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Educational differences in alcohol-related mortality and their impact on life expectancy and lifespan variation in Spain (2016–2018): a cross-sectional analysis using multiple causes of death

Sergi Trias-Llimós, Jeroen J. A. Spijker

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Centre d'Estudis Demografics, Centres de Recerca de Catalunya (CERCA), Universitat Autònoma de Barcelona, Bellaterra, Spain

Correspondence to
Dr Sergi Trias-Llimós;
strias@ced.uab.cat

ABSTRACT

Background Socioeconomic inequalities in alcohol-related mortality in Spain exists, and are postulated to contribute to inequalities in all-cause mortality. We aim to assess absolute and relative educational inequalities in alcohol-related mortality, and to estimate the role of alcohol in educational inequalities in both life expectancy and lifespan variation in Spain.

Methods We used multiple cause-of-death (MCOD) mortality data for individuals aged 30 and over for Spain (2016–2018) by educational attainment. We estimated by sex and educational attainment age-standardised alcohol-attributable mortality rates, relative and absolute indices of educational inequalities; and total life expectancy and lifespan variation at age 30 for all-cause mortality and after eliminating alcohol-attributable mortality.

Results The use of MCOD resulted in an additional 2543 annual alcohol-related deaths (+75% among men and +50% among women) compared with estimates derived from underlying causes of death. In absolute terms, educational inequalities were the highest among men aged 45–84 and among women aged 45–64. In relative terms, higher inequalities raised in working ages, whereas at older ages inequalities tended to be lower, although still important among men. Alcohol contributed to educational inequalities in life expectancy (men: 0.13 years (3.2%); women 0.02 years (0.7%)) and lifespan variation (2.1% and 1.4% for men and women, respectively).

Conclusion Alcohol consumption remains an important lifestyle habit to be tackled in order to reduce socioeconomic inequalities in mortality in Spain, particularly among men.

Strengths and limitations of this study

- ► We examined socioeconomic inequalities in alcohol-related mortality in Spain using individual-level multiple causes-of-death (MCOD) mortality data linked with educational attainment as key socioeconomic variable.
- ► This is the first study that examines population-level socioeconomic inequalities in alcohol-related mortality in Spain using MCOD data.
- ► The observed inequalities are sensitive to the grouping of the socioeconomic variable, education and its composition, which may complicate comparisons with future studies of the same group.
- ► MCOD data may still not be capturing all deaths due to alcohol consumption, although this underestimation is lower compared with commonly used underlying cause-of-death approaches.

INTRODUCTION

Alcohol consumption is a major contributor to the burden of disease and mortality.[1] Despite the important role of alcohol in health outcomes, overall estimates mask notable socioeconomic differences, as low socioeconomic groups tend to suffer a greater health burden from alcohol consumption than those from a higher socioeconomic strata.[2–6] Although the estimates are sensitive to country contexts and how alcohol-related mortality and socioeconomic groups are defined and measured, according to previous research low socioeconomic groups have between 2 and 10 times higher mortality due to alcohol consumption compared with their high socioeconomic counterparts.[2 4 6] These inequalities in alcohol-related mortality make alcohol a net contributor to all-cause socioeconomic inequalities in mortality.[2 7]

Understanding why these socioeconomic differentials in alcohol-related mortality exist is, however, not that straightforward as it is not only associated with similar social gradients in consumption patterns. Although it is true that, as for other lifestyles, individuals from low socioeconomic groups tend to have higher prevalence of risky alcohol consumption such as heavy drinking,[8 9] the impact of alcohol on health and mortality is known to be disproportionally higher among low socioeconomic groups. In other words, when consumption levels are controlled for, low socioeconomic groups suffer a higher health burden due to alcohol. This paradox is known as the alcohol-harm paradox, which is partly explained by other unhealthy lifestyles such as poor diet, smoking or insufficient physical activity.[10 11]

While most recent European studies on socioeconomic differences in alcohol-related mortality have focused on Nordic or Eastern European countries,[6 12 13] Spain and other southern European countries have received little attention, despite there being distinct reasons to do so. First, alcohol drinking is considered a cultural aspect of social life in Spain, and alcohol consumption is widespread.[14] Second, after continuous declines in alcohol consumption since the late 1970s, its levels increased moderately in the period 2013–2016,[15] and are currently at 10.9 L of pure alcohol consumption per capita.[15] Third, earlier studies reported a socioeconomic gradient in alcohol-related mortality in a sample of 22 million residents aged 35 and over in the period 2001–2011,[4] as well as in three Spanish subpopulations (Barcelona, Basque Country and Madrid) during the late 1990s and 2000s.[2] In both studies, alcohol-related mortality was found to be 4–6 times higher among low socioeconomic groups compared with the high socioeconomic groups. Yet, these previous studies are based on old or regional data and not on national-level data. Finally, beyond alcohol-related mortality inequalities, all-cause mortality inequalities have persisted (or even increased) over the last several decades in Spain.[16 17]

Socioeconomic inequalities in alcohol-related mortality have been mostly examined using underlying causes-of-death (UCOD).[2 3 18] UCOD approaches tend to underestimate the impact of alcohol on mortality as they are only capturing the share of mortality attributable to alcohol from diseases clearly related to alcohol (eg, alcoholic liver cirrhosis), and therefore these methods are not able to capture the burden of alcohol to other diseases and causes of death in which alcohol is not the risk factor (eg, ischaemic heart diseases or several neoplasms). The complex interactions between alcohol consumption (levels and patterns of drinking) and health outcomes represent an important challenge as regards to accurately estimate the impact of alcohol on mortality at the population level.[1 19–21] One of the possibilities to partly overcome some of the limitations of UCOD consists in defining alcohol-related mortality as the sum of deaths with a cause of death wholly attributable to alcohol (100% attributable to alcohol) listed in the death certificate (eg, alcoholic liver cirrhosis, mental and behavioural disorders due to use of alcohol), either as underlying or contributory, also known as the multiple cause-of-death (MCOD) approach.

The use of MCOD approaches is a promising tool for population-level alcohol research studies. However, there are only a handful of studies that used MCOD to examine socioeconomic inequalities in alcohol-related mortality. These mainly come from the Nordic countries,[13 22] where alcohol-related mortality was found to account for 15%–35% of the income gradient in life expectancy among men and 10%–25% among women.[13] Research on alcohol-related mortality using MCOD has also been conducted in France,[20] the USA[23 24] and the UK,[25] but none of these studies focused on socioeconomic differentials therein. In other contexts, including Southern European countries, lie Spain, there is still a lack of studies on inequalities in alcohol-attributable mortality using more refined approaches compared with the UCOD.

Using Spanish MCOD mortality data for time period 2016–2018 our objective is therefore twofold:

1. To assess absolute and relative socioeconomic differences in alcohol-related mortality.
2. To assess the role of educational differences in alcohol-related mortality to all-cause inequalities in life expectancy and lifespan variation.

METHODS

Data

Detailed sex-specific and age-specific mortality data for individuals aged 30 and over containing all causes listed in the death certificate were retrieved for the years 2016–2018 from the Spanish National Statistics Institute (INE). These data contain information on educational attainment retrieved from a data linkage with a source feed from multiple datasets and carried out by INE. The latest includes municipal population registers (Padrón), the 2001 and 2011 censuses, data on official degrees issued by the Ministry of education or data on enrolment at Spanish universities, register of enrolled and graduated at non-university education. In case of multiple educational attainment information, the highest level of education was chosen. More details about this data linkage can be found elsewhere.[26 27] Population estimates from 2017 by age, sex and educational attainment, also retrieved from INE, were set as denominators to produce our mortality indicators. Based on both data sources, we created three educational attainment categories: low (primary education or less, ISCED-2011 0–2) middle (lower and upper secondary education, ISCED-2011 3) and high (postsecondary vocational and university education, ISCED-2011 4+). The population distribution by age, sex and educational attainment is shown in online supplemental figure S1.

Patient and public involvement

No patients were involved in this study.

METHODS

Alcohol-related mortality was defined as the sum of deaths with a cause of death 100% attributable to alcohol mentioned anywhere in the death certificate (MCOD). In line with previous studies,[20 28] we used the following causes of death that are wholly related to alcohol: alcoholic dependence (International Classification of Diseases version 10 (ICD-10): F10), alcoholic liver cirrhosis (K70), external causes due to alcohol use (X45, X65 and Y15) and other causes wholly attributable to alcohol (G312, G621, G721, I426, K292 and K852; causes with zero deaths were not included, eg, E244, 0354, Q860 and R780). Therefore, deaths with one of the abovementioned causes either listed as underlying or as contributory (at any other section in the death certificate) were considered to be related with alcohol.[22]

Educational inequalities in alcohol-related mortality (MCOD approach)

We calculated age-standardised alcohol-related mortality rates by age (30–44, 45–64, 65–84, 85+ and 30+), sex and educational category using the Spanish population in 2016–2018 as the standard. 95% CIs were estimated using conventional approaches:

$$\text{asdr } 95\%\text{ CI} = \text{asdr} \pm \left(1.96 \frac{\text{asdr}}{\sqrt{\text{n deaths}}}\right)$$

where, asdr refers to age-standardised death rates and *n* deaths to the observed number of deaths.

Educational inequalities in alcohol-related mortality were estimated by means of both absolute and relative inequality measures. The relative index of inequality (RII) was used for measuring relative inequalities. The RII assumes the relative position of each educational group within the population, and it can be interpreted as the mortality rate ratio comparing those with low education to those with high education. The RII was estimated from a multiplicative Poisson model adjusting by age following the work by Moreno-Betancur *et al*.[29] Absolute inequalities were measured by means of the slope index of inequality (SII),[2] which measures the rate differences between those with low education to those with high education:

$$\text{SII} = \frac{2\times\text{asdr}\times(\text{RII}-1)}{(\text{RII}+1)}$$

The role of alcohol (MCOD approach) in all-cause mortality

To analyse the role of alcohol in all-cause mortality, we estimated life expectancies at age 30 (e_{30}) for each sex and educational group for the whole population and eliminating alcohol-related mortality. We did so by using 5-year age group data starting at age 30 and by applying standard life table techniques.[30] Lifespan variation for the same population groups was measured as the SD in the age at death from age 30 (SD_{30}) using life table data. To estimate it from age 30, we adapted the formula provided in previous research.[5,31]

We estimated the contribution of alcohol to life expectancy and lifespan variation by sex and educational group by comparing the corresponding values for the whole population and excluding alcohol-related deaths, defined as potential gains in life expectancy (PGLE).[32] In other words, PGLE measures the potential increases in life expectancy if alcohol-related mortality was eliminated. Finally, we estimated the inequality gap in life expectancy and lifespan variation between the highest and the lowest educated group, both in absolute and in relative terms.

RESULTS

Descriptive results

We estimated nearly 8000 alcohol-related deaths in Spain for the period 2016–2018 (table 1). Within the UCOD, alcohol-related mortality was mostly composed of deaths from alcoholic liver cirrhosis (77.4%) and alcohol dependence (15.4%). MCOD deaths represented an increase in alcohol-related mortality of 75.1% among men and 50.2% among women.

Table 1 Alcohol-related death counts by age and cause distinguishing between main underlying causes, alcohol listed in the contributory causes of death and total derived from either underlying or contributory causes: MCOD, Spain 2016–2018

	Deaths with alcohol-related causes as UCOD							
	Alcoholic liver cirrhosis (K70)	Alcoholic dependence (F10)	External causes due to alcohol use (X45, X65, Y15)	Other causes wholly-attributable to alcohol*	All alcohol as underlying	Alcohol listed in the contributory causes of death†	MCOD	MCOD/UCOD
Men								
30–44	156	18	28	6	208	66	274	1.32
45–64	1728	276	62	94	2160	1293	3453	1.60
65–84	1057	294	15	68	1434	1444	2878	2.01
85+	74	27	0	3	104	132	236	2.27
All ages 30+	3015	615	105	171	3906	2935	6841	1.75
Women								
30–44	42	3	6	3	54	15	69	1.28
45–64	340	47	28	10	425	163	588	1.38
65–84	168	38	2	9	217	160	377	1.74
85+	13	9	1	0	23	23	46	2.00
All ages 30+	563	97	37	22	719	361	1080	1.50

*Corresponds to the cause-of-death categories and ICD-10 codes: degeneration of nervous system due to alcohol (G31.2), alcoholic polyneuropathy (G62.1), alcoholic myopathy (G721), alcoholic cardiomyopathy (I42.6), alcoholic gastritis (K29.2) and alcohol-induced acute pancreatitis (K85.2).
†Refers to any alcohol-related cause of death listed in columns 1–3 and the above note.
MCOD, multiple causes-of-death; UCOD, underlying causes-of-death.

Table 2 Age-standardised alcohol-related mortality rates (per 100 000 person-years) by age groups and educational attainment, RII and SII, Spain 2016–18

	Age-standardised mortality rates by educational group (95% CI)								Inequalities	
	All		Low		Middle		High		RII (95% CI)	SII
Men										
30–44	1.5	1.3 to 1.7	2.5	2.1 to 2.9	1.6	1.2 to 2.0	0.4	0.2 to 0.5	**5.17 (3.13 to 8.55)**	2.0
45–64	16.9	16.4 to 17.5	24.1	23.2 to 25.1	13.7	12.5 to 14.8	7.0	6.3 to 7.7	**3.42 (2.78 to 4.22)**	18.5
65–84	27.5	26.5 to 28.6	33.2	31.8 to 34.5	17.7	15.4 to 20.0	12.7	11.1 to 14.4	**2.75 (2.42 to 3.12)**	25.7
85+	15.3	13.3 to 17.3	16.6	14.4 to 18.9	10.5	4.3 to 16.7	7.0	2.6 to 11.3	**2.38 (1.34 to 4.24)**	12.5
All ages 30+	14.3	14.0 to 14.7	18.9	18.4 to 19.4	10.5	9.8 to 11.2	6.2	5.7 to 6.6	**3.08 (1.82 to 5.02)**	8.0
Women										
30–44	0.4	0.3 to 0.5	0.7	0.5 to 1.0	0.5	0.2 to 0.7	0.1	0.0 to 0.2	**6.05 (2.80 to 13.04)**	0.6
45–64	2.7	2.5 to 3.0	3.8	3.4 to 4.2	2.3	1.9 to 2.8	1.5	1.2 to 1.8	**2.62 (1.95 to 3.52)**	2.4
65–84	2.9	2.6 to 3.2	2.9	2.5 to 3.2	2.9	1.9 to 3.9	3.7	2.6 to 4.9	0.86 (0.60 to 1.22)	−0.4
85+	1.6	1.1 to 2.0	1.5	1.0 to 1.9	1.4	−0.5 to 3.3	4.3	0.5 to 8.0	0.39 (0.15 to 1.00)	−1.4
All ages 30+	2.0	1.8 to 2.1	2.5	2.3 to 2.7	1.8	1.5 to 2.1	1.7	1.4 to 1.9	**2.11 (1.21 to 3.68)**	1.4

*Bold indicates statistically significant (95%) RII values.
RII, relative index of inequality; SII, slope index of inequality.

Alcohol-related mortality by age group, sex and educational attainment and relative inequalities

Among men, alcohol-related mortality rates ranged from 6.2 (5.7–6.6) per 100 000 person-years among the highest educated group to 18.9 (18.4–19.4) per 100 000 person-years among the lowest educated group (table 2). Among women, alcohol-related mortality rates ranged between 1.7 (1.4–1.9) and 2.5 (2.3–2.7) per 100 000 person-years, among the highest and the lowest educated groups, respectively. When stratified by educational groups, a clear socioeconomic gradient can be visually observed across age groups, particularly among men and among working-age women (figure 1).

The relative index of inequality (RII) was 3.08 (1.82–5.22) among men and 2.11 (1.21–3.68) among women. Among men it ranged from 5.17 (3.13–8.55) at ages 30–44 to 2.38 (1.34–4.24) at ages 85 and over, while among women it ranged from 6.05 (2.80–13.04) to 0.39 (0.15–1.00) in the youngest and older age group, respectively. The SII peaked at ages 65–84 among men with 25.7 deaths per 100 000 person-years; and at ages 45–64 among women with 2.4 deaths per 100 000 person-years.

Impact of alcohol on overall mortality and on inequalities therein

In Spain, the PGLE was 0.15 years among men and 0.03 years among women (table 3). Mortality indicators were more favourable among highest educated groups: higher life expectancies at age 30 (e_{30}) and lower lifespan variation (SD_{30}). When alcohol-related mortality was eliminated, life

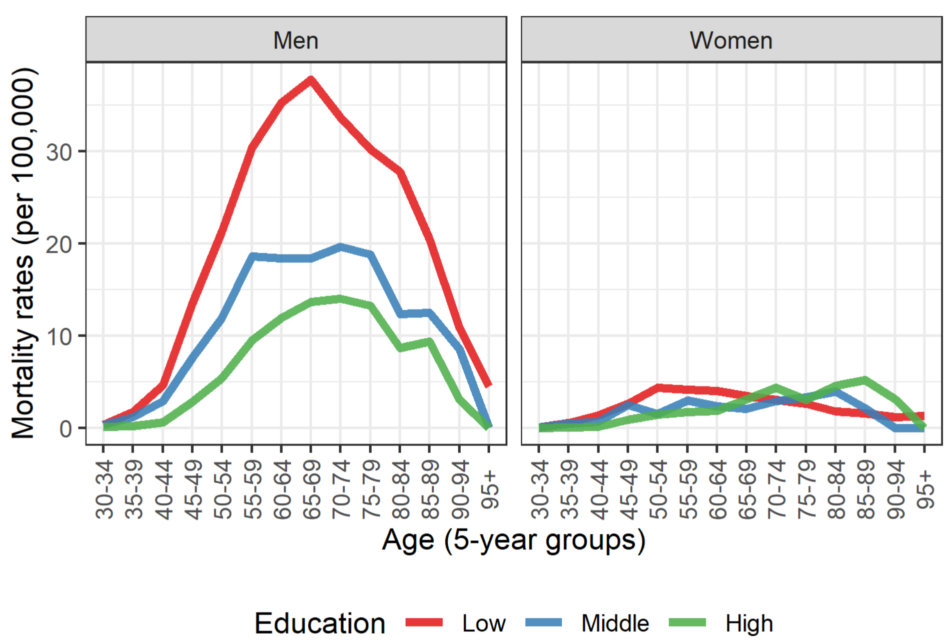

Figure 1 Alcohol-related mortality rates by age and educational attainment in Spain 2016–2018.

Table 3 Contribution of alcohol to all-cause life expectancy and lifespan educational inequalities at age 30 by sex, Spain 2016–2018

	Educational groups					% Reduction in inequality by eliminating alcohol
	All	Low	Middle	High	Inequality gap	
Men						
e_{30}	50.66	49.19	52.49	53.36	4.17	
e_{30} eliminating alcohol	50.81	49.39	52.62	53.43	4.04	
PGLE alcohol	0.15	0.20	0.12	0.07	0.13	3.2
SD_{30}	12.86	13.63	12.89	11.66	−1.98	
SD_{30} eliminating alcohol	12.79	13.55	12.82	11.61	−1.93	
Difference	−0.07	−0.09	−0.07	−0.04	−0.04	2.1
Women						
e_{30}	55.92	55.16	57.61	57.73	2.56	
e_{30} eliminating alcohol	55.95	55.20	57.64	57.75	2.55	
PGLE alcohol	0.03	0.04	0.03	0.02	0.02	0.7
SD_{30}	11.46	12.19	11.39	10.69	−1.50	
SD_{30} eliminating alcohol	11.43	12.15	11.36	10.67	−1.48	
Difference	−0.03	−0.04	−0.03	−0.02	−0.02	1.4

PGLE, potential gains in life expectancy.

expectancy at age 30 increased by 0.20, 0.12. and 0.07 years among low, middle and high educated groups in men; and by 0.04, 0.03 and 0.02 years among the corresponding groups in women. Additionally, alcohol-related mortality contributed to lifespan variation. By eliminating alcohol-related mortality, all-cause inequalities in men would decline by 3.2% in terms of life expectancy at age 30 and 2.1% in terms of lifespan variation. Among women, the corresponding declines would be 0.7% and 1.4%.

DISCUSSION

Summary of results

We have assessed educational inequalities in alcohol-related mortality and their role in all-cause mortality inequalities using multiple causes of death data for Spain, and life tables and regression-based inequality measures. Educational inequalities in alcohol-related mortality were larger in working age groups (RII around or above 3), whereas they decreased at older ages, particularly among women. When eliminating alcohol-related mortality, inequalities in life expectancy at age 30 diminished by 3.2% in men and 0.7% in women; and lifespan variation diminished by 2.1% in men and 1.4% in women.

Comparison of results

Our results of the observed educational inequalities in alcohol-related mortality among men are in line with previous research from Mackenbach *et al* who assessed alcohol-related mortality from UCOD in three Spanish regional populations in the period 2001–2010.[2] Among women, we found relative inequalities at ages 30 and over, and particularly at ages 30–64, but not among 65 or over groups. Indeed, at ages 85 and over it seems that lower educated women have lower alcohol-related mortality (RII: 0.39, 95% CI: 0.15 to 1.00). Weaker inequalities among women were also previously found elsewhere,[2] but unfortunately age-specific results were not reported.

Interestingly, our results on educational inequalities in alcohol-related mortality can be compared with those from smoking-related mortality from a recent study that used Spanish data from 2016.[33] In relative terms, our results for the relative inequalities seem larger as compared with those from smoking-related mortality,[33] for men (our estimates: RII=3.08, 95% CI: 1.82 to 5.22; smoking estimates: RII=1.61, 95% CI: 1.55 to 1.67) and women (our estimates: RII=2.11, 95% CI: 1.21 to 3.68; smoking estimates: RII=0.39, 95% CI: 0.35 to 0.42), suggesting a higher relative importance of alcohol in educational inequalities in health. In both alcohol-related and smoking-related mortality an inverse gradient with higher lifestyle-related mortality among women aged 65 and over from high social classes was found. In absolute terms, this comparison suggests higher absolute inequalities in smoking-related mortality as compared with alcohol-related mortality among men, which seems to be explained by the higher levels of smoking-related mortality compared with alcohol-related mortality.

Alcohol was found to contribute to all-cause life expectancy and lifespan variation. For life expectancy and for the age group 30–74 these contributions were 1.8% for women and 4.2% for men (online supplemental table S1). As expected, these values are slightly higher compared with previous estimates from the early 2000s that used UCOD data and the SII as inequality measure.[2]

In the present study, we found that the role of alcohol in all-cause mortality inequalities among women was slightly larger for lifespan variation than for life expectancy. This finding implies that alcohol seems to play a major role in the distribution of deaths over age (lifespan variation) rather than in its age-standardised mean (life expectancy), in line with previous findings from England and Wales.[5] This stresses the importance of complementing conventional average indicators widely used in the literature with indicators of age-at-death dispersion.

Our results on the contribution of alcohol to educational differences in life expectancy are difficult to be compared with other studies as the only studies assessing socioeconomic inequalities in alcohol-related mortality using multiple causes-of-death stratified the population by income quintiles. These studies, which focused on Nordic countries, found that alcohol accounted for 16%–36% and 6%–27% of the gap in life expectancy at ages 25–79 between top and bottom income quintiles among men and women, respectively.[12 13] Despite that their study population pertained to a slightly smaller age range and they used a different socioeconomic variable and compared outer quintiles rather than terciles, the contribution of alcohol to socioeconomic differences in mortality in Nordic countries does seem to be somewhat larger than in Spain. This would not be surprising given the overall higher alcohol-related mortality there.[2]

Interpretation of results

The observed age-specific socioeconomic differentials in alcohol-related mortality among women are particularly worth noting. The observed age-effects do not seem to be driven by age factors given the substantial differences in the adoption of alcohol consumption across women from different socioeconomic statuses and cohorts.[34] A plausible explanation may be found in the theory of diffusion of innovations[35] regarding alcohol use. Similar to what has been well-documented for smoking in Spain,[36] alcohol use first became widespread among men, followed by women from high socioeconomic classes before women from low socioeconomic classes also began consuming alcohol in larger numbers. In the context of our study, the oldest age group (85 and over) was born before 1943 and represents a generation of women characterised by large socioeconomic differentials in alcohol use. This is the case in Spain as well as in most European countries.[37 38] Conversely, current Spanish middle-aged women were born in a context of a more widespread alcohol use among all socioeconomic classes, and as current drinking patterns suggest, they will continue to drink at older ages. It is therefore possible that alcohol consumption and alcohol-related problems in older women will increase in the near future.[34 38]

Our findings on the increasing relative educational inequalities over age (except for the older age groups) are in line with the literature on socioeconomic inequalities in health and were observed as well for smoking-related mortality in Spain.[33] Yet, in absolute terms, inequalities increase with age as a result of an accumulation of exposures across the life course that have been affected by the social and economic experiences of the individual.[39 40] However, at old age variables such as income and education become less decisive determinants for health as age becomes a leveller mechanism, in part due to selective mortality as frailer individuals, who are more likely to pertain to a lower socioeconomic class, die earlier and surviving members may then be less sensitive to income gains and losses.[41 42]

The results of our study should be also framed in the context of the alcohol consumption situation in Spain. According to data from the early 2010s, high socioeconomic groups tend to have higher binge drinking consumption prevalence compared with their lower educated counterparts.[43] Given that binge drinking or heavy episodic drinking patterns are the highest contributor to morbidity and mortality outcomes,[8] our results may therefore seem counterintuitive as we found higher alcohol-related mortality among the lower educated. Yet, this so-called alcohol-harm paradox is observed and documented elsewhere.[10 11] Our results, could be partly explained by the interaction between binge drinking and overall alcohol consumption. For example, the prevalence of high risk drinker (an average of >40 g/day in the last 12 months among men and >24 g/day among women) does not show educational differences in men, while a positive educational gradient was apparent in binge drinking.[43] In the case of women, educational differences in heavy drinking were even larger as compared with binge drinking.[43] Thus, the prevalence of high-risk drinkers seems to partly explain the alcohol-harm paradox. Yet, further studies are needed, preferably that include dietary patterns[44] with as well as morbidity and mortality follow-ups, to disentangle the mechanisms that contribute the most to explaining the socioeconomic differences in alcohol consumption and related health outcomes.

Evaluation of data and methods

This study relied on MCOD data to estimate alcohol-related mortality. This is the first time that these estimates are produced for Spain. Using MCOD, we estimated around 2640 annual deaths (2016–2018), which represents increases of 75% and 50% among men and women, respectively, compared with UCOD estimates. However, we only included those causes of death 100% attributable to alcohol, meaning that they would not have occurred without alcohol consumption. We therefore left out major alcohol-related chronic diseases that are not always or entirely attributable to alcohol, including liver cancer, non-alcoholic liver cirrhosis, ischaemic heart diseases and stroke.[1 45 46] Recent research using attributable fraction (AF) approaches estimated around 15 000 annual deaths in Spain in the period 2010–2017[28] and around 31 500 deaths in 2017 according to the Global Burden of Disease estimates.[47] Our estimate of the impact of alcohol on male life expectancy (0.15 years in

2016–2018) is also lower when compared with those from another GBD data-based study (0.95 years in 2013).[48] These differences could be due to several factors. While AF-driven approaches capture a larger proportion of mortality that stems from alcohol consumption (and thus educational differences), these methods have been criticised for its potential biases in combining different sources of data. First, it is the difficult to obtain accurate estimates of alcohol consumption and relative risks for alcohol-attributable health outcomes that may differ across countries and socioeconomic status.[21] Second, capturing old-age mortality patterns is particularly challenging. Indeed, in Spain, almost half of the estimated 15 000 annual deaths were actually at ages 75 and over (nearly 7000),[28] but discrepancies across estimates may be important.[20 21 49]

Overall, we must acknowledge that MCOD methods in Spain may not be accurately capturing deaths from causes partly related to alcohol, as recently documented and discussed in the US context.[24 50] For instance, alcohol-related cancer mortality was only very rarely accounted for in the MCOD approach, compared with the 6500 deaths estimated using AF approach.[28] Furthermore, we did not include non-alcoholic liver cirrhosis (ICD-10: K74), even though an important share of deaths from liver cirrhosis is estimated to be attributable to alcohol: over 80% for men aged 45–74[28] ; or around 60%–80% in high-income countries.[51] Consequently, liver cirrhosis is one of the most important contributors to overall alcohol-related mortality in Spain.[28 52] These elevated shares may be partly due to the high stigmatisation in reporting causes of death where alcohol is explicitly mentioned.[24 53] We therefore performed a sensitivity analysis by including non-alcoholic liver cirrhosis (K74) in our alcohol-related mortality estimates. Results showed that the impact of alcohol on life expectancy increased by up to 0.5 years for lower educated men. The contribution of alcohol to overall life expectancy inequalities increased to 6.5% and 2.6% among men and women, respectively (compared with our original estimates of 3.2% and 0.7%); and these estimates were larger when restricting the population to ages 30 to 74 (9.0% among men and 4.8% among women) (see online supplemental tables S2-S4).

In addition, as in all cause-specific mortality studies, we must acknowledge that death certificates may not always be accurately filled out.[54] Although the quality of vital registration systems is considered to be 'very high' in Spain,[55] further research is needed to more comprehensively assess the biases that exist in the death certificate data.[56] One possible way to improve the quality of mortality data would be to increase the share of autopsied bodies (currently around 5.6%) to, for example, the levels of Finland (21%),[57] and to assess the extent to which certificates may be differently completed according to socioeconomic status.

Furthermore, regarding the methodological details we have used cause-deleted life table methods for estimating PGLE. We did so as our aggregated results seemed much lower compared with AF-derived estimates. Yet, in other types of MCOD studies cause-deleted life table should be used carefully as they may overestimate the final outcome.

Finally, as in all studies examining socioeconomic inequalities, the results are sensitive to the socioeconomic variables chosen and its distribution. In our case education was the only possibility in our data. However, the rapid educational expansion in the Spanish society represents a challenge in the ability to compare educational inequalities across age. We therefore grouped the educational attainment categories (less than or equal to primary school, secondary school, postsecondary vocational and university education) in order to ensure enough cases at both extremes in the youngest and oldest ages. Despite the abovementioned limitations and given that our aim was to estimate socioeconomic inequalities, the MCOD approach is preferred above the UCOD approach, even if the impact of alcohol on mortality is likely to be underestimated as the AF approach also suffers from uncertainties in its estimates and limitations of its use for studying socioeconomic differentials.

CONCLUSIONS

Alcohol-related mortality inequalities according to socioeconomic status remain important in Spain. The existence of distinct age-specific patterns, with inequalities being stronger among younger age groups suggest socioeconomic inequalities to persist in the coming decades. These inequalities had an undesirable impact on overall mortality inequalities, both in terms of mean indicators (life expectancy) and dispersion of deaths (lifespan inequalities). Our estimates based on MCOD raised the death counts substantially compared to when only UCOD would have been used. Finally, monitoring recent trends in alcohol use and related mortality is necessary to obtain a deeper understanding of its role on all-cause mortality. Public health policymakers should consider tackling alcohol abuse in order to reduce the harmful effects of alcohol on health outcomes and monitor inequalities across population groups.

Contributors ST-L contributed to the conception and design of the work; the acquisition, analysis and interpretation of data for the work; drafted and revised the work critically for important intellectual content; approved the final version of the work to be published; and agrees to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. JS contributed to the conception and design of the work; contributed to the interpretation of data for the work; revised the work critically for important intellectual content; approved the final version of the work to be published. ST-L is acting as guarantor.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involved secondary data analysis of public sources, which did not have any individual identifiers. As such, ethical approval for human subject research from the Institutional Review Board of the respective institutions was exempted.

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Data availability statement Data may be obtained from a third party and are not publicly available. Multiple causes of death data and population exposures by educational attainment was obtained from the Instituto Nacional de Estadística (INE). Interested researchers have the possibility to obtain data access by contacting INE.

ORCID iDs
Sergi Trias-Llimós http://orcid.org/0000-0002-8052-6736
Jeroen J. A. Spijker http://orcid.org/0000-0002-3957-9553

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Supplementary material

Figure S1. Distribution of the population by educational levels, Spain 2016-18

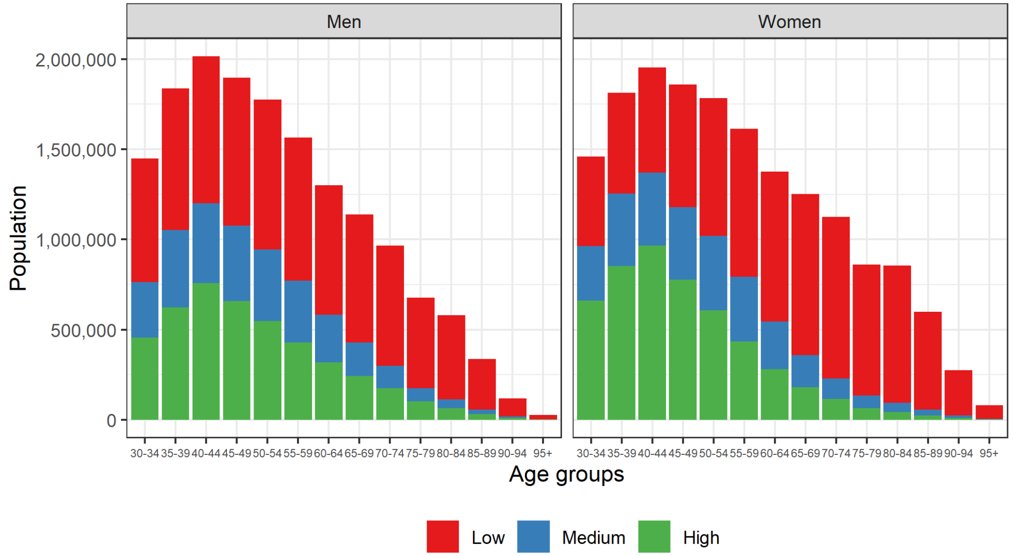

Table S1. Contribution of alcohol to all-cause life expectancy educational inequalities between ages 30 and 74 by sex, Spain 2016-18

	ALL	Low	Middle	High	Inequality gap	% Reduction in inequality by eliminating alcohol
Men						
e_{30}	41.93	41.15	42.37	43.00	1.85	
e_{30} eliminating alcohol	42.00	41.26	42.43	43.03	1.77	
PGLE alcohol	0.08	0.11	0.06	0.03	0.08	4.2%
Women						
e_{30}	43.48	43.11	43.67	43.87	0.76	
e_{30} eliminating alcohol	43.49	43.13	43.68	43.88	0.74	
PGLE alcohol	0.01	0.02	0.01	0.01	0.01	1.8%

Table S2. Contribution of alcohol (and liver cirrhosis) to all-cause life expectancy and lifespan educational inequalities at age 30 by sex, Spain 2016-18

	ALL	Low	Middle	High	Inequality gap	% Reduction in inequality by eliminating alcohol
Men						
e_{30}	50.66	49.19	52.49	53.36	4.17	
e_{30} eliminating alcohol	51.04	49.67	52.82	53.57	3.90	
PGLE alcohol	0.38	0.48	0.33	0.21	0.27	6.5%
sd_{30}	12.86	13.63	12.89	11.66	-1.98	
sd_{30} eliminating alcohol	12.70	13.45	12.73	11.56	-1.89	
difference	-0.16	-0.19	-0.16	-0.10	-0.09	4.3%
Women						
e_{30}	55.92	55.16	57.61	57.73	2.56	
e_{30} eliminating alcohol	56.04	55.31	57.72	57.81	2.50	
PGLE alcohol	0.12	0.15	0.10	0.08	0.07	2.6%
sd_{30}	11.46	12.19	11.39	10.69	-1.50	
sd_{30} eliminating alcohol	11.39	12.10	11.32	10.64	-1.45	
difference	-0.07	-0.09	-0.07	-0.04	-0.05	3.2%

Table S3. Contribution of alcohol (and liver cirrhosis) to all-cause life expectancy educational inequalities between ages 30 and 74 by sex, Spain 2016-18

	ALL	Low	Middle	High	Inequality gap	% Reduction in inequality by eliminating alcohol
Men						
e_{30}	41.93	41.15	42.37	43.00	1.85	
e_{30} eliminating alcohol	42.10	41.40	42.51	43.08	1.68	
PGLE alcohol	0.18	0.24	0.14	0.08	0.17	9.0%
Women						
e_{30}	43.48	43.11	43.67	43.87	0.76	
e_{30} eliminating alcohol	43.52	43.17	43.70	43.89	0.72	
PGLE alcohol	0.04	0.06	0.03	0.02	0.04	4.8%

Table S4. Age-standardized alcohol-related (and liver cirrhosis) mortality rates (per 100,000) by age groups and educational attainment, and relative index of inequalities (RII) Spain 2016-18

	Age-standardized mortality rates by educational group (95%CI)								Inequalities	
	ALL		Low		Middle		High		RII (95%CI)	SII
Men										
30-44	3.0	(2.7- 3.3)	5.3	(4.7- 5.8)	2.4	(1.9- 2.9)	0.8	(0.6- 1.0)	**6.04 (4.62-7.89)**	4.3
45-64	39.2	(38.3-40.0)	55.3	(53.8-56.8)	31.5	(29.8-33.2)	17.3	(16.2-18.4)	**3.23 (2.45-4.26)**	41.3
65-84	80.0	(78.3-81.8)	90.8	(88.5-93.0)	62.9	(58.5-67.2)	50.1	(46.8-53.5)	**1.88 (1.71-2.07)**	48.9
85+	56.0	(52.2-59.8)	58.4	(54.2-62.7)	45.1	(32.1-58.2)	42.6	(31.9-53.4)	**1.42 (1.04-1.93)**	19.4
All ages 30+	37.6	(37.0-38.1)	47.4	(46.6-48.2)	29.9	(28.7-31.1)	20.6	(19.7-21.5)	**2.50 (1.57-3.99)**	32.2
Women										
30-44	0.9	(0.7- 1.0)	1.7	(1.4- 2.1)	0.9	(0.6- 1.3)	0.3	(0.2- 0.4)	**5.48 (3.03-9.93)**	1.2
45-64	7.2	(6.8- 7.5)	9.9	(9.3-10.5)	6.1	(5.4- 6.9)	3.6	(3.1- 4.1)	**2.79 (2.35-3.31)**	6.8
65-84	25.0	(24.1-25.9)	26.5	(25.5-27.5)	19.0	(16.5-21.6)	17.7	(15.2-20.2)	1.60 (1.33-1.93)	11.5
85+	29.0	(27.0-31.0)	29.2	(27.1-31.3)	22.7	(15.0-30.4)	32.4	(22.1-42.7)	1.01 (0.74-1.38)	0.3
All ages 30+	10.2	(9.9-10.4)	11.9	(11.6-12.3)	8.1	(7.4- 8.8)	7.0	(6.4- 7.7)	**2.39 (1.58-3.63)**	8.4