity, women are ahead of men, with initial higher obesity prevalence and earlier increases. In most European countries, low-educated women now experience the highest prevalence of obesity (compared with other groups and past periods), with no signs yet for a decrease. This may add to the mortality associated with initially 'male dominant' risk factors.

CONCLUSIONS

Analyses of changes by birth cohort give a different, and less favourable, picture of trends in educational inequalities in mortality than analyses of changes by calendar period. In many European countries, trends among more recently born generations are worrying. If current trends among younger birth cohorts continue, mortality inequalities are likely to further widen in the future, particularly among women.

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Acknowledgements This study was conducted as part of the Centre for Global Health Inequalities Research (CHAIN), which is funded by the Norwegian Research Council (project number: 288638) and Erasmus Medical Center, Rotterdam, the Netherlands. Data were partly collected as part of the LIFEPATH project, which has received financial support from the European Commission (Horizon 2020 grant number 633666), and the DEMETRIQ project, which received support from the European Commission (grant numbers FP7-CP-FP and 278511). The permission of the Office for National Statistics (ONS) to use the Longitudinal Study is gratefully acknowledged, as is the help provided by staff of the Centre for Longitudinal Study Information & User Support (CeLSIUS). CeLSIUS is supported by the ESRC Census of Population Programme (award reference ES/K000365/1). The authors alone are responsible for the interpretation of the data. This work contains statistical data from ONS, which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets, which might not exactly reproduce National Statistics aggregates. The mortality data for Switzerland were obtained from the Swiss National Cohort, which is based on mortality and census data provided by the Federal Statistical Office and supported by the Swiss National Science Foundation (grant nos. 3347CO-108806, 33CS30_134273 and 33CS30_148415). Pekka T. Martikainen was funded by the Academy of Finland and the MINDMAP project, which received financial support from the European Commission (Horizon 2020 grant number 667661). Mall Leinsalu was supported by the Estonian Research Council (grant PRG722). We acknowledge Bjørn Heine Strand, Carme Borell, Chris White, Eva-Maria Asamer, Gwenn Menvielle, Katalin Kovács, Olle Lundberg, for providing data.

Contributors Material preparation, data were collected by JPM and WJN and were prepared by BHS, CB, CW, E-MA, GC, GM, HB-H, ML, KK, MB, OL, PD, PM and RK. Data analyses were performed by DL. The first draft of the manuscript was written by JPM and revised by DL, WJN and SK. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript. WJN is the guarantor.

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

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