Changes in mortality inequalities over two decades: register based study of European countries

Johan P Mackenbach,[1] Ivana Kulhánová,[1] Barbara Artnik,[2] Matthias Bopp,[3] Carme Borrell,[4] Tom Clemens,[5] Giuseppe Costa,[6] Chris Dibben,[5] Ramune Kalediene,[7] Olle Lundberg,[8,9] Pekka Martikainen,[10] Gwenn Menvielle,[11] Olof Östergren,[8] Remigijus Prochorskas,[7] Maica Rodríguez-Sanz,[4] Bjørn Heine Strand,[12] Caspar W N Looman,[1] Rianne de Gelder[1]

ABSTRACT

OBJECTIVE
To determine whether government efforts in reducing inequalities in health in European countries have actually made a difference to mortality inequalities by socioeconomic group.

DESIGN
Register based study.

DATA SOURCE
Mortality data by level of education and occupational class in the period 1990-2010, usually collected in a census linked longitudinal study design. We compared changes in mortality between the lowest and highest socioeconomic groups, and calculated their effect on absolute and relative inequalities in mortality (measured as rate differences and rate ratios, respectively).

SETTING
All European countries for which data on socioeconomic inequalities in mortality were available for the approximate period between years 1990 and 2010. These included Finland, Norway, Sweden, Scotland, England and Wales (data applied to both together), France, Switzerland, Spain (Barcelona), Italy (Turin), Slovenia, and Lithuania.

RESULTS
Substantial mortality declines occurred in lower socioeconomic groups in most European countries covered by this study. Relative inequalities in mortality widened almost universally, because percentage declines were usually smaller in lower socioeconomic groups. However, as absolute declines were often smaller in higher socioeconomic groups, absolute inequalities narrowed by up to 35%, particularly among men. Narrowing was partly driven by ischaemic heart disease, smoking related causes, and causes amenable to medical intervention. Progress in reducing absolute inequalities was greatest in Spain (Barcelona), Scotland, England and Wales, and Italy (Turin), and absent in Finland and Norway. More detailed studies preferably using individual level data are necessary to identify the causes of these variations.

CONCLUSIONS
Over the past two decades, trends in inequalities in mortality have been more favourable in most European countries than is commonly assumed. Absolute inequalities have decreased in several countries, probably more as a side effect of population wide behavioural changes and improvements in prevention and treatment, than as an effect of policies explicitly aimed at reducing health inequalities.

WHAT IS ALREADY KNOWN ON THIS TOPIC

A few decades ago, reducing inequalities in health between socioeconomic groups became a priority for health policy makers in many countries

Of studies analysing trends in mortality inequalities since then, most were limited to one country, a few looked at relative and absolute inequalities, and no study has quantitatively compared progress in reducing inequalities between countries

WHAT THIS STUDY ADDS

Since the early 1990s, absolute inequalities in mortality have declined among men in many European countries; relative inequalities in mortality have increased overall; progress in reducing absolute inequalities was largest in Spain (Barcelona), Scotland, England and Wales, and Italy (Turin), but absent in Finland and Norway

Narrowing of absolute inequalities was driven by substantial progress in reducing mortality in lower socioeconomic groups from ischaemic heart disease, smoking related causes, and causes amenable to medical intervention; however, there were substantial setbacks for alcohol related mortality

Recent trends in inequalities in mortality in Europe have been more encouraging than commonly thought, although progress has varied between countries

Introduction

Reducing inequalities in health between socioeconomic groups within a country is one of the greatest challenges for public health, even in the highly developed welfare states of Europe.[1] Recognising this, several countries have set quantitative targets for reducing these inequalities. A target to reduce health inequalities by 25% was introduced by the World Health Organization in 1985, and renewed in 1998.[2] Several European countries—such as England, Finland, and Lithuania—have adopted national targets for the reduction of socioeconomic inequalities in mortality.[3]

Since these targets were set, reports have suggested that inequalities in mortality have widened instead of narrowed, both in countries that have set targets and in many other high income countries (some of which have prioritised health inequalities reduction even in the absence of quantitative targets).[4-6] However, our study of changes between 1990-94 and 2000-4 in a range of European countries suggested that although relative inequalities in mortality (eg, measured as rate ratios) have universally increased, trends in absolute inequalities (eg, measured as rate differences) have not.[7] We now extend this work by including more recent data, and by systematically assessing whether there has been progress, and if so, how much, in reducing relative and absolute inequalities in mortality.

There is no agreement among researchers or policy makers on what measures to use for monitoring progress towards the reduction or elimination of health

inequalities,[8] and different measures reflect different normative standpoints.[9] The approach we take explicitly acknowledges that in a context of declining mortality, where baseline levels of mortality are higher in lower socioeconomic groups than in higher socioeconomic groups, the only way to reduce inequalities in mortality is to achieve stronger reductions in lower socioeconomic groups than in higher socioeconomic groups.[10]

This objective is difficult for declines in mortality as measured on a relative scale (eg, as a percentage of the original mortality rate), because it requires greater reach or greater effectiveness of interventions among lower socioeconomic groups. It is easier, although still challenging, to achieve larger absolute declines in lower socioeconomic groups (eg, measured in number of deaths per 100 000 people), because starting levels of mortality are higher in these groups. We therefore distinguished three possible outcomes:

- Larger absolute and larger relative declines in lower socioeconomic groups, leading to a narrowing of absolute and relative inequalities in mortality.
- Larger absolute but smaller relative declines in lower socioeconomic groups, leading to a narrowing of absolute but widening of relative inequalities in mortality.
- Smaller absolute and smaller relative declines in lower socioeconomic groups, leading to a widening of absolute and relative inequalities in mortality.

While outcome 1 (narrowing of relative and absolute inequalities) will generally be seen as the most desirable, outcome 2 (narrowing of absolute inequalities only) is still valuable, because ultimately it is the absolute excess death rate in lower groups that affects people's lives, not the relative excess of a more and more infrequent event. Even outcome 3 has some value, because a decline of mortality benefits lower socioeconomic groups regardless of whether inequalities increase or not.

Methods
Data
Data came from sources with a population wide coverage in which mortality could be related to indicators of socioeconomic position as reported in a census. Web tables A1 and A2 give an overview of the main characteristics of these data sources. For this analysis, we selected all European countries for which data on socioeconomic inequalities in mortality were available for the approximate period between years 1990 and 2010. Data for Spain and Italy came from regional populations (Barcelona and Turin, respectively). Data for England and Wales were only available together.

Most data stem from a longitudinal mortality follow-up after a census, in which socioeconomic information of the population at risk and of the deceased has been recorded in the census. Spain (Barcelona) had so-called repeated cross sectional data in which socioeconomic information on the population at risk came from repeated censuses, and information on people who had died came from death certificates. Lithuania had cross sectional data for years 1988-90 and 2000-02 and longitudinal data for 2001-05 and 2006-09. Because

Lithuania's cross sectional data have been shown to overestimate inequalities in mortality,[11] we adjusted Lithuania's estimates of inequalities in mortality for 1988-90 downwards. We used the differences between Lithuania's cross sectional data (2000-02) and longitudinal data (2001-05) for observed inequality estimates to calculate the relative overestimation in the cross sectional estimates. We then multiplied Lithuania's cross sectionally observed inequality estimates for 1988-90 by the inverse of this value.

We used two indicators of socioeconomic position: level of education ("low", "mid", and "high" corresponding to the International Standard Classification of Education (ISCED) 1997 categories 0-2, 3-4, 5-6) and occupational class (non-manual, manual, farmers, and self employed, categorised according to the Erikson-Goldthorpe-Portocarero scheme). For England and Wales, the low and mid educated had to be combined because of lack of detail in the 1991 census. The strong decline between 1990-94 and 2005-09 in the proportion of low educated people seen in our data (web table A2) corresponds well with that seen in other data sources. Occupational class was not available for all populations covered by the analysis, and classification of women by occupational class was difficult, so we presented results for men by occupational class in web fig A2 and web tables A6 and A7.

In the analysis we focused on four main groups of causes of death that together accounted for total mortality (cardiovascular disease, cancer, other diseases, external causes) and on specific causes of death for which strong trends in mortality have occurred that are relatively well understood. These causes included: ischaemic heart disease (favourable behaviour changes and advances in prevention and treatment), road traffic injuries (advances in prevention), smoking related causes (favourable behaviour changes partly in response to tobacco control measures),[12] alcohol related causes (unfavourable behaviour changes),[13] and causes amenable to medical intervention (advances in access and quality of care).[14] Web table A3 provides the corresponding ICD (international classification of diseases) code numbers.

Analysis
Mortality rates by educational level and occupational class were directly age standardised using the European Standard Population.[15] All analyses for education were restricted to the age range 35-79 years (web table A1 lists some exceptions), and those for occupation restricted to the age range 35-64 years. Most countries classified person years and deaths by age at death, but Slovenia classified person years and deaths by age at baseline. For Slovenia, an adjustment was applied, which was a further refinement of a procedure developed and validated within the EURO-GBD-SE study.[16]

Data were available per five year period (1990-94, 1995-99, 2000-04, and 2005-09 or similar; for exact periods see web table A1). Changes in mortality by educational group or occupational class were determined by quantifying absolute change (in deaths per 100 000 person years) and percentage change (as compared

with starting levels) between the approximate periods 1990-94 and 2005-09. We studied changes in the magnitude of both relative and absolute inequalities, using the easily interpretable measures of the rate ratio and rate difference. These measures were calculated from the age standardised mortality rates in the lowest and highest socioeconomic group (low v high education as defined above, and manual v non-manual occupation).
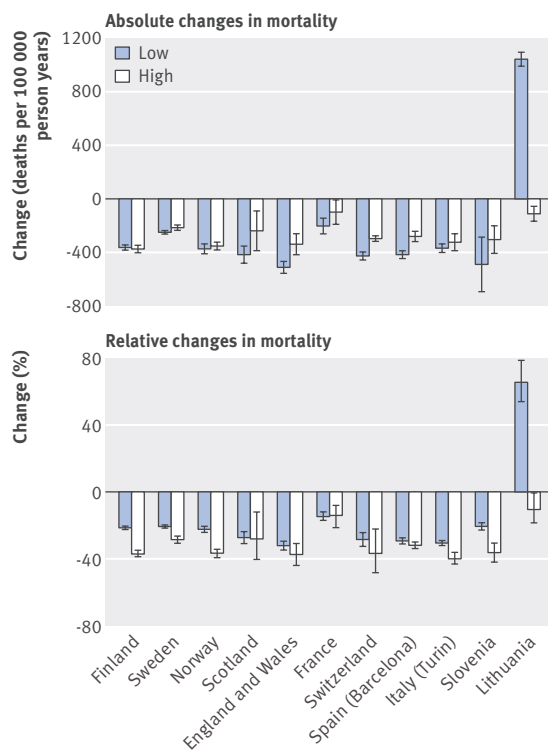
Fig 1 | Absolute and relative changes (95% CI) in all cause mortality among men with low and high education, between years 1990-94 versus 2005-09, by country. All data are age standardised. In England and Wales, the low educated group contained both the low educated (that is, according to ISCED 0-2) and mid educated (ISCED 3-4)
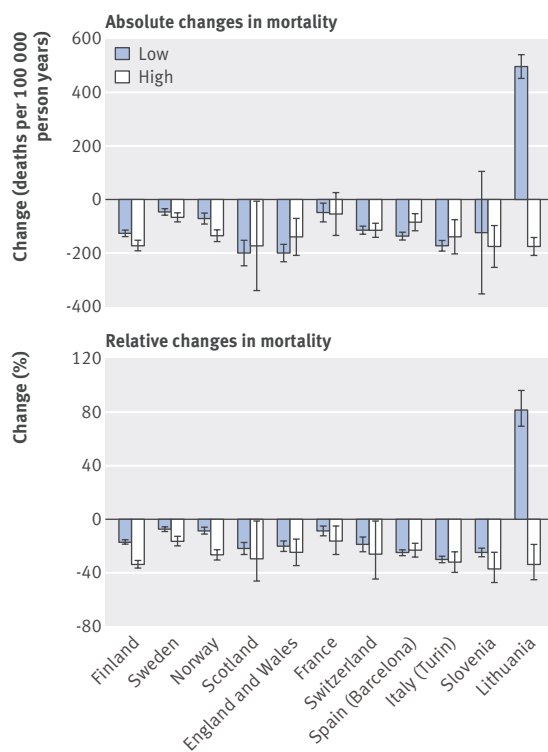
Fig 2 | Absolute and relative changes (95% CI) in all cause mortality among women with low and high education, between years 1990-94 versus 2005-09, by country. All data are age standardised. In England and Wales, the low educated group contained both the low educated (that is, according to ISCED 0-2) and mid educated (ISCED 3-4)

We determined 95% confidence intervals using parametric bootstrapping: for each age standardised rate we first calculated its distribution by drawing, for each age group and in 1000 replicas, numbers from a Poisson distribution with the observed number of deaths as parameter. These replicas of each age standardised rate were then used to calculate replicas of rate ratios and rate differences from which confidence intervals and P values were derived. We plotted countries' changes in rate ratios and rate differences in a two dimensional graph.[17] We also calculated relative indices of inequality and slope indices of inequality by education, but because results were generally in agreement with those on the basis of rate ratios and rate differences, we reported these in web table A6.

Patient involvement
No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for design or implementation of the study. No patients were asked to advise on interpretation or writing up of results. There are no plans to disseminate the results of the research to study participants or the relevant patient community.

Results
Figures 1 and 2 and web fig A1 presents changes in all cause mortality among the low and high educated groups. Apart from Lithuania, the trend in all cause mortality has been clearly downward among both low and high educated. Absolute and relative declines have generally been larger among men than among women, and while relative declines have almost always been larger among the high educated than the low educated, absolute declines were often largest among the low educated, particularly among men.

Tables 1 and 2 show how these changes in mortality have played out in terms of inequalities in mortality. Absolute inequalities in mortality among men fell in Sweden, Scotland, England and Wales, Switzerland, and Spain (Barcelona), but went up in Lithuania (table 1). Changes in absolute inequalities in mortality were less favourable among women (table 2), with increases observed in Finland, Norway and, again, Lithuania. By contrast, relative inequalities in all cause mortality mostly went up, although these increases were not always significant. Similar patterns were found with relative indices of inequality and slope indices of inequality (web table A4).

Figure 3 presents a more comprehensive picture of progress of countries in reducing absolute and relative inequalities in mortality. A country's position in the lower left hand quadrant implies that, owing to larger absolute and relative mortality declines in the lower socioeconomic groups, both absolute and relative inequalities in mortality have decreased over time. This optimal situation was only seen for women in Spain (Barcelona), although the reduction of relative inequalities was not significant (table 1). For men, most countries were in the upper left hand quadrant of fig 3, implying declining absolute inequalities in mortality,

Table 1 | Rate ratios and rate differences of all cause mortality in men, comparing low versus high education group, by country in 1990-04 versus 2005-09

	Absolute inequalities (rate difference (95% CI))			Relative inequalities (rate ratio (95% CI))		
	1990-94	2005-09	Change (P value)	1990-94	2005-09	Change (P value)
Finland	658 (631 to 683)	667 (647 to 686)	0.562	1.66 (1.62 to 1.70)	2.06 (2.02 to 2.11)	<0.001*
Sweden	445 (423 to 466)	412 (398 to 425)	0.010*	1.60 (1.56 to 1.65)	1.78 (1.74 to 1.82)	<0.001*
Norway	711 (676 to 743)	688 (655 to 720)	0.340	1.75 (1.70 to 1.81)	2.15 (2.07 to 2.24)	<0.001*
Scotland	681 (542 to 821)	502 (419 to 580)	0.030*	1.81 (1.56 to 2.15)	1.83 (1.64 to 2.04)	0.902
England and Wales	494 (424 to 566)	317 (261 to 370)	<0.001*	1.55 (1.44 to 1.68)	1.57 (1.44 to 1.71)	0.858
France	677 (593 to 765)	574 (499 to 642)	0.069	2.00 (1.80 to 2.27)	2.00 (1.80 to 2.22)	0.954
Switzerland	688 (663 to 712)	557 (531 to 585)	<0.001*	1.86 (1.82 to 1.90)	2.10 (2.03 to 2.17)	<0.001*
Spain (Barcelona)	552 (513 to 590)	412 (380 to 443)	<0.001*	1.64 (1.58 to 1.71)	1.71 (1.63 to 1.79)	0.235
Italy (Turin)	384 (324 to 439)	340 (293 to 382)	0.242	1.47 (1.38 to 1.58)	1.70 (1.56 to 1.85)	0.01*
Slovenia	814 (623 to 1045)	806 (703 to 1080)	0.086	1.85 (1.57 to 2.15)	2.31 (2.08 to 2.79)	0.009*
Lithuania	569 (521 to 618)	1722 (1667 to 1776)	<0.001*	1.56 (1.49 to 1.63)	2.89 (2.79 to 3.00)	<0.001*

Rate differences compare low educated with high educated, in deaths per 100 000 person years. Rate ratios compare low educated with high educated. In England and Wales, these two measures compared the low and mid educated with the high educated. All data are age standardised.
*Change between 1990-94 and 2005-09 was statistically significant (P<0.05).

Table 2 | Rate ratios and rate differences of all cause mortality in women, comparing low versus high education group, by country in 1990-04 versus 2005-09

	Absolute inequalities (rate difference (95% CI))			Relative inequalities (rate ratio (95% CI))		
	1990-94	2005-09	Change (P value)	1990-94	2005-09	Change (P value)
Finland	231 (213 to 249)	277 (263 to 292)	<0.001*	1.46 (1.41 to 1.50)	1.78 (1.74 to 1.82)	<0.001*
Sweden	248 (232 to 263)	266 (256 to 278)	0.055	1.62 (1.56 to 1.68)	1.80 (1.75 to 1.85)	<0.001*
Norway	328 (304 to 351)	392 (368 to 415)	<0.001*	1.65 (1.57 to 1.72)	2.05 (1.95 to 2.16)	<0.001*
Scotland	335 (173 to 501)	307 (246 to 368)	0.755	1.57 (1.23 to 2.17)	1.75 (1.53 to 2.00)	0.521
England and Wales	254 (189 to 311)	193 (148 to 239)	0.120	1.46 (1.31 to 1.61)	1.46 (1.32 to 1.63)	0.944
France	208 (133 to 277)	214 (164 to 270)	0.885	1.62 (1.32 to 2.02)	1.76 (1.51 to 2.13)	0.548
Switzerland	171 (149 to 193)	170 (150 to 191)	0.984	1.39 (1.33 to 1.47)	1.53 (1.45 to 1.62)	0.015*
Spain (Barcelona)	179 (150 to 208)	127 (106 to 148)	0.005*	1.49 (1.39 to 1.61)	1.45 (1.36 to 1.56)	0.640
Italy (Turin)	141 (80 to 196)	109 (73 to 144)	0.346	1.33 (1.16 to 1.53)	1.37 (1.23 to 1.55)	0.724
Slovenia	248 (189 to 482)	251 (212 to 358)	0.971	1.47 (1.31 to 2.14)	1.76 (1.59 to 2.12)	0.809
Lithuania	93 (60 to 126)	765 (717 to 810)	<0.001*	1.18 (1.11 to 1.26)	3.24 (3.07 to 3.43)	<0.001*

Rate differences compare low educated with high educated, in deaths per 100 000 person years. Rate ratios compare the low educated with the high educated. In England and Wales, these two measures compared the low and mid educated with the high educated. All data are age standardised.
*Change between 1990-94 and 2005-09 was statistically significant (P<0.05).

but increasing relative inequalities in mortality. Large reductions in absolute inequalities, combined with only modest increases in relative inequalities, were seen in England and Wales, Scotland, and Spain (Barcelona). For women, trends were generally less favourable, with substantial increases in both absolute and relative inequalities in Finland and Norway.

Differences between the low and high educated in cause specific mortality change are presented in fig 4 for five specific causes, and in web table A5 for all causes. In Finland, Sweden, Norway, Scotland, and England and Wales, ischaemic heart disease contributed substantially to declining absolute inequalities in mortality, among both men and women. Smoking related causes contributed to declining absolute inequalities in mortality in many countries among men, but only in a few countries among women. Causes of death amenable to medical intervention contributed to decreasing absolute inequalities in mortality in many countries, but serious setbacks occurred for alcohol related mortality in Finland, England and Wales, and Slovenia, with mortality rising more among low educated groups than among high educated groups.

Web fig A2 and web tables A6 and A7 present results for occupational class inequalities in mortality. In general terms, patterns were similar to those seen for educational inequalities. Absolute declines in mortality were larger among men with manual occupations than among men with non-manual occupations in most countries, with absolute inequalities decreasing as a result. However, relative declines were larger among men with non-manual occupations than those with manual occupations, with relative inequalities going up. Country by country, however, we saw some differences between educational and occupational class inequalities, with absolute inequalities in Finland being stable by education, but narrowing by occupational class, and those in Italy (Turin) narrowing for education, but widening by occupational class. Cause specific patterns were also similar.
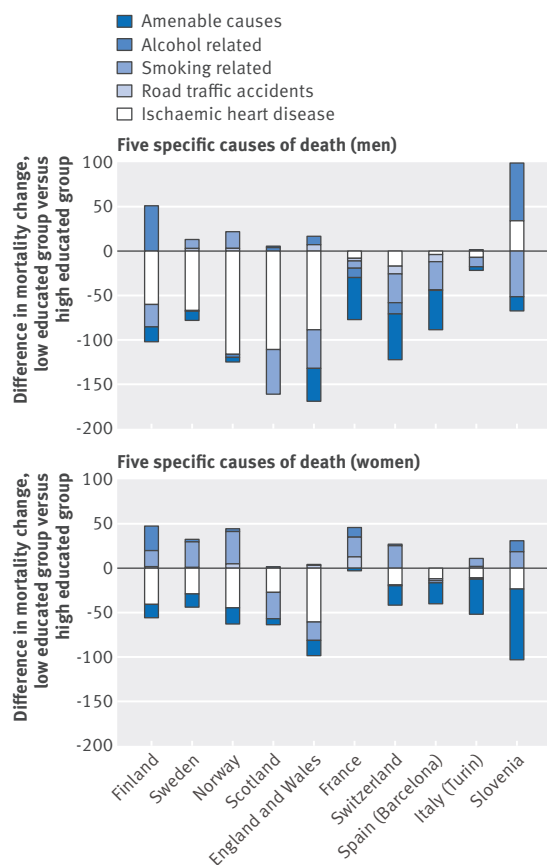
Discussion
Main findings
In this study, we saw substantial reductions in mortality in lower socioeconomic groups in most European countries for which data on socioeconomic inequalities in mortality were available for the approximate period

Progress in reducing mortality inequalities (men)

Progress in reducing mortality inequalities (women)

Fig 3 | Changes in absolute and relative educational inequalities in all cause mortality in (A) men and (B) women, between 1990-94 and 2004-09. Change in absolute inequalities calculated as: $100 \times (RD_{2004-09} - RD_{1990-94}) \div RD_{1990-94}$ (where RD=rate difference). Change in relative inequalities calculated as: $100 \times (RR_{2004-09} - RR_{1990-94}) \div (RR_{2004-09} - 1)$ (where RR=rate ratio). All data are age standardised. Lithuania not included because of the deviant trends

Five specific causes of death (men)

Five specific causes of death (women)
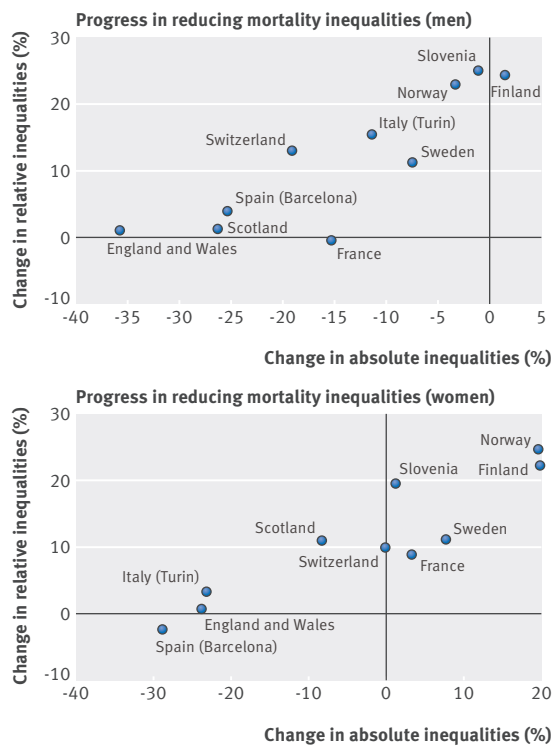
Fig 4 | Differences between the low educated and the high educated in absolute mortality change for (A) men and (B) women, between 1990-94 and 2004-09, by country and for five specific causes of death. Difference in mortality change (in deaths per 100 000 person years) between the low and high educated was calculated as: $(ASMR_{2004-09, low} - ASMR_{1990-04, low}) - (ASMR_{2004-09, high} - ASMR_{1990-04, high})$ (where ASMR=age standardised mortality rate). Road traffic accident data were not available for Scotland and Slovenia

between years 1990 and 2010. Relative inequalities in mortality widened almost universally, because percentage declines were usually smaller in lower socioeconomic groups. However, because absolute declines were often smaller in higher socioeconomic groups, absolute inequalities narrowed by up to 35%, particularly among men. Narrowing of absolute inequalities was mainly driven by ischaemic heart disease, smoking related causes, and causes amenable to medical intervention. Progress in reducing absolute inequalities was greatest in Spain (Barcelona), Scotland, England and Wales, and Italy (Turin), and absent in Finland and Norway.

Strengths and limitations

To our knowledge, this is the most comprehensive analysis of trends in inequalities in mortality ever conducted, covering roughly two decades and at least 10 countries. However, its broad international scope inevitably raises issues of data comparability.

For Spain and Italy, only urban and relatively prosperous populations could be included. Recent national level studies from Spain[18] and Italy,[19] as well as older comparative studies including national level data from these countries,[20] also found relatively small inequalities in Spain and Italy. Thus, there is no reason to think that our study misrepresents the situation in these two countries. Furthermore, because the Lithuanian data did not include deaths between age 70 and 79 years, we probably underestimated absolute inequalities in mortality in this country. The length of time covered by our analysis also differed between countries (web table A1), the longest being in Lithuania and shortest in France. This could have contributed to the relatively poor results seen for France (fig 3).

In England and Wales, the low educated group could not be distinguished from the mid educated group in the 1991 census. Although we had previously shown that this does not bias the comparison between England and Wales and other countries of trends over time,[7] results for England and Wales should be treated with caution. But the fact that changes of absolute inequalities by occupational class (web table A6) were also favourable lends support to our observation on inequalities by education (table 1 and fig 3).

Certification and coding of causes of death vary between countries, and a substantial underestimation of ischaemic heart disease in official mortality statistics had been reported for France.[21] Even if such underestimation does not differ between socioeconomic groups, and does not affect estimates of relative inequalities in mortality, it will affect estimates of absolute inequalities in mortality from ischaemic heart disease.

Another strength of our paper is that we could include both education and occupational class as indicators of socioeconomic position, at least for men. Although the results were broadly similar, and confirmed a tendency for absolute inequalities among men to narrow for both education and occupational class, we did observe some differences between countries. These differences could have been due to problems in classification, particularly for occupational class (eg, exclusion of economically inactive people), but there could have also been substantive explanations (eg, differences between the two indicators in capturing various aspects of socioeconomic position).

Over the two decades of this study, there has been a strong decline in the size of the lower education and occupational class groups. Because a smaller size may imply a more extreme social position—which could in itself lead to a wider gap in mortality—we also studied relative and slope indices of inequality that make adjustments for such changes.[8] Patterns of changes were similar to those reported in this paper, with absolute inequalities in mortality narrowing in many countries among men, and relative inequalities widening almost everywhere, among both men and women. But changes in relative and slope indices of inequality were often more favourable as a result of the decreasing proportion of the low educated groups in all populations (web table A4). Furthermore, results from Finland indicated that trends in mortality inequality by income—for which percentile groups can be used that help to circumvent distributional change—corresponded well with results obtained for education.[22] However, relative and slope indices of inequality do not adjust for changes in composition of lower and higher educated groups—for example, for the fact that lower educated groups are likely to have become more homogeneous with regard to various forms of personal and social disadvantage.[23] These changes made it all the more noteworthy that we mostly found favourable mortality trends among low educated groups.

Finally, our study covered adult ages between 35 and 79 years, implying that the many deaths occurring at higher ages were not included, and neither were deaths at younger ages for which trends and contributing causes might partly be different.[24]

Interpretation

Our results show that, in a context of declining mortality, a narrowing of relative inequalities is very rare, but a narrowing of absolute inequalities in mortality is not. Policy makers are therefore more likely to achieve their quantitative targets if they aim to reduce absolute inequalities. Indeed, over the past few decades, Spain (Barcelona), Scotland, England and Wales, and Italy (Turin) have achieved a 20-35% reduction of absolute inequalities in mortality among both men and women (fig 3). Although the concurrent but modest rise in relative inequalities implies that "closing the gap in a generation"[1] might well be an elusive goal even in these countries, it is a highly valuable achievement. Historical evidence on the reduction of inequalities in mortality from infectious diseases such as tuberculosis also supports the view that what we can hope for is a reduction of absolute, not relative, inequalities in mortality.[25]

How have these reductions been achieved? Several of the countries represented in this study have developed and implemented national programmes to tackle health inequalities during the study period. Foremost among these countries is England, which has, between 1997 and 2010, carried out an ambitious and comprehensive programme to reduce inequalities in health.[26] England has been followed, with some delay, by other countries (Sweden, Norway, and Finland) that have all developed and (partly) implemented national strategies to reduce health inequalities. All the other countries in our study have shown far less commitment to reducing health inequalities.[27] As seen in fig 3, countries with and without national strategies to reduce health inequalities do not systematically differ in their mortality inequality trends. Furthermore, the narrowing of absolute inequalities in England and Wales started long before 1997 (unpublished data), and evaluations of the impact of the English programme to reduce health inequalities have not produced clear evidence for its effectiveness.[28]

Our cause specific results also suggest that the reductions in absolute inequalities in mortality are a by-product of population wide improvements in prevention and treatment. Absolute declines in mortality were almost always larger in lower socioeconomic groups than in higher socioeconomic groups (with absolute inequalities narrowing as a result) for ischaemic heart disease, smoking related causes (men only), and causes amenable to medical intervention. For ischaemic heart disease, these trends must be due to more favourable changes in either proximate determinants of ischaemic heart disease—such as health related behaviours (eg, smoking, diet, and exercise) or healthcare effectiveness (eg, hypertension detection and treatment, thrombolytic therapy), or both—among low educated groups compared with high educated groups. A recent narrowing of absolute inequalities in cardiovascular disease mortality has been reported for both England and Scotland, and has been attributed to an even distribution of treatment benefits rather than to risk factor changes.[29][30] Recent evidence for other countries is missing.

Absolute inequalities in smoking related mortality have also been decreasing among men in many European countries, as we have shown above and report in more detail elsewhere.[31] These reductions reflect long term declines in smoking prevalence, which are probably due to the delayed effects of health education campaigns and other attempts to reduce smoking in the 1980s and 1990s. Although modern tobacco control efforts have done little to reduce inequalities in smoking,[32] it is heartening that reductions in smoking prevalence are finally paying off in smaller inequalities in smoking related mortality among men. One possible explanation for the less favourable trends of mortality inequalities among women is that the mortality impact of smoking, and of smoking related inequalities, is still increasing among women in many countries.[33] The only countries where a downward effect in smoking related causes on inequalities in mortality is already seen among women are Scotland and England and Wales (table 2).

Another encouraging finding is the decline of absolute inequalities in mortality from conditions amenable to medical intervention. It is likely that this decline reflects substantial improvements among lower socioeconomic groups in prevention and treatment of these conditions, which range from infectious diseases to cervical cancer and Hodgkin's disease, and from cerebrovascular disease to perinatal mortality. Previous studies have found large socioeconomic inequalities in mortality from these conditions, and attributed these differences to inequalities

in access or quality of medical care.[34] Our findings suggest either that these inequalities in access or quality of medical care have diminished over time, or that further improvements in medical care have reached all social strata of the population despite continuing inequalities in access or quality. In both cases, it is good news that medical care has contributed to a narrowing of inequalities in mortality in many European countries.

Real setbacks have occurred for alcohol related mortality. Widening inequalities in mortality from alcohol related mortality, as seen in the north and east of Europe, reflect stronger increases in mortality from these conditions in lower socioeconomic groups than in higher socioeconomic groups. Over the past half century, alcohol control has become less strict in some countries in the north or Europe (partly as a result of harmonisation of national laws and regulations following membership of the European Union), but more strict in the south of Europe.[35] This difference in control could have contributed to rising inequalities in the northern but not the southern countries[13] (fig 4). Increased affordability of alcoholic drinks might also have had a role.[36]

Inequalities in mortality in Lithuania have increased substantially during the study period, which has been due to a combination of rising mortality among the low educated and stable mortality among the high educated (figs 1 and 2). It is likely that these unfavourable developments were caused by the economic crisis and the subsequent economic reforms that followed the collapse of the Soviet Union. In the early 1990s, Lithuania experienced large declines in national income and large increases in unemployment rates, more so than other eastern European countries that had not been part of the Soviet Union.[37] Our results point to an important contribution of mortality from smoking related, alcohol related, and amenable conditions to the widening gap in all cause mortality in Lithuania (web table A7). These results suggest that behavioural factors as well as problems in access and quality of medical care have been key in mediating the widening of the gap in mortality.

It is good to see that absolute inequalities in mortality have narrowed in several countries, but how could relative inequalities decrease as well? One suggested approach to reducing health inequalities is proportionate universalism,[38] defined as universal action with a proportionate (or targeted) element tailored to the level of disadvantage or need experienced by middle and lower socioeconomic groups.[39] This approach could reduce inequality across the gradient instead of between top and bottom only. However, whether proportionate universalism will be sufficient to achieve larger reductions in relative mortality in lower socioeconomic groups than in higher socioeconomic groups will depend on how disadvantage or need is measured. Allocating resources proportional to the current levels of morbidity or mortality by socioeconomic group will be insufficient, because outcomes of interventions are usually worse in lower socioeconomic groups.[40] To reverse this, it will be necessary to measure need in more radical terms—that is, doing what is necessary to achieve larger declines in relative mortality in lower socioeconomic groups than in higher socioeconomic groups. This approach would require a much larger redistribution of healthcare and other welfare resources from higher to lower socioeconomic groups than has been realised in even the most advanced European welfare states.

Apart from Lithuania, all European countries in this analysis have had strong mortality declines in lower socioeconomic groups, among both men and women. This result is all the more remarkable as reports from the United States have shown less favourable developments, with increasing mortality rates among lower educated white women, and possibly reduced life expectancy among lower educated white men and women.[41] It also remains to be seen whether the favourable developments seen in Europe will continue during and after the economic crisis starting in 2008, from which the effects cannot yet be discerned in our data.

Conclusions

Trends in inequalities in mortality have been more favourable than commonly assumed. Absolute inequalities have been reduced in several countries, probably more as a side effect of population wide behavioural changes and improvements in prevention and treatment than as an effect of policies explicitly aimed at reducing health inequalities.

AUTHOR AFFILIATIONS

[1]Department of Public Health, Erasmus MC, PO Box 2040, 3000 CA Rotterdam, Netherlands

[2]Department of Public Health, Faculty of Medicine, Ljubljana, Slovenia

[3]Epidemiology, Biostatistics and Prevention Institute, University of Zürich, Switzerland

[4]Agència de Salut Pública de Barcelona, Barcelona, Spain

[5]School of Geosciences, University of Edinburgh, Edinburgh

[6]Department of Clinical Medicine and Biology, University of Turin, Italy

[7]Lithuanian University of Health Sciences, Kaunas, Lithuania

[8]Center for Health Equity Studies, Stockholm, Sweden

[9]Department of Health Sciences, Mid Sweden University, Östersund

[10]Department of Sociology, University of Helsinki, Finland

[11]Sorbonne Universités, INSERM, Institut Pierre Louis d'Épidémiologie et de Santé Publique (IPLESP UMRS 1136), Paris, France

[12]Division of Epidemiology, Norwegian Institute of Public Health, Oslo, Norway

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The lead author (JPM) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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Web appendix: Supplementary material