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Socioeconomic differences in alcohol-attributable mortality compared with all-cause mortality: a systematic review and meta-analysis

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Abstract

Background: Factors underlying socioeconomic inequalities in mortality are not well understood. This study contributes to our understanding of potential pathways to result in socioeconomic inequalities, by examining alcohol consumption as one potential explanation via comparing socioeconomic inequalities in alcohol-attributable mortality and all-cause mortality.

Methods: Web of Science, MEDLINE, PsycINFO and ETOH were searched systematically from their inception to second week of February 2013 for articles reporting alcohol-attributable mortality by socioeconomic status, operationalized by using information on education, occupation, employment status or income. The sex-specific ratios of relative risks (RRRs) of alcohol-attributable mortality to all-cause mortality were pooled for different operationalizations of socioeconomic status using inverse-variance weighted random effects models. These RRRs were then combined to a single estimate.

Results: We identified 15 unique papers suitable for a meta-analysis; capturing about 133 million people, 3 741 334 deaths from all causes and 167 652 alcohol-attributable deaths. The overall RRRs amounted to RRR = 1.78 (95% confidence interval (CI) 1.43 to 2.22) and RRR = 1.66 (95% CI 1.20 to 2.31), for women and men, respectively. In other words: lower socioeconomic status leads to 1.5–2-fold higher mortality for alcohol-attributable causes compared with all causes.

Conclusions: Alcohol was identified as a factor underlying higher mortality risks in more disadvantaged populations. All alcohol-attributable mortality is in principle avoidable,

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and future alcohol policies must take into consideration any differential effect on socioeconomic groups.

Key words: Alcohol-attributable mortality, socioeconomic status, meta-analysis, socioeconomic inequality, socioeconomic differences, alcohol, all-cause mortality, SES, education, income, occupation

Key Messages

- Socioeconomic differences in mortality are more pronounced in alcohol-attributable causes of death compared with all-cause mortality.
- All alcohol-attributable mortality is in principle avoidable and future alcohol policies should take into consideration any differential effect on socioeconomic groups.
- Primary healthcare practitioners and family doctors could play an important role in reducing socioeconomic inequality in mortality by using evidence-based screening, brief intervention and treatment referral practices.

Background

Low socioeconomic status (SES) has been repeatedly shown to be associated with an elevated mortality risk.[1–5] Life expectancy in Europe is increasing, and socioeconomic differences in mortality are increasing.[6] In most studies, SES has been identified via education, income or occupation.[7] For all three indicators of SES, substantial differences in mortality have been shown.[8–11] However, the underlying factors and mechanisms are not fully understood. For instance, attempts to explain such socioeconomic differences via influences of material wealth (e.g. financial resources, car ownership),[12–14] behavioural activities (e.g. physical activity, smoking behaviour)[9,10,15] or psychological factors (e.g. stress, coping strategies)[16,17] could explain only part of the underlying differences, with inconsistent results.

This study tries to explain socioeconomic differences in mortality by focusing on causes of death related to alcohol consumption. Alcohol is known to be causally associated with more than 200 International Classification of Disease (ICD) three-digit disease and injury categories, including more than 30 such categories being 100% attributable to alcohol;[18,19] i.e. these latter diseases and injuries would disappear completely without prior exposure to alcohol. Recently, the Global Burden of Disease and Injury Study revealed alcohol use as the fifth largest risk factor for global burden of disease:[20] 3.9% of the global burden of disease was attributable to alcohol use, 5.4% and 2.0% for men and women, respectively.

Individual studies seem to indicate that socioeconomic differences in mortality may be particularly large when alcohol-attributable causes of death are examined.[21–23] Furthermore, although the effects of economic downturns and rising unemployment on health and inequality in health have been discussed controversially,[24] strongly rising unemployment rates have been specifically linked to increased alcohol-attributable mortality.[25] But to date no systematic review across countries and measures of SES has been undertaken to statistically compare socioeconomic differences in all-cause and alcohol-attributable mortality. This study is the first to give a quantitative overview of the profile of socioeconomic mortality differences by comparing relative risk in alcohol-attributable and all-cause mortality. Specifically we wanted to test the following hypothesis: independently of measurement (by education, occupation, employment status or income), the relative risk comparing low with high SES is larger for alcohol-attributable mortality than for all-cause mortality.

Methods

This systematic review and meta-analysis followed the Meta-analysis of Observational Studies in Epidemiology—a Proposal for Reporting (MOOSE,[26] see Supplementary Table S1 for research checklist, available as Supplementary data at *IJE* online). It was based on a wider search for all studies examining the impact of SES on alcohol-attributable mortality and selected only studies that reported both alcohol-attributable mortality and all-cause mortality (see study protocol in Supplementary Text S1, available as Supplementary data at *IJE* online).

The meta-analysis was carried out in Germany at Technische Universität Dresden where no ethics approval is required for meta-analyses.

Literature research and study selection

Web of Science, MEDLINE, PsycINFO and ETOH were searched from their inception to the second week of February 2013, using the following terms: (alcohol related mortality OR alcohol attributable death OR alcohol attributable mortality) AND (ratio* OR risk*) AND (ses OR social class OR socioeconomic variable* OR socioeconomic status OR socioeconomic factor*). In order to meet the specific requirements of the databases, the search-algorithm was slightly adapted, using MeSH terms in MEDLINE and PsycINFO (see study protocol in Supplementary Text S1, available as Supplementary data at *IJE* online). All titles and abstracts were screened for eligibility criteria as listed in Table 1. A rating of accordance was carried out by S.B., J.R. and C.P. on a sample of 10 abstracts: mean accordance was 73%, with the less experienced raters showing inclusion of more studies. To be conservative, we decided to retrieve all potentially relevant articles in full text. Final decisions about inclusion were discussed between J.R., M.R. and C.P. Since a number of studies reported on overlapping populations (leading to duplicate data) we chose the article for in clusion based on the quality criteria mentioned below.

Data abstraction

We abstracted several variables concerning characteristics of the study population: design; measurement of SES, categorized into education, occupation, income and employment status (e.g. employed vs unemployed); measurement of mortality; results; and adjustments for confounding (for details see study protocol in Supplementary Text S1, available as Supplementary data at *IJE* online). All differences in abstraction were discussed and consensually decided between J.R., M.R. and C.P. Alcohol-attributable diagnoses investigated in each study were documented using their ICD-10 code. Rate ratios, hazard ratios, relative risks and odds ratios were treated as equivalent measures of relative risk. Concerning adjustments, we gave preference to risk estimates that were only age-adjusted in order to avoid over-adjustment, e.g. adjusting one measure of SES for another measure of SES. Missing value imputation was applied as per study protocol (Supplementary Text S1, available as Supplementary data at *IJE* online). In two cases with missing data on key variables, it was possible to obtain original data directly from the authors.[23,27]

Study quality

The following aspects of study quality were derived from main quality features in observational studies:[28] representativeness of the sample; loss of data due to problems in measurement of SES; operationalization of alcohol-attributable mortality concerning alcohol-attributable fractions; linkage of survey data; and age-adjustment. These quality features were monitored using a custom-made quality checklist (see Supplementary Table S2, available as Supplementary data at *IJE* online), because common checklists are usually tailored for randomized clinical trials. Since the quality aspects differ in their importance, an aggregate score was not applied. Details of the definition of quality criteria can be found in the study protocol (Supplementary Text S1, available as Supplementary data at *IJE* online).

Statistical analysis

For each study, the ratio of relative risks (RRR) between alcohol-attributable mortality (numerator) and all-cause mortality (denominator) was calculated. The underlying relative risks were based on the mortality rate of the lowest SES category divided by the mortality rate of the highest SES category. For instance, if SES was measured by education with four categories (university, college, high school,

Table 1. Inclusion and exclusion criteria for study selection

Criterion	Inclusion	Exclusion
Mortality	Mortality is measured at individual level; Mortality is attributed to alcohol	Indirectly affected people are investigated (e.g. non-alcoholized victims of alcoholized car drivers)
SES	SES is measured via occupation, employment status, income, or education; SES is measured on at least two values; SES is measured at individual level	SES is measured by the parent's SES or childhood SES
Design	The study is empirical and quantitative	The study is an intervention study
Sample	The sample is population-based; participants are at least 15 years of age	A clinical sample is investigated
Results	Alcohol-attributable mortality is reported by SES of the deceased; one measure of risk (relative risk, odds ratio, hazard ratio) and its CI, or raw data for calculation are reported	
Language	Language is restricted to English or German	

less than high school), the relative risk would be derived from dividing the mortality rate for the lowest SES (less than high school) by the rate of the highest SES level (university). These comparisons of lowest with highest SES are standard in the scientific analyses of inequality and our methodology was also chosen to include the maximum of underlying research.

The RRRs described above were pooled for each SES measure separately using random effects meta-analyses. In a second step, the resulting RRRs were pooled to obtain a global estimation across all four measures of SES. The resulting RRR describes the factor by which subjects with lower SES die more from alcohol-attributable causes of death compared with all causes of death. All meta-analyses were conducted stratified by sex using inverse-variance weighted DerSimonian-Laird random effects models to allow for between-study heterogeneity.[29] We quantified between-study heterogeneity using Cochran's Q[30] and the I^2 statistic.[31] I^2 can be interpreted as the proportion of the total variation in the estimated RRRs for each study that is due to heterogeneity between studies. I^2 values above 50% were considered substantial. Potential publication bias was examined using Egger's regression-based test.[32] In order to control for disproportionate influence of any single study, leave-one-out analyses were performed. For investigation of possible sex differences random effects meta-regression[33] was performed. Following the recommendation of the Cochrane Handbook, meta-regression was conducted only when at least 10 cohorts from primary studies were available.[34] All calculations were conducted on the natural log-scale using STATA software (Version 11).

Results

Literature search results

In total 33 articles were eligible for inclusion as per inclusion criteria (Table 1). After exclusion of population overlap and studies that did not report on all-cause mortality, 15 studies remained for statistical analyses (Figure 1), reporting on data assessed between 1970 and 2006. Of the 15 studies most were from Finland ($n = 6$), the others from Sweden ($n = 2$), Russia ($n = 2$), Estonia ($n = 1$), Poland ($n = 1$), Switzerland ($n = 1$) and Canada ($n = 1$). One study reported data from seven countries and nine different cohorts[27] and one reported two cohorts from the same country.[35] Overall, these meta-analyses included about 133 million people (69 million women and 64 million men), 3 741 334 deaths from all causes (1 500 381 women and 2 240 953 men) and 167 652 alcohol-attributable deaths (29 302 women and 138 350 men). For detailed information about the included studies see Table 2. All diagnoses, their ICD-10 code and the number of studies that included the respective diagnosis are listed in Supplementary Table S3 and details on the measures extracted in the meta-analysis (measure of SES, alcohol-attributable mortality and outcome measures) are displayed in Supplementary Table S4 (both available as Supplementary data at *IJE* online).

Meta-analyses

All analyses were stratified by sex (Figure 2 and 3). For education, six and seven studies were pooled for women and men, respectively: the resulting RRRs were 1.49 (95% CI 1.22 to 1.82) for women and RRR = 1.56 (95% CI 1.35 to 1.79) for men. Meta-analyses pooling the four eligible studies for occupation led to the following effects: RRR = 1.47 (95% CI 1.12 to 1.93) and RRR = 1.95 (95% CI 1.64 to 2.32), for women and men, respectively. Three studies reported on employment status; the pooled RRR for employment status for women was: RRR = 1.86 (95% CI 1.54 to 2.24); the confidence interval of the RRR of socioeconomic inequality in alcohol-attributable compared with all-cause mortality in men did include one RRR = 1.11 (95% CI 0.98 to 1.26). One study reported on income; the RRRs were 2.49 (95% CI 1.92 to 3.23) and 2.28 (95% CI 2.00 to 2.60), for women and men, respectively.

Pooling the RRRs from education, occupation, employment status and income resulted in RRR = 1.78 (95% CI 1.43 to 2.22) and RRR = 1.66 (95% CI 1.20 to 2.31), for women and men, respectively (Figure 4). The results indicate a 1.5–2-fold higher mortality for alcohol-attributable causes compared with all causes in subjects with low SES.

Quality assessment, heterogeneity, and bias control

With regard to study quality, representativeness of the sample for the whole population was not given in three studies; one study excluded a considerable share of the study population due to problems in classification of SES. Five studies included at least one disease category that is not wholly alcohol-attributable (see Supplementary Table S2; available as Supplementary data at *IJE* online). Four studies did not link individual (census) information about SES to individual death certificates; one study did not report age-adjusted results. Seven studies fulfilled all quality criteria.

Substantial heterogeneity was detected in the meta-analyses for education as well as for occupation in both sexes, with an $I^2 > 50\%$ and a Q-value with $P < 0.01$. In the analyses of employment status, no heterogeneity was detected for either of the sexes with $I^2 = 0\%$ and a Q-value with $P > 0.1$. Because of the number of primary studies,

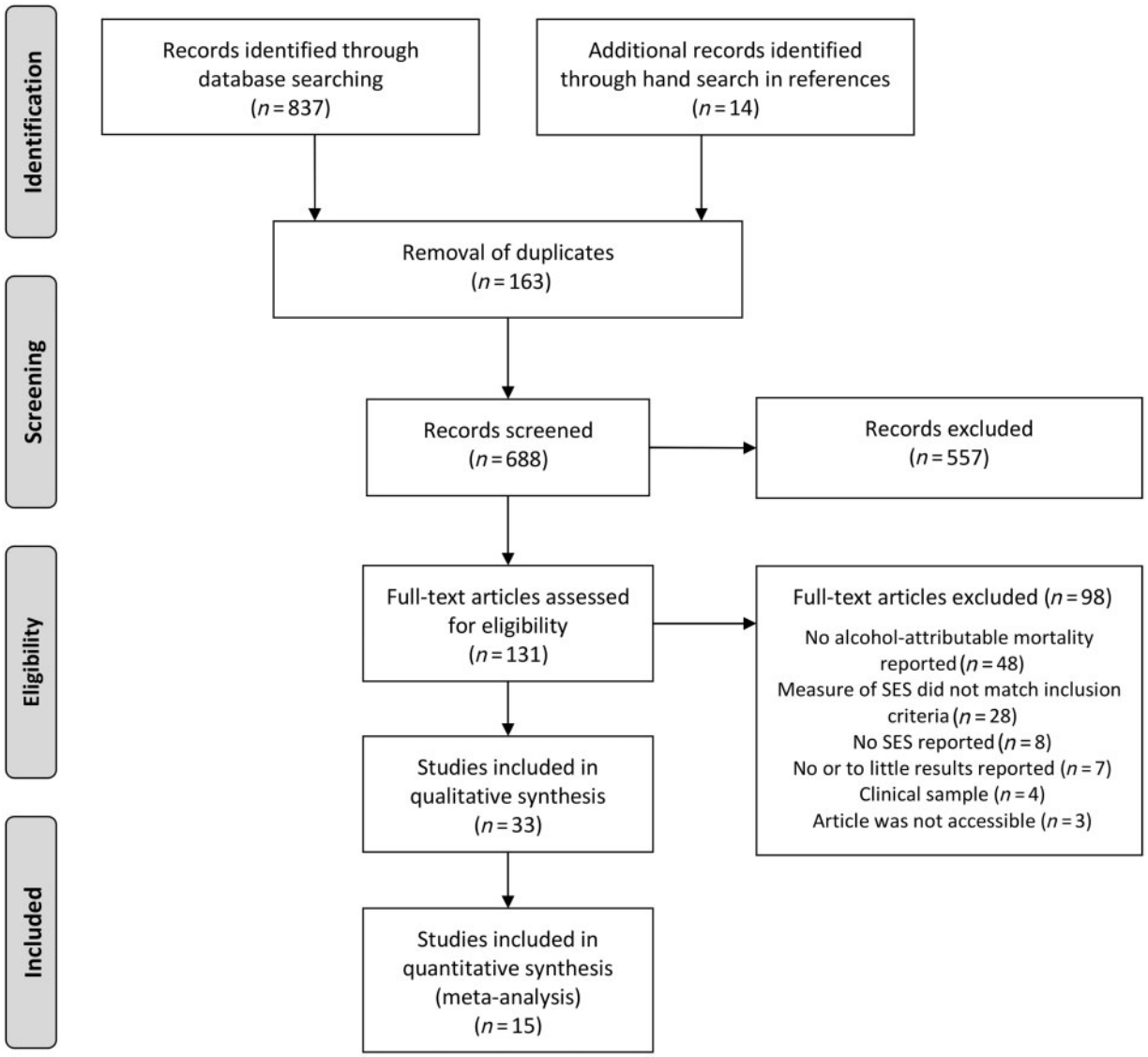

Figure 1. Flow diagram for study selection and exclusion. SES, socioeconomic status.

random effects meta-regression and Egger's test for publication bias were only possible for education. No substantial difference in RRRs for sex was found. Finnish studies did not differ substantially from the other studies. Egger's regression test showed bias for women ($P < 0.01$) but not for men ($P = 0.15$). Leave-one-out analysis revealed substantial influence only in the meta-analysis of employment status for men. The results for employment status were mainly based on one study[40] (see Figures 2 and 3).

Discussion

Principal findings

The reasons underlying socioeconomic differences in mortality are not fully understood. The present study compared socioeconomic inequality in alcohol-attributable and all-cause mortality. The overall analysis pooling results from education, occupation, employment status and income showed that the relative risk of dying from alcohol-attributable causes is roughly 1.7-fold the relative risk of all-cause mortality for both sexes. This indicates that whereas low SES is associated with an elevated risk of dying, this risk is especially elevated for alcohol-attributable causes of death. Meta-analyses stratified by measure of SES revealed consistent results. Employment status in men was the only exception, but because of the small number of studies for employment status, the results for this SES indicator have to be interpreted with caution.

Methodological limitations

All but one (Canada[22]) studies underlying our results were from European countries. Most of them were high-income

Table 2. Study characteristics of all studies included in the meta-analysis

Study	Country	Sex (age in years)	SES Assessment[a]	SES indicator (Number of levels)	Mortality assessment[b]	Version of ICD	*N*	*N* all-cause (alc.-attrib.)[c]	Quality[d]
Valkonen (1993)[36]	Finland	F, M (35-64)	1970, 1975, 1980	Occupation (4)	1971–75, 1976–80, 1981–85	Not specified	1 567 000[e]	147 808 (11 000[e])	(+)
Koskinen (1994)[37]	Finland	F, M (35-64)	1980	Education (3)	1981–85	Not specified	1 622 000[e]	52 533 (2488)	(+)
Mäkelä (1997)[38]	Finland	F, M (20+)	1985, 1990	Occupation (3)	1987–90, 1991–93	ICD-9	3 249 000[e]	276 730 (20 835)	(+)
Shkolnikov (1998)[23]	Russia	F, M (20-69)	1989	Education (2)	1989	ICD-8, ICD-9	89 436 000[e]	503 824 (9210)	(−)
Martikainen (2001)[21]	Finland	F, M (30-90)	1990	Income (10)	1991–96	ICD-9	2 709 000[e]	260 941 (6556)	(+)
Hemström (2002)[39]	Sweden	F, M (20-64)	1980, 1990	Occupation (3)	1990–95	ICD-9	1 480 000[e]	192 117 (9547)	(+)
Kivimäki (2003)[40]	Finland	F, M (18-36)	1990–00	Employment status (4)	1990–2001	ICD-9, ICD-10	92 351	1332 (414)	(−)
Leinsalu (2003)[35]	Estonia	F, M (20-70)	1989, 2000	Education (3)	1987–90; 1999–2000	ICD-9, ICD-10	2 097 607	107 480 (3500[e])	(−)
Voss (2004)[41]	Sweden	F, M (15-47)	1973	Employment status (2)	1973–83	ICD-8, ICD-9	20 632	1191 (50)	(−)
Kivimäki (2007)[42]	Finland	F, M (19-64)	1994–2000	Education (2), Occupation (3)	1994–2000	ICD-9, ICD-10	65 405	626 (179)	(−)
Mackenbach (2008)[27]	Finland	F, M (30-74)	1990	Education (3)	1990–2000	ICD-9, ICD-10	2 587 000[e]	269 781 (14 100[e])	(+)
	Norway	F, M (30-74)	1990	Education (3)	1990–2000	ICD-9, ICD-10	1 995 500[e]	213 022 (10 800[e])	(+)
	Belgium	F, M (30-74)	1991	Education (3)	1991–95	ICD-9, ICD-10	5 524 500[e]	283 349 (13 500[e])	(+)
	Italy (Turin)	F, M (30-74)	1991	Education (3)	1991–2001	ICD-9, ICD-10	487 000[e]	50 621 (2600[e])	(+)
	Sweden	F, M (30-74)	1991	Education (3)	1991–2000	ICD-9, ICD-10	4 583 000[e]	404 151 (23 700[e])	(+)
	Spain (Barcelona)	F, M (30-74)	1992	Education (3)	1992–2001	ICD-9, ICD-10	858 000[e]	77 101 (4400[e])	(+)
	Denmark	F, M (30-74)	1996	Education (3)	1996–2000	ICD-9, ICD-10	3 094 500[e]	136 065 (7600[e])	(+)
	Spain (Basque country)	F, M (30-74)	1996	Education (3)	1996–97	ICD-9, ICD-10	3 663 300[e]	22 585[e] (2000[e])	(+)
	Spain (Madrid)	F, M (30-74)	1996	Education (3)	1996–2001	ICD-9, ICD-10	1 108 800[e]	41 704 (3300[e])	(+)
Zagozdzon (2009)[43]	Poland (Gdansk)	F, M (20-64)	1999	Employment status (2)	1999–2004	ICD-10	367 848	8521 (1500[e])	(−)
Faeh (2010)[44]	Switzerland	F, M (30-69)	1992/1993	Education (3)	1990–2000	ICD-8, ICD-10	3 450 120	261 314 (16 156)	(−)
Pridemore (2010)[45]	Russia (Izhevst)	M (25-54)	2002	Education (6)	2003–05	ICD-10	3149	1559 (100)	(−)
Tjepkema (2012)[22]	Canada	F, M (25-80)	1991	Education (4)	1991–2006	ICD-9, ICD10	2 734 800	426 979 (4117)	(+)

F=Female; M=Male.

[a]All data are based on census or register data except of Pridemore *et al.*[45] who performed proxy interviews and Kivimäki *et al.*[42] who also included survey data.

[b]All data are based on some sort of death register except Pridemore *et al.*[45] who performed proxy interviews.

[c]Number of deaths from all causes (number of alcohol-attributable deaths).

[d](+), all quality criteria are met; (−), at least one quality criterion is not met.

[e]Estimated value as described in study protocol (Supplementary Text S1, available as Supplementary data at *IJE* online).

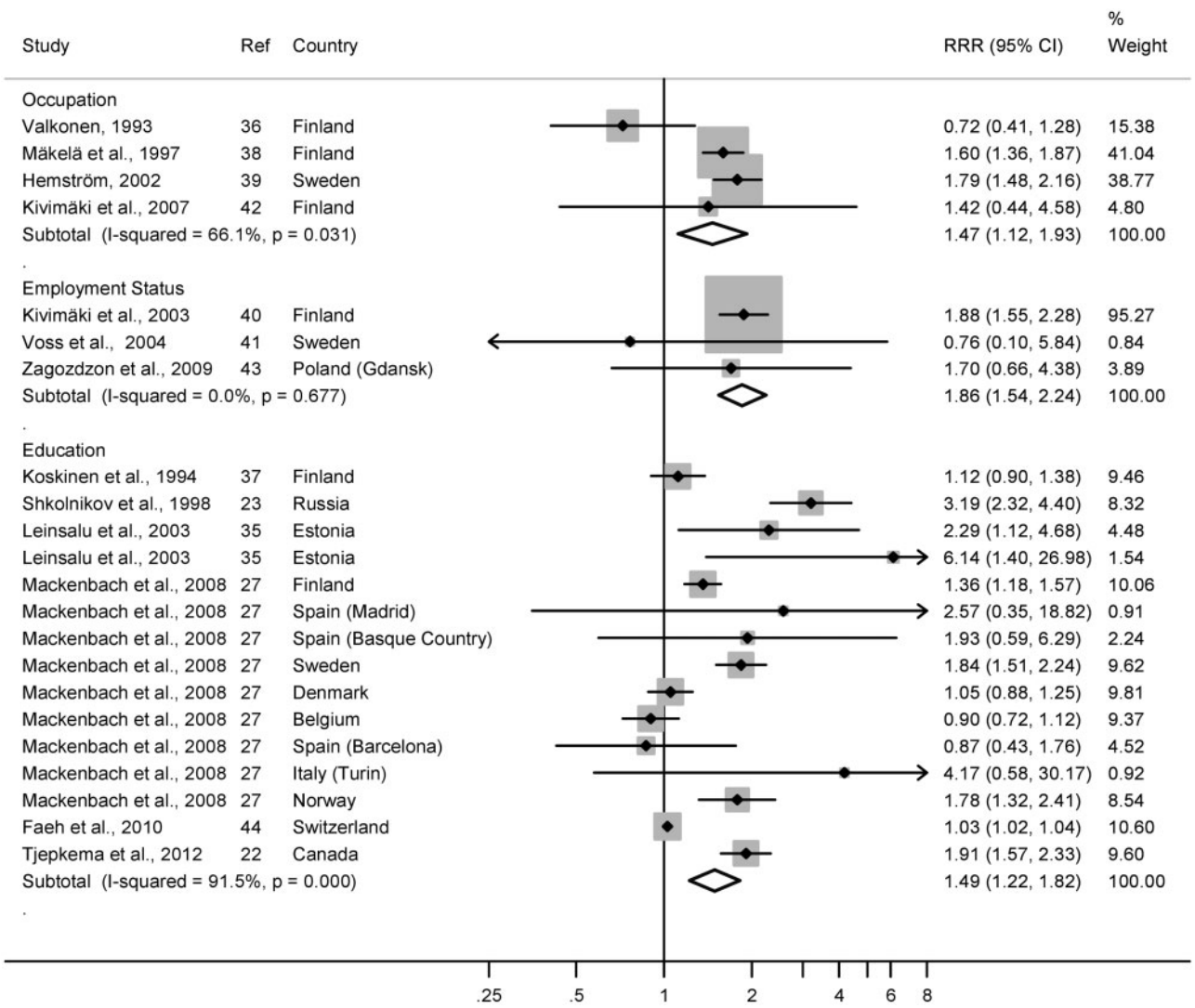

Figure 2. Random effects meta-analyses for women. Forest plot of pooled RRR for women, stratified by measure of SES. Size of squares corresponds to the weight of each study in the meta-analysis. Ref, reference number in references; RRR, ratio of relative risk; SES, socioeconomic status; CI, confidence interval.

countries at the time of data collection, with Estonia and Russia being the only exceptions. Finnish studies are disproportionately represented. Thus the results are generalizable for European high-income countries or other high-income countries with comparable distributions in socioeconomic indicators. Working with aggregated data (as is the case in meta-analyses) always entails the risk of ecological fallacy.[46] This should be kept in mind when discussing mechanisms underlying the socioeconomic differences because factors such as individual alcohol consumption or occupations were beyond our control.

As indicated in Table 2, data on cause of death were derived from public registers and might vary in preciseness within and across studies. It is possible that alcohol-attributable causes are underrepresented because of the stigma attached to them. We cannot rule out the possibility of such a bias or a bias related to the SES of the deceased.

We found substantial statistical between-study heterogeneity in almost all analyses, mostly because of the large sample size and resulting small errors of the mean in almost all studies included. We therefore used inverse-variance weighted DerSimonian-Laird random effects models to allow for this between-study heterogeneity when calculating the CIs.[29] The lower number of alcohol-attributable deaths in women partially led to broad CIs, limiting the reliability of the estimation. Further large-scale investigations are needed for women.

We examined study quality for all studies included in the meta-analysis (Supplementary Table S2, available as Supplementary data at *IJE* online). Meta-regressions for each quality criterion were not feasible due to the small

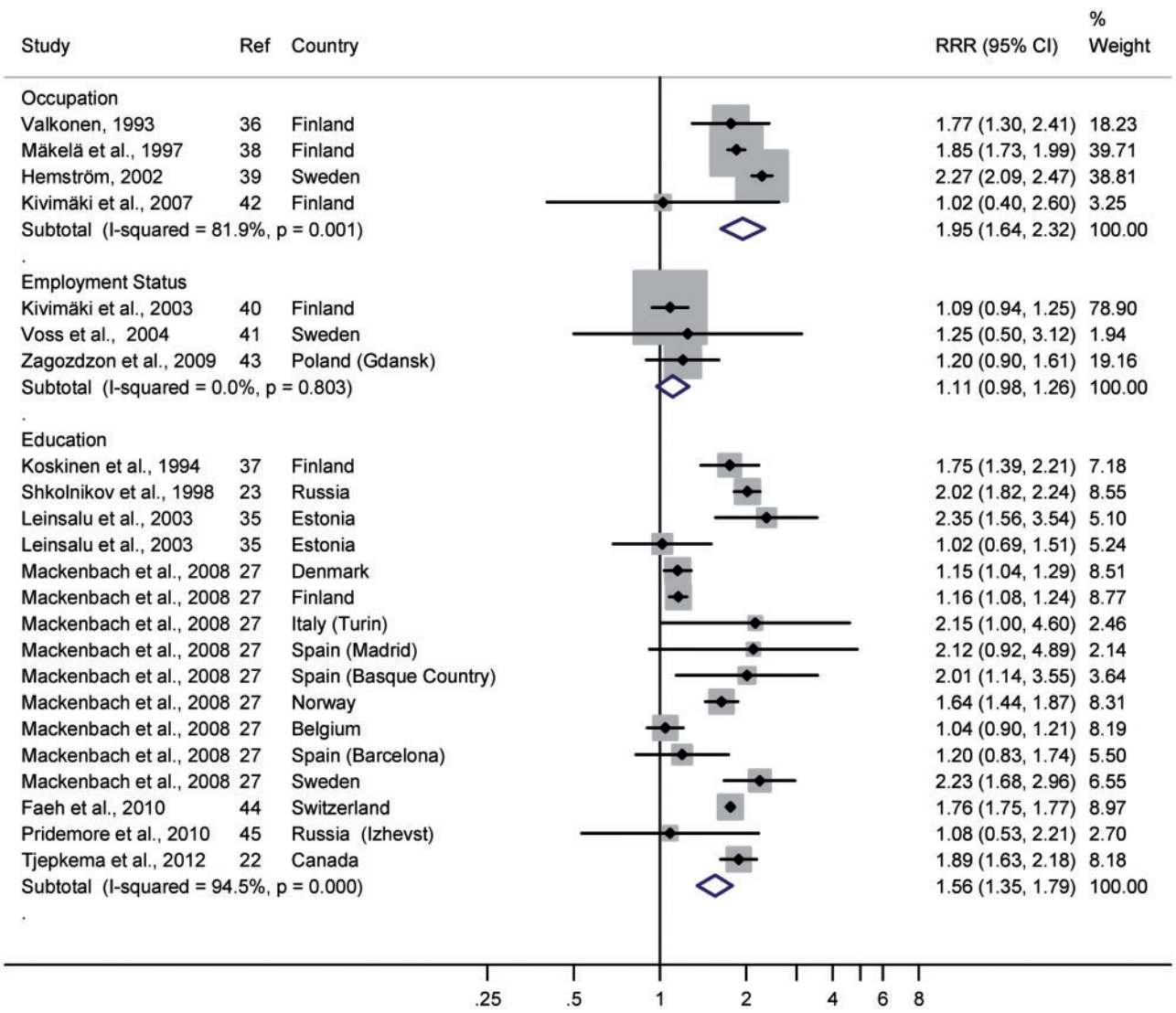

Figure 3. Random effects meta-analyses for men. Forest plot of pooled RRR for men, stratified by measure of SES. Size of squares corresponds to the weight of each study in the meta-analysis. Ref, reference number in references; RRR, ratio of relative risk; SES, socioeconomic status; CI, confidence interval.

number of studies included.[34] Investigation of study quality showed that each of the three studies investigating employment status as indicator of SES did not fulfill several criteria.[40,41,43] These limitations should be considered when the respective results are interpreted.

Interpretation of results

The most obvious explanation for those socioeconomic differences in alcohol-attributable mortality would be systematic differences in alcohol consumption habits and patterns. Across different measures of SES, studies from a number of European countries as well as the USA, New Zealand and Australia showed differences in drinking patterns over social classes.[47–53] Men of high SES tended to drink frequently, smaller amounts of alcohol per drinking occasion, whereas men with low SES tended to drink larger amounts on fewer occasions, e.g. drink in order to get drunk. For women, SES-related differences in drinking patterns were less consistent. Particularly in Western/European countries (Germany, The Netherlands, Switzerland, France, Austria, and the UK) women of a high SES were more likely to consume heavily compared with women of middle or lower SES. In men as well as women, the share of abstinence increased with descending SES. Mäkelä and Paljärvi found in a Finnish sample that socioeconomic differences in alcohol-attributable morbidity and mortality could not be fully explained by differences in alcohol consumption patterns.[54] Overall the findings indicate a multiplicative interaction of alcohol and SES, leading to greater harm in subjects with low SES even when the average level of alcohol consumption and some

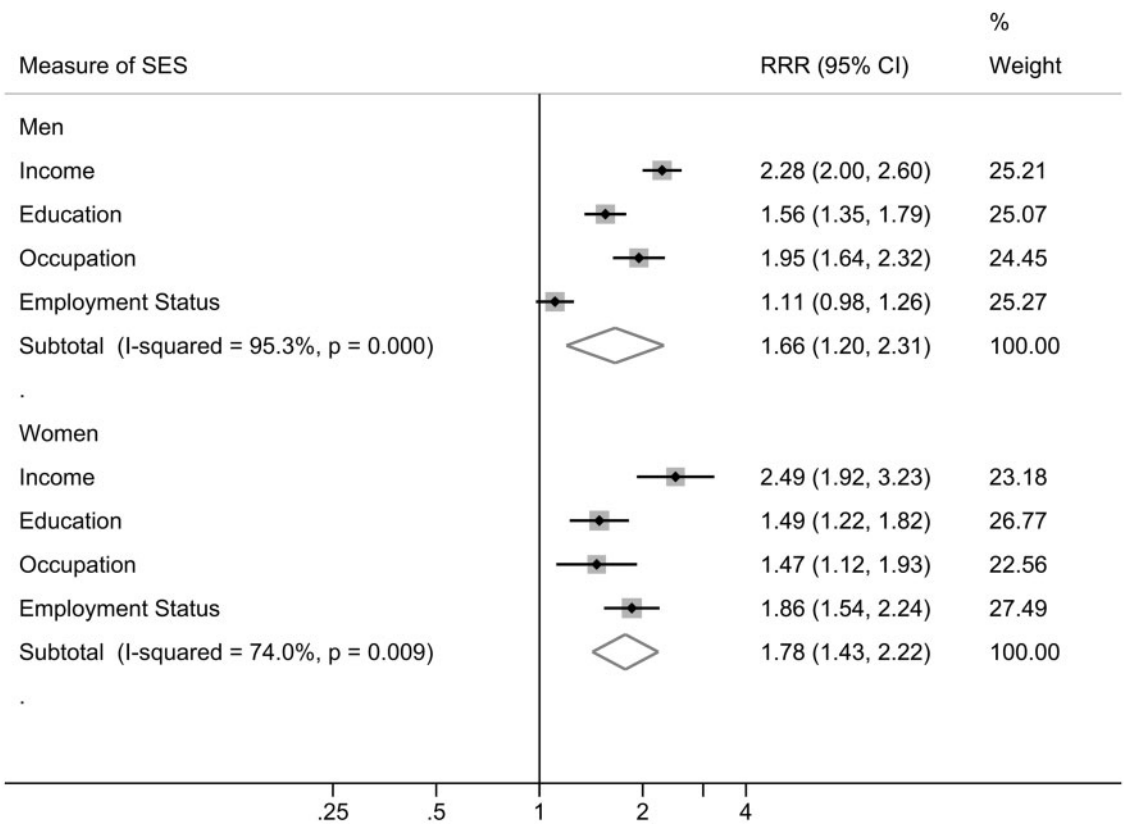

Figure 4. Overall random effects meta-analyses. Forest plot of pooled RRR across measures of SES, stratified by sex. Size of squares corresponds to the weight of each study in the meta-analysis. RRR, ratio of relative risk; SES, socioeconomic status; CI, confidence interval.

consumption patterns are controlled for. In the following, we consider healthcare supply, dietary habits, and smoking behaviours as putative main factors underlying this phenomenon.

Alcohol-related primary care interventions are cost-effective measures to reduce alcohol consumption and mortality.[55,56] Studies showed that people of low SES are more often confronted with barriers to accessing health services than people of high SES.[57,58] These barriers refer to accessibility (e.g. costs, transport) and availability (e.g. proximity to residence, waiting lists) of healthcare supply. Furthermore, at-risk drinking[59] and alcohol-related disorders are highly stigmatized.[60,61] People with alcohol dependence are often seen as being unpredictable, dangerous and responsible for their disorder and related problems.[61,62] This stigma has been shown to be particularly high for subjects of low SES.[63] A high perceived stigmatization was in turn related to decreased perception of treatment need and a reduced usage of health services.[63,64] These findings show that, due to a lack of accessibility and availability of healthcare services as well as stigmatization, especially subjects of a low SES are unlikely to receive professional help in alcohol-related diseases and disorders.

Investigation of dietary patterns in Western countries found repeatedly that people with a low SES were more likely to purchase foods that are high in fat, salt and sugar[65] and to consume processed and fast food.[66,67] Moreover, low SES was linked to dietary patterns inconsistent with dietary recommendations,[68–70] such as low fruit and vegetable consumption.[71–73] This kind of malnutrition probably interacts with alcohol consumption: Especially the intake of proteins and vitamins is affected by alcohol consumption, leading to increased risk of liver diseases as well as harmful effects on multiple health outcomes.[74,75] Furthermore, malnutrition and heavy alcohol consumption interact to produce immunosuppressive effects,[76] which are in turn linked to a number of disease endpoints such as liver disease or infectious diseases.[77–79] These results suggest that dietary patterns of people with low SES interact with alcohol consumption in a harmful way and might thereby contribute to socioeconomic differences in alcohol-attributable mortality. Not surprisingly, obesity as well is distributed unequally in society.[80,81] Again, adverse interactions of obesity and alcohol intake have been shown, e.g. for an increased risk of colorectal cancer.[82] Evidence on the interaction of alcohol and nutrition/obesity and their implications for socioeconomic

inequality in mortality is still sparse and epidemiological research is needed.

In several Western/European countries, smoking behaviour is much more prevalent among people with low SES.[83–86] Reviews revealed a multiplicative interaction of alcohol and smoking leading to an increased risk of aero-digestive cancers.[87,88] Given the SES-related differences in smoking behaviour, people of low SES are at higher risk of being affected by the described interactive effects of alcohol and smoking. Aero-digestive cancers (concerning e.g. oral cavity, larynx, pharynx, or oesophagus) constitute only a small proportion of alcohol-attributable deaths, limiting the potential impact of the interaction hypothesized.

In summary, our results indicate that alcohol plays an important role in the development of socioeconomic differences in mortality. This might partially be due to the fact that it interacts with other risk factors such as nutrition, smoking behaviour or health care utilization, all of which were unequally distributed across SES as well.

Implications for policy and practice

All alcohol-attributable harm is in principle avoidable.[89] In Europe an estimated 13.9% of all deaths in adult (aged 15–64 years) men and 7.7% of all deaths in adult (aged 15–64 years) women are attributable to alcohol.[90] Based on our estimations, the relative risk (occupation) of all-cause mortality in men could be reduced by 6% if 30% of alcohol-attributable deaths in subjects with low SES were prevented. A prevention of 50% of those deaths would reduce socioeconomic differences in all-cause mortality by 10%. For women, the same reductions in alcohol-attributable mortality would lead to a 2.5% and a 4.5% reduction of the relative risk for all-cause mortality, respectively.

Most preventive measures concerning alcohol-related harm reduction target society as a whole and rather little is known about effective measures targeting subjects with low SES. Herttua and colleagues investigated the development of alcohol-attributable deaths after a reduction of alcohol taxes.[91] They found a stronger increase of alcohol-attributable deaths among people of low SES compared with people of high SES. If this effect would work the reverse way as well, i.e. that an increase of taxes leads to relative decrease of alcohol-attributable death in low SES, remains undecided. Next to measures of taxation, limitation of selling times, liquor licenses and density of alcohol selling stores have turned out to be effective.[92] It is imaginable to reduce the socioeconomic slope by targeted reduction of alcohol availability in underprivileged areas. The moral justifiability and political practicability of some of these measures may be debatable, however. In any case such measures should be combined with community-based preventive measures and educational opportunities.[93,94] Next to restrictive measures, policy makers should revise social welfare spending which, for instance, can buffer detrimental effects of unemployment and financial crises, such as alcohol-attributable mortality.[25,95] Stuckler, Basu, and McKee showed that a rise in social welfare spending was associated with a decrease in alcohol-attributable mortality whereas rising healthcare spending was not.[96]

Nevertheless, primary healthcare practitioners could constitute a direct way of reducing societal differences in alcohol-attributable health and mortality. Alcohol-related primary care interventions, such as screening and brief counselling, have been shown to be cost-effective measures to reduce alcohol consumption, related harm and mortality.[55,56,97–100] Especially patients of low SES should be informed about risks and consequences of alcohol use as well as basic rules for risk-reduced alcohol consumption, such as lower risk drinking guidelines.[101] Additionally, primary healthcare practitioners could play an important role in reducing socioeconomic inequality in mortality by linking patients to specialized alcohol treatment services.

Future research

Specific pathways from low SES through alcohol consumption to mortality need to be investigated in future research. This requires longitudinal observational studies that allow for an accurate investigation of SES, societal-, territorial- and healthcare-related circumstances, alcohol consumption patterns, dietary habits, smoking behaviour, and health service use. Another important, yet unresolved question is how to specifically target people of low SES with alcohol-related preventive measures. Intervention studies aiming at a reduction of the socioeconomic gap in alcohol-attributable mortality are needed.

Supplementary Data

Supplementary data are available at *IJE* online.

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Details of contributors

C.P. is named as the guarantor and has overall responsibility of all steps. J.R. and S.B. supervised the whole working process. C.P., J.R. and S.B. conceived and designed the

meta-analysis. C.P., J.R. and M.R. performed the literature research and study selection. C.P., S.B. and J.R. performed rating of inclusion/exclusion. M.R., J.R. and C.P. decided on statistical procedures and analyzed the data. They had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. C.P. wrote the first draft of the manuscript. All authors contributed to the writing and revision of the manuscript and final approval of the version to be published. C.P. confirms that the material has not been published previously.

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