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Trends in educational inequalities in smoking-attributable mortality and their impact on changes in general mortality inequalities: evidence from England and Wales, Finland, and Italy (Turin)

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ABSTRACT

Background Socioeconomic mortality inequalities are persistent in Europe but have been changing over time. Smoking is a known contributor to inequality levels, but knowledge about its impact on time trends in inequalities is sparse.

Methods We studied trends in educational inequalities in smoking-attributable mortality (SAM) and assessed their impact on general mortality inequality trends in England and Wales (E&W), Finland, and Italy (Turin) from 1972 to 2017. We used yearly individually linked all-cause and lung cancer mortality data by educational level and sex for individuals aged 30 and older. SAM was indirectly estimated using the Preston-Glei-Wilmoth method. We calculated the slope index of inequality (SII) and performed segmented regression on SIIs for all-cause, smoking and non-SAM to identify phases in inequality trends. The impact of SAM on all-cause mortality inequality trends was estimated by comparing changes in SII for all-cause with non-SAM.

Results Inequalities in SAM generally declined among males and increased among females, except in Italy. Among males in E&W and Finland, SAM contributed 93% and 76% to declining absolute all-cause mortality inequalities, but this contribution varied over time. Among males in Italy, SAM drove the 1976–1992 increase in all-cause mortality inequalities. Among females in Finland, increasing inequalities in SAM hampered larger declines in mortality inequalities.

Conclusion Our findings demonstrate that differing education-specific SAM trends by country and sex result in different inequality trends, and consequent contributions of SAM on educational mortality inequalities. The following decades of the smoking epidemic could increase educational mortality inequalities among Finnish and Italian women.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Although socioeconomic mortality inequalities persist in current-day Europe, they have been dynamic over time.
⇒ Knowledge about the impact of changing smoking rates among different socioeconomic groups on trends in general mortality inequalities is limited.

WHAT THIS STUDY ADDS

⇒ Declining educational inequalities in smoking-attributable mortality (SAM) have steered overall inequality declines among British and Finnish males.
⇒ Increasing SAM inequalities have slowed down declines in general mortality inequality among Finnish females, and steered the 1976–1992 inequality increase among Italian males.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ SAM inequalities will generally decline and contribute more to declines in general mortality inequality for populations who are more advanced in the smoking epidemic (eg, Finnish and British males).
⇒ Populations with a later start of the smoking epidemic (eg, Finnish and Italian females) warrant research and policy attention, given future increases in SAM that impact general mortality inequalities are likely.

INTRODUCTION

In current-day Europe, all national populations are characterised by inequalities in mortality and longevity, whereby individuals with lower educational attainment, occupational class or income, have higher mortality rates and live, on average, shorter lives.[1]

Although these inequalities have been persistent over decades, their size has varied over time. Multiple-country studies on educational inequalities in mortality in Europe have generally found widening relative, but fairly stable or declining absolute inequalities for their study periods. Mackenbach *et al* thereby studied changes between 1990 and 2010 by 5 year spans for all European countries with data on educational and occupational mortality inequalities, and found the strongest declines in absolute inequalities in Spain, Scotland, England and Wales (E&W), and Italy (Turin); but none in Finland and Norway.[2] de Gelder *et al* focused on long-term trends (ie, 1970–2010 by 5-year spans) for E&W, Finland, France, Hungary, Italy (Turin) and Norway, and found Hungary and Norway were exceptions to generally narrowing absolute inequalities.[3] Recently published research

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on E&W, Finland and Italy (Turin) has gone a step further by using yearly data and observed multiple phases of increasing and decreasing inequalities between 1972 and 2017 for these countries, demonstrating more detailed dynamics of longevity inequalities.[4] The determinants of these trends are, however, not well understood.

Smoking, as the largest preventable mortality risk factor in Europe[5] and with higher occurrence-related mortality among people with a low rather than high socioeconomic status (SES),[6] is a logical culprit. Indeed, research has established that smoking-attributable mortality (SAM) has contributed to the size of the social gradient in all-cause mortality more than any other lifestyle-attributable deaths have in the past 70 years.[7] Nevertheless, the impact of SAM on general mortality inequalities was smaller in the 2000s than the 1990s for men, but not women.[6]

The so-called 'tobacco or smoking epidemic' and its differential timing by country, sex and educational attainment, likely underlies this differing impact of SAM on all-cause mortality inequalities over time and by sex. Smoking is taken up by highly-educated groups first early on in the epidemic (ie, increasing inequality), after which it 'diffuses' throughout the population (ie, declining inequality) and is adopted by the lowest-educated latest. The highest educated group is also the first to abandon smoking while rates among the lower educated may still be on the rise (ie, widening inequality), whereby the abandonment of smoking is then later again followed by the middle and low educated (ie, declining inequality),[8,9] in line with the 'diffusion of innovations' theory.[10] The same epidemic curve is observed three to four decades later for SAM, given the lag times between smoking and related mortality. This process occurs earlier for men than women, and generally also earlier in north-western European countries than in southern and eastern Europe.[11,12]

Importantly, studies that quantify the role of SAM for trends in general mortality inequalities over time are scarce. To our knowledge, only research from the Nordic has indeed looked into the contribution of SAM to changing educational mortality and longevity inequalities, and has found that from 1971–1975 to 2006–2010 in Finland, 1991–2008 in Sweden, and since 1985 in Denmark, increasing life expectancy inequalities among women were almost entirely accounted for by the increasing role of smoking,[13–15] while the most recent Danish research attributes 29% of the increase in mortality rate differences (lowest-highest educational quartile) between 1995 and 2019 to SAM.[16] However, we do not know about the contribution of SAM to long-term trends in all-cause mortality in other European regions due to a lack of recent and yearly cause-specific mortality data by SES.

In order to fill this gap, this paper aims to reveal how SAM contributes to general mortality inequality trends. We analyse educational inequalities in SAM over time and assess how these have contributed to trends in educational inequalities in all-cause mortality between 1972 and 2017 for three European countries at different country-sex-specific stages of the smoking epidemic: E&W (fairly advanced for both sexes), Finland (advanced for men, less so for women) and Italy (Turin) (late for both sexes).

METHODS

Data

We used individually linked all-cause (also 'general') and lung-cancer mortality data by educational level, sex and 5-year age group for individuals aged 30 and older in E&W (Office for National Statistics Longitudinal Study (ONS-LS)), Finland (Statistics Finland) and Italy (Turin Longitudinal Study (TLS)), for single calendar years from 1972 to 2017. Death records were matched at the individual level with information on the educational level of the deceased and the population at risk obtained from population censuses (Finland, Italy) or census subsamples (E&W).

We used educational attainment classified according to the 1997 International Standard Classification of Education (ISCED).[17] The following categories were considered: 'lower' as preprimary, primary and lower secondary education (ISCED 0–2), 'middle' as upper secondary and post-secondary non-tertiary education (ISCED 3–4) and 'higher' as tertiary education (ISCED 5–6), in line with previous studies.[3,18] The data for E&W have been harmonised to enable the use of this three-group educational structure as well as allow for comparability of findings with those for Finland and Italy (Turin).[19] The TLS all-cause and lung cancer data counts and person-years were smoothed with the Rizzi *et al*[20] technique by using the R package 'ungroup'[21] to deal with random fluctuations and zero cell counts.

More information about the data used in this study can be found in https://www.futurelongevitybyeducation.com/background-information/ (Password=VICI_info).

Smoking-attributable mortality

We estimated yearly SAM by educational level, sex and 5-year age groups (30–34, 35–39,…,90–94, 95 and older) for each country using the indirect regression-based Preston-Glei-Wilmoth ('PGW') method,[22,23] in line with former research.[6,13,24] This method relies on age-specific and sex-specific lung cancer death rates as an indicator of damage from smoking. It uses information on lung cancer and all-cause mortality for 21 countries by sex for the 1950–2007 period in a regression model that uses lung cancer mortality to predict mortality from other causes of death.[22] The resulting coefficients are combined with information on expected lung cancer deaths among non-smokers to estimate SAM fractions by sex and age group (SAMF). We used the PGW 2010 book chapter coefficients (based on 21 countries, 1950–2007, ages 50–84),[22] extrapolated to younger ages.[24] These SAMFs were multiplied by their respective all-cause deaths in each year. Dividing these smoking-attributable deaths by population numbers, we obtained SAM rates by age, sex, education level and year for each country.

Analyses

Non-SAM was calculated by subtracting smoking-attributable deaths from all deaths. We age-standardised all-cause, smoking and non-SAM rates using the 2013 European Standard Population for ages 30 and older.[25] Educational inequalities in all-cause, smoking and non-SAM were estimated using the slope index of inequality (SII) by year, country and sex. We calculated the Relative Inequality Index (RII) using the multiplicative Poisson model described by Moreno-Betancur *et al*,[26] whereby deaths are fitted by educational rank, adjusting by 5-year age groups. The SII was deduced from the RII as follows: $SII=2\times SDR\times(RII-1)/(RII+1)$, similar to prior studies and with SDR representing the age-standardised mortality rate in the general population.[3,27] The SII is interpreted as a rate difference between the lowest and highest possible end of the educational spectrum.[28]

We applied segmented regression modelling for all-cause, smoking-attributable and non-SAM using the 'Segmented' package in R, to identify any statistically significant changes in the trends in SII.[29] The change in SII for all-cause mortality was compared with the change in SII for non-SAM to assess the contribution of SAM on trends in educational inequalities in all-cause mortality. We did so between 1972 and 2017, and between additional years for which trend breaks in the SII for all-cause mortality were identified. We used the fitted values from the segmented regression to decrease the impact of outlier values in 1972, 2017 or the years of trend break(s).

RESULTS

Trends in educational inequalities in SAM

Educational inequalities in SAM generally declined for males, except in Italy where they somewhat increased (figure 1). The declines are attributable to sharper decreases in SAM among the lower educated in E&W and Finland. Nevertheless, for males in E&W, this process only became apparent after 1989. The growing educational gap in Italy is caused by earlier and steeper declines in SAM for the higher (early 1980s) and middle educated (late 1980s), than for the lower educated (1990s).

In contrast to our findings for males, educational inequalities in SAM among females have mainly increased (figure 2). For females in E&W, the SII climbed most steeply, but large fluctuation is worth noting and caused by unstable mortality rates among the higher and middle educated. For Finnish females, the SII in SAM increased due to steadily increasing mortality rates among the lower-educated in particular, with levels surpassing those for the middle and higher educated during the late 1980s. Among Italian females, inequalities in SAM remained stable over time and not one particular educational group showed consistently higher mortality rates (figure 2).

The impact of smoking on trends in educational inequalities in all-cause mortality

Online supplemental figure A1 shows standardised all-cause mortality rates by country, sex and education. Figure 3 visualises how SII trends for all-cause mortality and non-SAM have evolved over time, the difference between these two outcomes represents the contribution of smoking. Table 1 goes on to summarise the change in SII for all-cause and non-SAM, as well as the impact of SAM on the all-cause mortality inequality trend and for identified periods.

Overall, all-cause mortality inequalities have declined between 1972 and 2017, although only from 1977 (males) or 1980 (females) onwards for E&W. SAM has strongly influenced these trends for males, but less so for females judging from the steeper declines in the SII in all-cause mortality than in non-SAM for males.

For males in E&W (1977–2017) and Finland (1972–2017), declining inequalities in SAM drove the decline in all-cause mortality inequalities with 93% and 76%, respectively. However, we identified three phases in the all-cause mortality inequality trend for Finnish males: (1) a period of decline (1972–1982); followed by (2) stagnation (1984–1997) and (3) another decline (1997–2017). 74% of the early decline and 35% of the late decline were attributable to SAM, but increases in non-SAM inequality mainly caused the period of all-cause mortality inequality stagnation from 1982 to 1997.

For males in Italy and females in Finland, increasing SAM has negatively contributed to declines in all-cause mortality inequalities. Three phases could be distinguished for Italian males' all-cause mortality inequalities, namely an initial strong decline (1972–1976), followed by an increase (1976–1992), and another decline in all-cause mortality inequalities (1992–2017). Nevertheless, inequalities without SAM have consistently declined at a low pace, pointing to a driving role of SAM for the 1976–1992 increase in all-cause mortality inequalities. Results for Finnish females portrayed only a small gap between mortality inequality trends with and without SAM, hence pointing to a smaller impact of SAM, −20%. Nevertheless, some divergence between the trends is visible as of the mid-1980s, whereby trends in mortality inequalities without SAM declined more steeply between 1976 and 2017 than those with SAM. SAM contributed −58% to the 1976–2017 all-cause SII change, thus hampering a steeper decline in all-cause mortality inequality (table 1).

Among females in E&W (1980–2017) the increasing trends in SAM inequalities did not—as we expected—correspond to stronger declines in inequalities for non-SAM compared with all-cause mortality but instead contributed to the decline in all-cause mortality inequalities (26%). We believe that the steep fluctuations we observed in particularly all-cause and non-SAM SII for this population (figure 3, dots in the upper panel) may have contributed to this observation. The mainly stable and small inequalities in SAM among Italian females resulted in slightly stronger declines in inequalities for non-SAM compared with all-cause mortality (−7%).

DISCUSSION

Summary of results

Our study findings reveal declines in absolute educational inequalities in SAM for males in E&W and Finland, and increases for Italian males and English and Welsh and Finnish females. Declining SAM inequalities have thereby had an important impact on declining educational inequalities in general mortality for males, with a 72% and 76% contribution of smoking for E&W and Finland throughout the study period, respectively. Changes in SAM by educational level furthermore increased mortality inequalities between 1976 and 1992 among Italian males and slowed down larger declines in mortality inequalities among Finnish females.

Interpretation of the main findings

The identified trends in educational inequalities in SAM largely follow known country-specific and sex-specific stages of the smoking epidemic. The populations who have advanced the most in the smoking epidemic (ie, males in E&W and Finland),[30] have also experienced large declines in SAM rates among the lowest educated in particular and, consequently, declining SAM and all-cause mortality inequalities. Populations who are least advanced in the epidemic (ie, women),[30] however, experienced increases in SAM rates that were largest among the lowest educated, with subsequently increasing SAM inequalities. As a group with a smoking epidemic curve in-between these two stages, Italian men's SAM decline has set in mainly among the middle and higher educated.

Our findings suggest that changes in SAM generally contribute more to declining general mortality inequalities for sex-country-specific populations who are in the advanced stages of the smoking epidemic. For example, throughout our study period (early 1970s–2017) smoking rates declined rapidly among Finnish males, from initial levels of over 40%.[31–33] These declines started first among the higher educated before spreading to other groups,[32] as did subsequent mortality (ie, SAM). As a result, absolute inequalities in SAM were initially large but steeply declined afterwards. The same applied to English and Welsh

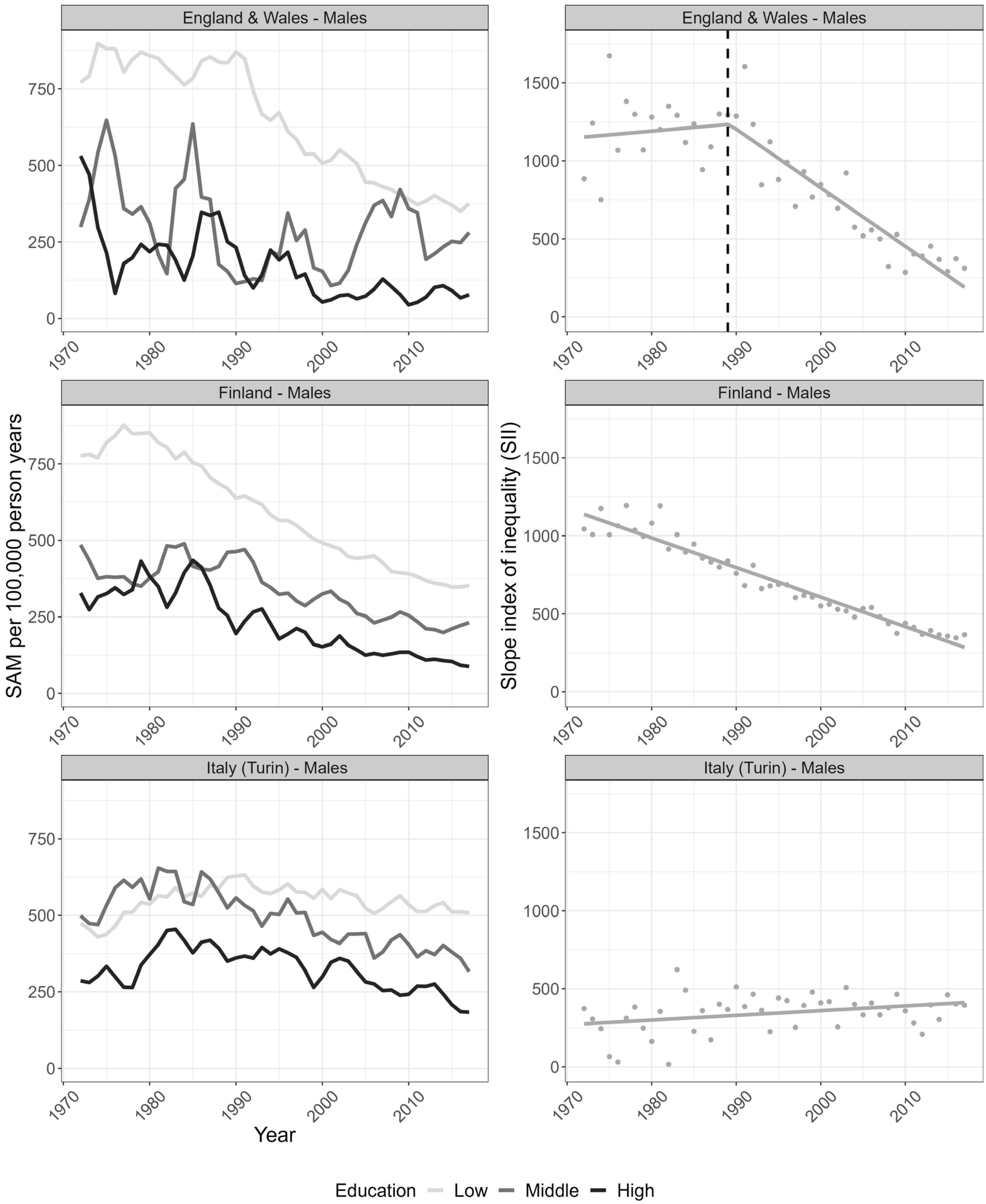

Figure 1 Trends in age-standardised smoking-attributable mortality (SAM) rates* by educational level and observed (dots) and fitted (lines) SII per 100 000 person-years. Males aged 30 and older in England and Wales, Finland, and Italy (Turin), 1972–2017. Dotted vertical lines represent significant trend breaks in all-cause mortality from segmented regression. Data sources: ONS Longitudinal Study/Statistics Finland/Turin Longitudinal Study. *Three-year moving averages.

men.[31–33] In contrast, among Italian men, smoking prevalence rates still increased at the beginning of the study period, to reach peak smoking prevalence levels of over 40% in the 1980s.[33] Peak SAM was observed one decade later, in the 1990s. Subsequent declines in SAM were mostly observed among the higher and middle educated, resulting in an increase in SAM inequalities for Italian men throughout the study period. For women in E&W and Finland, peak smoking prevalence was reached only in the 1990s, up to levels of about 20%–25%.[31–33] SAM continued to increase among the lower-educated until recently (eg, 2010s in Finland), with increasing SAM inequalities throughout the study period. As in a previous Finnish study, we found that SAM

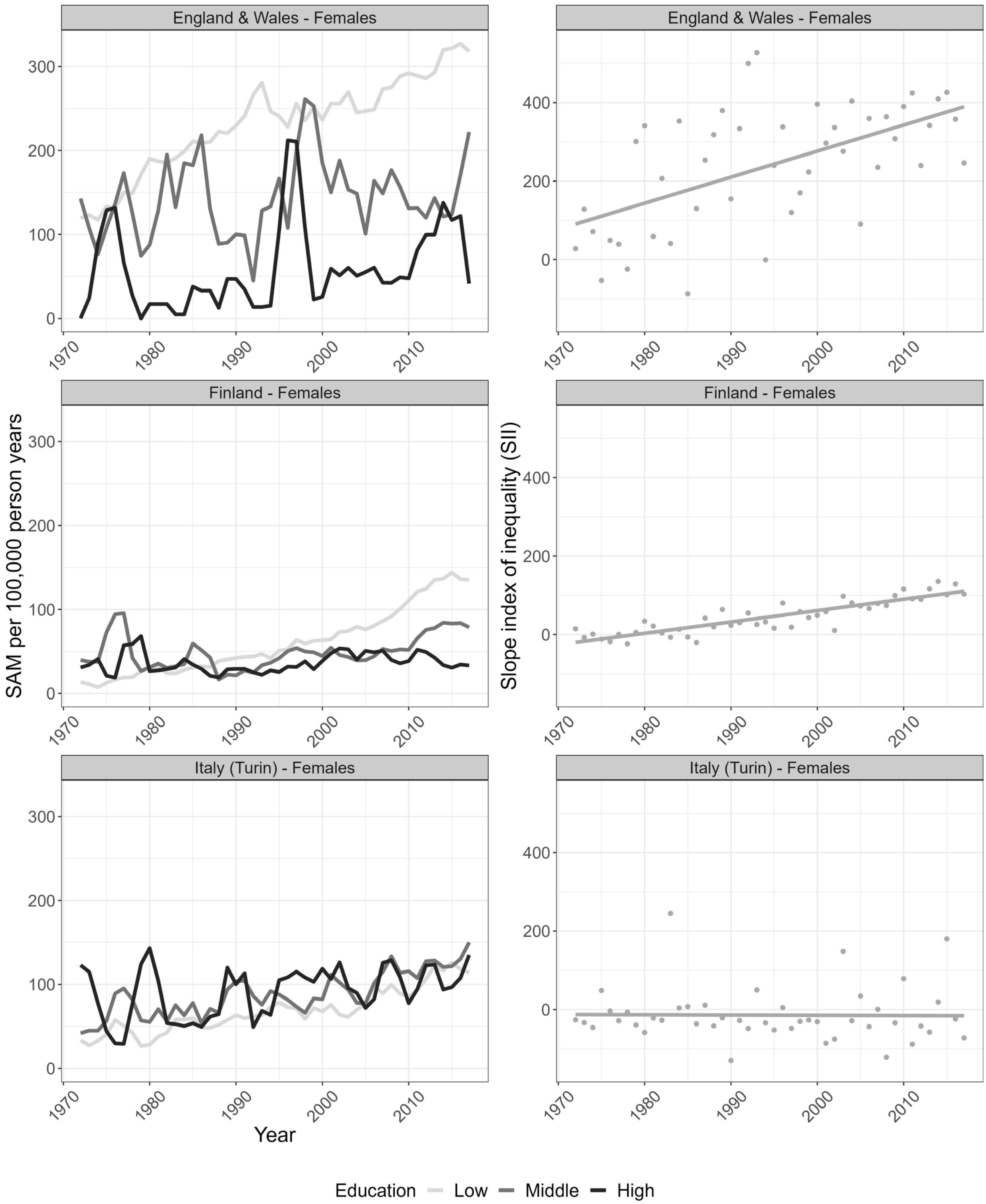

Figure 2 Trend in age-standardised smoking-attributable mortality rates* (SAM) by educational level and observed (dots) and fitted (lines) SII per 100 000 person-years. Females aged 30 and older in England and Wales, Finland, and Italy (Turin), 1972–2017. Data sources: ONS Longitudinal Study/ Statistics Finland/Turin Longitudinal Study. *Three-year moving averages

thereby contributed to widening life expectancy inequalities among females.[24] For Italian women, the group that was least advanced in the smoking epidemic, stagnating smoking rates appear as of the 1990s,[33] with declining smoking prevalence rates being first observable among the younger, higher-educated women.[34] Due to long latency periods between smoking and its related mortality, SAM continuously increased for all education groups throughout our study period. However, SAM inequalities were of limited size for this group, as was their impact on general mortality inequality trends.

We found an important impact of SAM on trends in general mortality, particularly among males. Compared with general mortality inequality trends, those in non-SAM inequalities declined more gradually and were more similar between the study

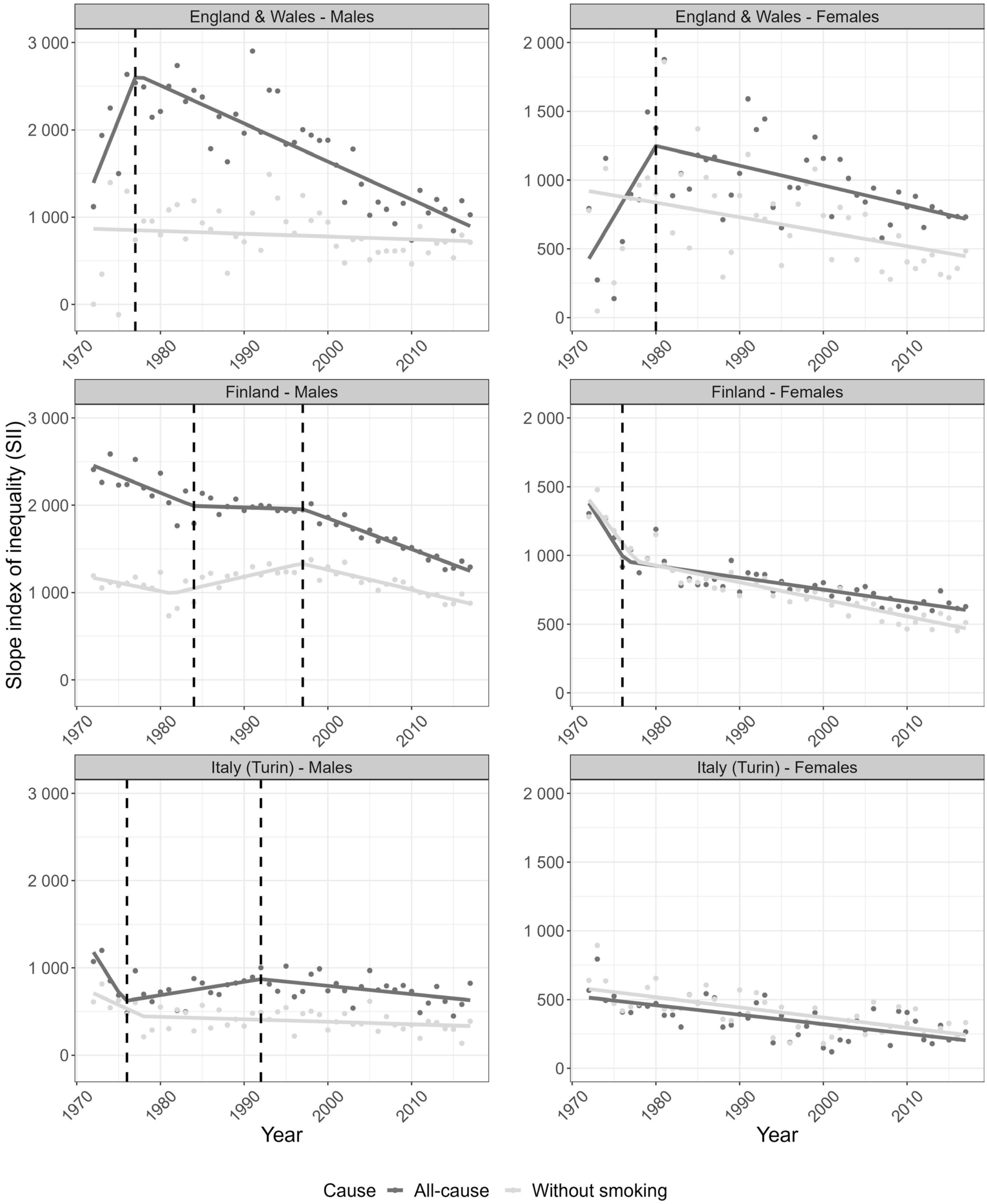

Figure 3 Trend in the SII in all-cause mortality with and without smoking-attributable mortality per 100 000 person-years. Observed (dots) and fitted (lines) values for the population aged 30 and older by sex in England and Wales, Finland, and Italy (Turin), 1972–2017. Dashed vertical lines represent significant trend breaks in the SII in all-cause mortality from the segmented regression. Data sources: ONS Longitudinal Study/Statistics Finland/Turin Longitudinal Study.

populations, with fewer trend breaks. Nevertheless, a number of trend breaks without SAM point to the role of other mortality risk factors for general mortality inequalities during our study period. Prior studies have indeed shown that a combination of behavioural risk factors such as physical inactivity and alcohol consumption, as well as more structural traits at the country level (eg, national income level and changes therein, quality of government, level of social transfers, healthcare expenditure), influence trends in socioeconomic mortality inequalities.[35 36] For Finnish males, research points to alcohol-attributable mortality inequalities as one of the main reasons for the identified phase of stagnating general and increasing non-SAM inequalities

Table 1 Change in the slope index of inequality (SII)* in all-cause mortality with and without smoking-attributable mortality (SAM) per 100 000 person-years, and the contribution of SAM on the changes in all-cause mortality inequalities for the population aged 30 and older by sex in England and Wales, Finland, and Italy (Turin), 1972–2017

	Change in SII per 100 000 person-years*		Contribution of SAM to the change in SII in all-cause mortality	
	All-cause (a)	Without smoking (b)	Absolute (c)†	Relative (%) (d)‡
England and Wales				
Males				
1972–2017	−497.14	−139.80	−357.34	72
Periods				
1972–1977	1206.45	−15.53	1221.98	101
1977–2017	−1703.59	−124.27	−1579.32	93
Females				
1972–2017	290.58	−474.62	765.20	263
Periods				
1972–1980	821.31	−84.41	905.72	110
1980–2017	−530.73	−390.21	−140.52	26
Finland				
Males				
1972–2017	−1206.80	−294.02	−912.78	76
Periods				
1972–1982	−462.45	−119.54	−342.90	74
1982–1997	−38.05	282.41	−320.46	842
1997–2017	−706.31	−456.89	−249.42	35
Females				
1972–2017	−776.88	−934.22	157.34	−20
Periods				
1972–1976	−384.18	−314.18	−70.00	18
1976–2017	−392.70	−620.05	227.34	−58
Italy (Turin)				
Males				
1972–2017	−550.37	−375.51	−174.86	32
Periods				
1972–1976	−555.81	−176.78	−379.03	68
1976–1992	246.48	−128.00	374.48	152
1992–2017	−241.04	−70.73	−170.31	71
Females				
1972–2017	−310.02	−332.90	22.88	-7

Negative numbers in (c) mean that smoking contributed to a decline in all-cause SII, whereas positive numbers in (c) mean that smoking increased it. Negative numbers in (d) mean that the contribution of SAM is opposed to the observed trend in all-cause SII. Numbers higher than 100 in (d) indicate that the direction of the trend in SII without SAM was the opposite of that observed for the SII in all-cause mortality. The findings for English and Welsh females need to be interpreted with caution given large fluctuations in SII for smoking-attributable, all-cause and non-smoking-attributable mortality. Data sources: ONS Longitudinal Study/Statistics Finland/Turin Longitudinal Study.
*Based on fitted values from segmented regression analysis.
†(c)=(a)−(b).
‡(d)=[(a)−(b)/(a)]×100.

among Finnish males from 1984 to 1997, with prior research demonstrating that alcohol consumption played a larger role in increasing life expectancy inequalities by income between the 1980s and 2009.[24] Nevertheless, our observed trend break in non-SAM in 1982 does not correspond well with specific alcohol policy measures in Finland, which were notable in 1995 when availability of alcohol expanded, and in 2004 when quotas on tax-free alcohol import from other European Union-countries were abolished and taxes on alcoholic beverages were lowered.[37] Declining general mortality inequalities among English and Welsh and Finnish females furthermore appear most heavily steered by declines in inequalities in mortality due to ischaemic heart disease identified in prior research.[2] For Italian women, the generally larger accessibility of healthcare services since the 1980s, combined with declines in cardiovascular disease mortality that were more pronounced among the lower educated, may explain the consistent decline in mortality inequalities.[38] For Italian men, the trend break from declining to stagnating inequalities in mortality without smoking in the late 1970s may be related to increasing AIDS mortality tied to drug use among the lower-educated in particular, although, to our knowledge, research evidence on this does not include the period prior to 1984.[39 40]

Methodological considerations

This paper adds to the literature on the contribution of SAM to the trends in general mortality inequalities with yearly data on smoking and non-SAM by educational level until 2017. This study was nevertheless subject to a number of limitations.

First, the Finland data cover the entire countries' registered population while the Italian data are limited to the Turin-area and the E&W data are a 1% representative population sample. The size of the two latter populations and subsequent variation in yearly smoking attributable death counts resulted in irregular SAM and SAM inequality trends. Especially for E&W, we cannot exclude that the data harmonisation—that increased the number of useable data points—has somewhat contributed to the fluctuation in SAM observed for middle-educated men and higher-educated and middle-educated women. Our results whereby SAM SII increased among English and Welsh females, but SAM seemingly contributed to the declining all-cause mortality inequalities, for example, may have been attributable to less robust fitted SII trends for this population. Nevertheless, the TLS is considered to represent mortality and inequalities therein in Italy relatively well,[41–43] and the performed data harmonisation did allow for a first-ever analysis of educational inequalities for E&W using a three-group structure in a multiple-country study, given that the ONS-LS did not contain direct information on educational levels that were comparable over time and with other countries prior to this harmonisation exercise.[44–46]

Second, missing information regarding educational attainment was dealt with differently: in Finland, these data come from postcompulsory educational certificate registries, whereby a lack of information by definition means that a person has benefited from basic education only and could, therefore, be considered lower educated. In the Italian data, however, individuals with missing educational information were removed from the follow-up. In the harmonised data for E&W, missing educational information is completed with data from prior censuses as much as possible, and remaining 'missings' are proportionally redistributed across the lower, middle and higher educated in order to increase population size.[19] If educational attainment information is thereby not missing at random in Italy or E&W, underestimating the size of the higher-educated or lower-educated groups in particular could result in underestimated SII.

Third, our study does not address the specific role that occupation or income has in smoking behaviour and subsequent mortality. Scholars have, for example, suggested that smoking may be more tied to income at late stages of the smoking epidemic in Europe, as this indicator may better capture precarious living circumstances that lead to smoking as a coping behaviour among those in a more disadvantaged position.[47] They indeed found independent effects of both income and education on smoking behaviour in 1998. Smoking behaviour has also been found to be more concentrated in specific occupational groups even after adjustment for education (1992–1993), such as industrial occupations for men, and in cleaning work for women.[48] Nevertheless, using educational level has important methodological advantages, such as its wide availability over time for both sexes and various countries, smaller likelihood to reflect reverse causation (ie, worse health determining lower SES), and it is a better reflection of women's SES than occupational or income variables.[49 50] Education furthermore somewhat serves as a proxy for permanent income and wealth,[51] has a stronger effect on smoking behaviours than other SES components[47 51] and predicts human capital, problem-solving skills, and social ties that are important aids to tobacco avoidance and cessation.[51]

Our estimation method for SAM, the PGW method, was developed to allow for an indirect estimation of SAM relying on lung cancer deaths as an indicator of population exposure to smoking.[23] The PGW method applies a macrolevel statistical association between lung cancer mortality and mortality from all other causes of death across countries and time, using data from 21 countries covering the period 1950 to 2007.[23] The advantage of PGW is that it does not rely on surveys estimates of smoking status at a single point in time or suffer from survey non-response or reporting biases. The method better captures lifetime smoking and exposure to passive smoking. In the Finnish context, PGW estimates are broadly consistent with prior estimates based on the Peto-Lopez method and slightly lower than estimates based on cause-of-death-specific population attributable fractions and estimates of smoking prevalence, thus providing credibility to the model assumptions, coefficients and estimates produced by the PGW-method.[13]

Finally, the SII is calculated from the regression-based RII, whereby the independent socioeconomic rank variable needs to consist of a minimum of three categories. Although a more elaborate educational categorisation may add more precision to the RII estimates, it significantly complicates data curation for multiple-country studies and other scholars performing multiple-country research on mortality inequalities have previously used three-group educational structures as well without raising any concern.[3 27] Country-specific studies may nevertheless choose to adopt a more detailed categorisation for educational attainment. We chose the SII as an inequality measure because it allowed us to demonstrate our results on trends in SAM inequalities and impact thereof on trends in all-cause mortality inequalities in an intuitive manner while still using information about all educational attainment groups. An overview of fitted RII values for the years in which an all-cause SII trend break occurs can be found in online supplemental table A1.

CONCLUSIONS

Our results show that SAM importantly contributed to declines in absolute educational mortality inequalities among men in E&W and Finland, populations well advanced in the smoking epidemic that have experienced large declines in SAM among the lower educated. For populations less advanced in the smoking epidemic (ie, Finnish and Italian women), the future progression of the epidemic and its subsequent mortality could slow down the generally declining trends in overall educational mortality inequalities, unless increasing SAM among the lowest educated can be halted.

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