RESEARCH REPORT

Gender differences in socioeconomic inequality in mortality

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Objectives: There is uncertainty about whether position in a socioeconomic hierarchy confers different mortality risks on men and women. The objective of this study was to conduct a systematic review of gender differences in socioeconomic inequality in risk of death.

Methods: This research systematically reviewed observational cohort studies describing all cause or cause specific mortality for populations aged 25–64 in developed countries. For inclusion in the review, mortality had to be reported stratified by gender and by one or more measures of socioeconomic status. For all eligible studies, five absolute and six relative measures of the socioeconomic inequality in mortality were computed for male and female populations separately.

Results: A total of 136 published papers were reviewed for eligibility, with 58 studies deemed eligible for inclusion. Of these eligible studies, 20 papers published data that permitted the computation of both absolute and relative measures of inequality. Absolute measures of socioeconomic mortality inequality for men and women generally agreed, with about 90% of studies indicating that male mortality was more unequal than female mortality across socioeconomic groups. In contrast, the pattern of relative inequality results across the 20 studies suggested that male and female socioeconomic inequality in mortality was equivalent.

Conclusions: Inferences about gender differences in socioeconomic inequality in mortality are sensitive to the choice of inequality measure. Wider understanding of this methodological issue would improve the clarity of the reporting and synthesis of evidence on the magnitude of health inequalities in populations.

This review takes as its starting point the apparent empirical regularity of a greater inequality in male mortality over socioeconomic groups relative to female mortality in the developed economies.[1–3] Before considering the relevant causal mechanisms for this apparent regularity, the fundamental issue of measurement artefact needs to be ruled out as a possible explanation. Error may arise in the measurement of socioeconomic status among men and women. There is a long tradition of concern in population health studies that the position in a social or economic hierarchy is measured with less precision among women than among men.[2 4 5] In addition, conclusions concerning the presence of gender differences in inequality may depend upon the choice of the summary of measure of inequality applied in the study. This last issue is the subject of this review.

Five groups have provided critical reviews of measures of inequality in population health studies, with the most recent contributions from Anand[6] and Etches.[7] Previously, Mackenbach *et al* identified 12 types of summary measures of inequality, and empirically compared the performance of these measures in summarising the distribution of health in relation to social hierarchy (mortality in Finland in relation to occupational class and self reported morbidity by educational level in the Netherlands).[8] The authors concluded that an optimal or ideal inequality measure could not be determined, and that it was advisable to apply different measures. Manor *et al* compared the performance of three measures of inequality in relation to two measures of social hierarchy (class at birth and educational qualifications) and concluded that inferences did not differ substantially using the three measures of inequality.[9] Wagstaff *et al* reviewed the properties of inequality measures in the measurement of health differences and gave an emphatic recommendation to measures from the class of slope or concentration curve indices.[10]

While gender specific mortality rates or mortality ratios stratified by socioeconomic status are frequently reported in demographic or epidemiological studies of developed country populations, we were unable to identify a review that systematically evaluated these studies to address the question of whether position in the socioeconomic hierarchy conferred different mortality risks for men and women. To address this deficiency, we undertook a systematic review of cohort studies in developed economy populations aged 25–64 that described all cause or cause specific mortality separately for men and women by one or more measures of socioeconomic status.

METHODS

To establish the sample for this review, we systematically searched the published literature for observational cohort studies describing all cause or cause specific mortality for populations aged 25–64 in developed economy countries published in the period 1970 to 2000. The search strategy applied a formal search of three concepts: mortality, gender and socioeconomic status. Formal MeSH terms were applied (mortality, sex, social class, socieconomic factors) as well as relevant variant keywords, such as ''gender'' as a substitute for the MeSh term ''sex''. Keyword indexing, titles, and abstracts were searched in a range of electronic databases, with most of the published studies located in Medline, Healthstar (now consolidated in PubMed) and Ageline. Hand searches of bibliographies identified in relevant published work were also conducted.

Of the 136 potentially eligible studies identified in the search of published work, abstracts or the complete report were then reviewed by two reviewers for confirmation that the information in the published study reported mortality stratified both by gender and by one or more measures of socioeconomic status. After this screening, 58 studies were retained as potentially eligible for inclusion. The final

inclusion criteria required that the data reported in the study supported the computation of both an absolute and a relative measure of inequality for at least one of the six classes of candidate inequality measures of interest in this study. In cases where the two reviewers' differed in their judgment of the eligibility of the study, a third reviewer (CM) participated in the review.

After this final evaluation, a total of 20 studies were deemed eligible for inclusion in the study. A number of research studies that directly focused on the question of interest in this review were deemed ineligible because the reported data in the published study did not support the computation of both absolute and relative inequality measures (see, for example, various studies[1 2 11–22]).

Inequality measures

The six classes of inequality measures used in this review have been critically evaluated in a number of previous reviews.[6–10] Each of the six classes of inequality measures have an absolute form and a relative form, with the exception of Agresti's α, which measures inequality only in a relative form. In absolute measures of inequality, the magnitude of mortality differences between comparison groups is retained in the computation of the measure. In the case of relative measures, information on the magnitude of mortality differences is not retained in the computation of the measure. Relative measures express the dispersion across socioeconomic strata as a proportion of the mean or value for a particular group. Relative and absolute measures can disagree as to which group has more or less inequality. This property is illustrated in the following simple example. Suppose men and women are classified into two groups; high socioeconomic status and low socioeconomic status. For men in the high socioeconomic status group, the mortality rate is 2/1000 person years, and for men in the low socioeconomic group, the mortality rate is 4/1000 years. For women, the comparable values are 1/1000 and 2/1000. On the basis of a simple rate difference (an absolute measure), the inequality observed for men (2/1000 person years) is twice that observed for women (1/1000 person years). However, if estimated using a relative inequality measure, the rate ratio, the observed inequality for men (4/1000 divided by 2/1000) is identical to the rate ratio for women (2/1000 divided by 1/1000).

In addition, there are important normative assumptions involved in choosing between these two forms, which we return to in the discussion. The measures are distinguished by a number of characteristics, as outlined in table 1.

For the 20 eligible studies, the five absolute and six relative measures of the socioeconomic inequality in mortality were computed for male and female populations separately. The one exception to this statement is the study by Pamuk,[23] for which only the slope index of inequality was reported. We chose to include this study because the authors reported both absolute and relative forms of this inequality measure. A number of studies reported results for different age groups,[24–29] for different countries[30] and for different time periods.[31–33] In these cases, inequality measures were computed for each relevant gender comparison, resulting in some studies contributing more than one series of 11 inequality measures (five absolute measures and six relative measures) (see table 2). In addition, seven studies reported gender specific mortality relative to more than one measure of socioeconomic status.[24 25 36–38 41 42]

Statistical analysis

Formal statistical inference tests that are appropriate to meta-analysis were not conducted in this review. The appropriate test in this review would apply a test of common dose-response across the ordinal structure of the independent variable, socioeconomic status.[43] In our opinion, the measures of socioeconomic status used across the range of studies in this sample is too heterogeneous in conception and measurement to be incorporated in a formal meta-analytic hypothesis test. The results reported in this review are provided within a qualitative appraisal framework.

RESULTS

Of the 20 studies eligible for inclusion in this review, Denmark[30] and Norway[30] were each represented in a single study, the United Kingdom was represented in four studies,[23 30 32 36] and the United States,[24 27 28 31 38 41] Finland,[26 30 33 35 37 40] and Sweden[25 29 30 34 39 42] were each represented in six studies.

There were a wide range of measures of socioeconomic status reported in the eligible studies. Occupation was the most frequently reported measure, followed by education, a composite measure of social position, and household income.

Table 1 Measures of inequality, classified by absolute or relative form

Measure	Absolute/relative	Bi/univariate	Health measure	SES measure	Type of inequality measure*	Detects reverse gradients	Detects group size
Rate difference	a	b	rates	extreme groups	e	y	n
Rate ratio	r	b	rates	extreme groups	e	y	n
Population attributable risk	a	b	rates	dichotomous	s	y	n
Population attributable risk	r	b	rates	dichotomous	s	y	n
Index of dissimilarity	a	b	usually cases/deaths	nominal	h	n	y
Index of dissimilarity	r	b	usually cases/deaths	nominal	h	n	y
Slope index of inequality	a	b	rates	ordinal	i	y	y
Slope index of inequality	r	b	rates	ordinal	i	y	y
Concentration index	a	b	Ratio scale measure	ordinal	i	y	y
Concentration index	r	b	Ratio scale measure	ordinal	i	y	y
Agresti's α	r	b	Ordinal scale measure	ordinal	i	y	y

*Type of inequality measure: (e) effect, (s) shortfall, (h) heterogeneity, (i) inequality. For detailed description of measures see various references.[6–10]

Table 2 Inequality calculations per study

Author(s)	Year	Ref no	Absolute inequality measures						Relative inequality measures							Stratification resulting in multiple entries	Mortality
			PAR	RD/RR	Slope	ID	CIg	Total	PAR	RD/RR	Slope	ID	Agresti	CI	Total		
Anderson *et al*	1997	24	6	10	6	6	6	34	6	10	6	6	6	6	40	Age, race, SES	All cause
Luoto *et al*	1998	33	1	1	1	1	1	5	1	1	1	1	1	1	6		CVD
Sundquist and Johansson	1997	25	3	3	1	3	3	13	3	3	1	3	3	3	16	Age, SES	All cause
Hemstrom	1996	34	1	1	1	1	1	5	1	1	1	1	1	1	6		All cause
Koskenvuo *et al*	1980	26	2	2	2	2	2	10	2	2	2	2	2	2	12	Age	IHD
Koskenvuo *et al*	1979	35	3	3	3	3	3	15	3	3	3	3	3	3	18	Farmers	All cause
Backlund *et al*	1996	27	3	3	3	3	3	15	3	3	3	3	3	3	18	Age	All cause
Morris *et al*	1996	36	2	2	2	2	2	10	2	2	2	2	2	2	12	SES	All cause
Wing *et al*	1987	31	5	5	5	5	5	25	5	5	5	5	5	5	30	Time periods	IHD
Valkonen	1989	30	6	6	6	6	6	30	6	6	6	6	6	6	36	Country	All cause
Martelin	1994	37	5	5	5	5	5	25	5	5	5	5	5	5	30	SES	All cause
Mcloone and Boddy	1994	32	2	2	2	2	2	10	2	2	2	2	2	2	12	Time periods	All cause
Gregorio *et al*	1997	38	4	4	4	4	4	20	4	4	4	4	4	4	24	SES	All cause
Smith *et al*	1997	28	3	3	3	3	3	15	3	3	3	3	3	3	18	Age	All cause
Hemstrom	1999	39	1	1	1	1	1	5	1	1	1	1	1	1	6		All cause
Pekkanen	1995	40	6	6	6	6	6	30	6	6	6	6	6	6	36	Occupation	All cause
Otterblad *et al*	1991	29	2	2	2	2	2	10	2	2	2	2	2	2	12	Age	All cause
Backlund *et al*	1999	41	2	2	2	2	2	10	2	2	2	2	2	2	12	SES	All cause
Vagero and Lundberg	1995	42	3	3	3	3	3	15	3	3	3	3	3	3	18	SES	All cause
Pamuk	1985	23	0	0	4	0	0	4	0	0	4	0	0	0	0	Time periods	All cause
Total			60	64	62	60	60	306	60	64	62	60	60	60	362		

With the exception of the study by Pamuk,[23] all studies contributed a minimum of 11 inequality measures (five absolute and six relative measures). Studies that reported results stratified by age, country, time periods, or alternate measures of socioeconomic status contributed more than one series of the 11 inequality measures. PAR, population attributable risk; RD/RR, risk difference, risk ratio; slope, slope index of inequality; ID, index of dissimilarity; CIg, CI, concentration index; Agresti, Agresti's α.

Table 3 Proportion of comparisons where men experience more inequality than women

Inequality measure Measure	Absolute			Relative		
	Denominator form			Denominator form		
	PY	persons	combined	PY*	persons	combined
RD/RR	0.95	1.00	0.97	0.70	0.67	0.69
PAR	0.94	0.96	0.95	0.55	0.52	0.53
ID	0.97	1.00	0.98	0.52	0.48	0.50
Slope	0.91	0.86	0.89	0.58	0.40	0.50
CI	0.91	0.96	0.93	0.61	0.44	0.53
Agresti	NA	NA	NA	0.55	0.44	0.50

PY, person years; RD/RR, risk difference, risk ratio; PAR, population attributable risk; ID, index of dissimilarity; slope, slope index of inequality; CI, concentration index; Agresti, Agresti's α.

No single socioeconomic status measure was represented in all studies in this review.

As described in table 3, there was both consistency and contradiction in the findings across the 20 studies in the comparison of male and female inequality. Across the five classes of absolute measures, men were found to have greater socioeconomic inequality in mortality than women. This result obtained whether the comparison was based on person years or person denominators. However, the results from the comparison of relative measures of inequality generally contradicted the findings of the comparison of absolute measures of inequality. In the case of most classes of relative inequality, the socioeconomic inequality in male and female mortality was virtually identical. The one exception to this general statement was comparisons of male and female inequality estimated from the rate ratio comparison.

These contrasting findings between the absolute and relative measures are displayed in table 4, which reports the mean inequality estimates for men and for women, stratified by the class of inequality measure. For example, the mean rate difference between the highest and lowest socioeconomic groups is 609 per 100 000 person years for men and 234 for women, while the mean rate ratios for person year data show a lesser gender difference at 1.77 and 1.59 respectively. The mean absolute PAR is 311 per 100 000 person years for men and 128 for women, again showing a more than twofold greater inequality among men, while the relative version of the PAR gives more equal seeming values of 0.25 and 0.21 respectively. The strong dominance of male inequality in the mean inequality estimates derived from absolute measures is not present in the mean inequality estimates based on relative measures.

The consistency of these results in relation to the measure of socioeconomic status used in the study is reported in table 5. In the case of the absolute measures, the finding of a dominance of male inequality over female inequality is found across all measures of socioeconomic status. In the case of the relative inequality measures, the results are more uneven. There is little important difference in inequality estimates based on individual measures of socioeconomic status and household or neighbourhood measures.

DISCUSSION

In this systematic review of mortality in the developed economies, about 90% of studies reported that male mortality was more unequal over socioeconomic groups than female mortality when evaluated by absolute measures of inequality. In contrast, male and female socioeconomic mortality inequalities were shown to be essentially identical when evaluated by relative measures of inequality.

Understanding the methodological basis for the very different conclusions to be drawn from a comparison of male and female socioeconomic mortality inequality based on absolute or on relative measures may well resolve a long-standing confusion in the literature. While a systematic review of socioeconomic mortality differences by gender has not been previously conducted, many authors have noted a prevailing view in the literature that the socioeconomic gradient in mortality is weaker in women.[2 3] This view seems to be an accurate appraisal based on absolute measures of inequality. However, this view is contradicted by the pattern of findings based on relative measures of inequality. Inferences about health inequalities between groups are sensitive to the choice of inequality measure.

A key implication of these distinct conclusions is to focus attention on the determinants of the persistent and substantial difference in life expectancy between men and women that underlie the gender differences in inequality

Table 4 Mean inequality estimates, stratified by class of inequality measure and gender (equal weighting of observations)

Inequality measure	Absolute*				Relative			
	person years		persons		person years		persons	
	Men	Women	Men	Women	Men	Women	Men	Women
Rate difference/ratio†	609	234	35	17	1.77	1.59	1.83	1.77
Population attributable risk‡	311	128	15	7	0.25	0.21	0.23	0.21
Index of dissimilarity§	96.8	41.7	5.01	2.87	0.0766	0.0749	0.078	0.0835
Slope index of inequality¶	−829	−345	−54.2	−41.6	−0.64	−0.62	−2.36	−3.67
Concentration indices**	−0.00109	−0.00046	−0.00613	−0.00332	−0.086	−0.083	−0.091	−0.096
Agresti's α††	NA	NA	NA	NA	1.36	1.35	1.37	1.408

*Units of measurement for absolute measures are deaths per 100 000 (person years) and deaths per 10 000 (persons). †Absolute, the difference between the rates for the least and most advantaged socioeconomic groups; relative, the ratio of these rates. ‡Absolute, the decrease in the population rate that would occur if all groups had the rate of the most advantaged socioeconomic group; relative, this decrease as a proportion of the population rate. §Absolute, the number of deaths that must be ''redistributed'' to achieve equality; relative, this value as a proportion of the total number of deaths. ¶Absolute, the difference between the predicted rates for the most and least advantaged persons based on a weighted regression of socioeconomic group rates on socioeconomic status; relative, this difference as a proportion of the population rate. **Absolute, twice the area between the generalised concentration curve of health and socioeconomic status and the line of equality; relative, this value as a proportion of the population rate. ††Relative, an odds ratio generalised to ordinal data.

Table 5 Proportion of comparisons where men experience more inequality than women, stratified by measure of socioeconomic status and absolute compared with relative inequality measures

	Absolute	N*	Relative	N*
Individual measures				
Education	0.90	40	0.70	50
Occupation	0.93	88	0.42	110
Income	0.88	16	0.70	20
Health status	1.00	3	0.00	4
Social position	0.89	28	0.13	30
Poverty	1.00	12	0.67	15
Total	**0.92**	**187**	**0.48**	**229**
Household or neighbourhood measures				
Housing tenure	1.00	3	0.00	4
Household income	1.00	16	0.05	20
Housing condition	1.00	4	1.00	5
Standard of equipment	1.00	4	1.00	5
Area deprivation	1.00	12	1.00	15
Area income	1.00	12	0.87	15
Area school performance	1.00	4	1.00	5
Total	**1.00**	**55**	**0.64**	**69**

*N represents the number of male/female comparison pairs in the socioeconomic strata. The count of relative measures exceeds the count of absolute measures because of the addition of Agresti's α in the relative inequality measures group.

portrayed by absolute measures. An understanding of the greater absolute socioeconomic mortality risk experienced by men will be informed by an understanding of the causes of higher male mortality. The causes of death with the greatest socioeconomic inequalities tend to be more common in men (for example, cardiovascular disease and accidents and violence) and conversely, causes of death that dominate female mortality tend to have shallower socioeconomic inequalities (for example, neoplasms).[1 44] Koskinen found that an analysis adjusting for gender differences in cause of death eliminated the pattern of a steeper male socioeconomic mortality gradient, estimated using the absolute measure of the index of dissimilarity.[1]

The finding of an equivalent relative mortality differential for men and women in relation to position in the socioeconomic hierarchy suggests that the pathways by which socioeconomic status influences the distribution of experiences and exposures with adverse effects on health are broadly equivalent for men and women. These pathways, acting through material conditions, psychological environments, and health behaviours, seem to have similar relative impacts (in aggregate) on male and female mortality risks.

At the same time, there has been a relative lack of research attention paid to examining gender differences in the pathways that produce socioeconomic mortality gradients. Male and female differences in labour market experiences have been considered as one potential explanation. For example, Waldron has suggested that perhaps 5%–10% of the excess male mortality rate in the United States can be attributed to greater male exposure to risk of work accidents and chemical or physical occupation hazards as a result of the sex distribution of occupations held.[45] Based on analyses of mortality in the French labour force, Vallin has offered a similar conclusion that differences between men and women in the rate of labour force participation has no important effect on the male/female mortality ratio.[44]

In addition to the potential role of material conditions and labour market experiences in contributing to the higher rates of male mortality, gender differences in psychosocial experiences may deserve attention. While there is a well established research tradition examining the role of social relationship in buffering a person's psychological and physiological response to external demand and challenge, the evidence for gender differences in the relation between psychosocial resources and risk of mortality is inconsistent. The Alameda County study found equivalently increased risks of death for men and women with low social interaction scores.[46] This finding of an equivalent risk for both men and women has been reported from other studies.[47 48] However, a number of other studies have reported higher mortality risks for men with low social support resources relative to women who report similar degrees of social isolation.[25 49 50] Further work on gender differences in the distribution of psychosocial resources over the life course and on the relation between psychosocial conditions and neuroendocrine function promises to enhance understanding of the potential for psychosocial environments to exert different influences on the health of men and women.[51 52]

Health behaviours, especially cigarette use and excess alcohol consumption, have been shown to account for a meaningful share of excess male mortality. For example, higher male cigarette use in North America over the period 1940–80 has been estimated to be responsible for about one half of the sex difference in total mortality, ranging from about two thirds of the sex mortality differential at age 40 to about one quarter of the differential at age 80.[45] Further insight into the impact of gender differences in alcohol consumption on male and female socioeconomic mortality gradients has been provided by a Finnish study.[53] In this work, mortality data have been used to classify deaths by cause, with an emphasis on identifying alcohol related deaths and occupational information on the death record has been used to compare the proportion of alcohol related deaths across the occupational hierarchy. Compared with men in the highest non-manual occupations, an estimated 9% of the excess mortality among men in lower non-manual occupations and 14% of excess deaths among men in manual occupations were attributed to alcohol related mortality. In contrast, the respective proportions for women were 3% and 4%. Removing the contribution of alcohol related mortality to the male socioeconomic mortality gradient does reduce, but does not eliminate the sex differential in socioeconomic mortality gradients.

WHICH MEASURE IS BEST?

This review has offered a comparison of the performance of six classes of inequality measures. The different characteristics of these measures have potential importance for their

performance in measuring inequality. All six classes of inequality measures have the capacity to detect the direction of a socioeconomic gradient with the exception of classes of measures based on the index of dissimilarity (ID). Use of the ID measure, while attractive for the property of incorporating the size of population strata in the calculation of group inequality, is vulnerable to this indifference to the direction of the socioeconomic gradient. Four of the six classes of measures incorporate information on the size of population strata. The potential shortcomings of the two classes of measures that do not incorporate the size of population strata (PAR and rate or ratio difference measures) should be recognised.

Consistent with recommendations provided earlier by Pamuk[23] and by Wagstaff,[10] we find two classes of measures to have optimal measurement properties for the description and comparison of health inequalities in populations. Slope measures of inequality and concentration index measures of inequality share the following optimal properties: (1) they can be computed on both an absolute and relative basis (which we generally recommend as an ideal practice), (2) they can make use of the full information available from an ordinal level measures of socioeconomic status, which respects the conceptual premise of the construction of social hierarchies in the developed economies, (3) they incorporate differences in the size of populations across the socio-economic strata, and (4) they can detect reverse gradients.

AN EMPHASIS ON RELATIVE OR ABSOLUTE MEASURES OF INEQUALITY?

There are very important but often unrecognised normative assumptions made when in the choice of reporting an absolute or a relative measure of inequality. As illustrated in this review, an absolute measure of inequality incorporates information on differences in the observed death rate between the groups compared in the study. For example, if the age adjusted mortality rate for men in a given country is twice that of women and the ratio of mortality rates between the top and bottom income quintiles is identical for men and women, the summary measure of inequality, applying an absolute measure, will be greater for men than for women. Using the same empirical example, the summary measure of inequality, applying a relative measure, would report approximately identical inequality measures for men and for women.

This fundamental difference between the families of relative and absolute measures of inequality is not well understood in the research and policy research literature. Absolute measures of inequality are based on direct measures of health, such as the rate of death per 1000 population. Relative measures of inequality are dimensionless, calculated as the value of the absolute measure of health divided by the mean value of health for a reference group. This means that whereas all deaths are of equal value for comparisons based on absolute measures, they are valued as a function of the health of the reference group when a relative measure is used. In the work reported in this paper, male deaths are assumed to be less significant when estimated using relative inequality measures because they are more common than female deaths. Absolute measures may therefore be more appropriate for policy purposes, where the population impact of health policy investments may be the principal objective. Relative measures, on the other hand, may be more appropriate to objectives that seek to understand aetiology and the mechanism of interventions.

In conclusion, this review may contribute to resolving uncertainty about whether position in a socioeconomic hierarchy confers different mortality risks on men and women. The findings of this review indicate that inferences about health inequalities between groups or across time are sensitive to the choice of the inequality measure. Wider understanding of this methodological issue would improve the clarity of the reporting and synthesis of evidence on the magnitude of health inequalities in populations.

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