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The cost of premature death from cancer attributable to alcohol: Productivity losses in Europe in 2018

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ABSTRACT

Background: More than 1.9 million people die from cancer each year in Europe. Alcohol use is a major modifiable risk factor for cancer and poses an economic burden on society. We estimated the cost of productivity lost due to premature death (under 65 years of age) from alcohol-attributable cancer in the European Union (EU) plus Iceland, Norway, Switzerland, and the United Kingdom (UK) in 2018.
Methods: We estimated cancer deaths attributable to alcohol using a Levin-based population attributable fractions method and cancer deaths in 2018 from the Global Cancer Observatory. Lost productivity was estimated for all alcohol-attributable cancer deaths by sex, cancer site, and country. Productivity losses were valued using the human capital approach.
Results: An estimated 23,300 cancer deaths among people aged less than 65 in the EU plus Iceland, Norway, Switzerland and the UK in 2018 were attributable to alcohol (18,200 males, 5100 females). This equated to €4.58 billion in total productivity losses in the region and 0.027 % of the European Gross Domestic Product (GDP). The average cost per alcohol-attributable cancer death was €196,000. Productivity lost to alcohol-attributable cancer per capita was highest in Western Europe. Hungary, Romania, Slovakia, Latvia, Lithuania, and Portugal had the highest rate of premature mortality from alcohol-attributable cancer and the highest productivity lost as a share of national GDP.
Conclusion: Our study provides estimates of lost productivity from alcohol-attributable cancer death in Europe. Cost-effective strategies to prevent alcohol-attributable cancer deaths could result in economic benefits for society and must be prioritised.

1. Introduction

Cancer is a major burden of disease in Europe with nearly 4.4 million people diagnosed in the region every year [1]. At least 1.9 million people die from cancer in Europe annually, and cancer deaths in the European Union (EU) are predicted to increase by 29 % by 2040 [2], providing grounds for Europe's Beating Cancer Plan [3]. Part of this plan encompasses reducing the use of alcohol which is higher in Europe than in other world regions [4]. Drinking alcohol is a causal factor for cancers of the oral cavity, pharynx, larynx, oesophagus, liver, colorectum, and breast [5], and alcohol consumption was responsible for an estimated 180,000 cases of cancer, or 4.5 % of all cases, in Europe in 2020 [6].

As one of the most prominent modifiable risk factors for cancer, alcohol consumption has the potential to generate a high economic burden on society due to direct costs of health care or indirect costs such as loss of productivity from alcohol-attributable cancers. In Europe, losses in paid productivity due to premature death from cancer cost an estimated €50–€53 billion in 2018 [7,8]. Furthermore, total productivity lost due to alcohol-attributable mortality from all alcohol-related diseases and injuries in the EU plus the United Kingdom (UK) has been

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estimated at €32.1 billion in 2016 [9]. Quantifying the contribution of alcohol-attributable cancers to productivity losses would be of great value and provide a new perspective on the impact of risk factors on economic cost of disease. To our knowledge, costs due to alcohol-attributable cancers have not yet been estimated.

We therefore aimed to estimate the cost of productivity lost due to premature mortality (death under 65 years of age) from alcohol-attributable cancer among men and women in the EU plus Iceland, Norway, Switzerland, and the UK in 2018. Our estimates will provide evidence of the cost of alcohol-attributable cancers to society and may support development of alcohol control policies within each country of the EU. They will also provide an example of productivity lost to risk factor-attributable disease for nations with a high burden of disease or those where prevalence of exposure to risk factors is high.

2. Methods

2.1. Cancer deaths attributable to alcohol consumption

We calculated the number of cancer deaths in the 27 EU countries plus Iceland, Norway, Switzerland, and the UK in 2018 attributable to alcohol consumption using a Levin-based population attributable fraction (PAF) method [10] adapted from a recent study by Rumgay et al. [6]. PAFs were based on a theoretical minimum-risk exposure of lifetime abstention from alcohol consumption. From the Global Cancer Observatory, GLOBOCAN 2018 database [11], we obtained the number of deaths and population by five-year age group (from 25–29 to 60–64 years), sex and country for cancer sites with "sufficient" or "limited" evidence of a causal relationship with the consumption of alcoholic beverages, as defined by the most recent International Agency for Research on Cancer (IARC) Monograph [5], and evidence suggesting a causal association with alcohol consumption as classified by the World Cancer Research Fund [12]. This constituted the following: oral cavity cancer (International Statistical Classification of Diseases and Related Health Problems, 10th revision [ICD-10] C00–06); oropharyngeal cancer (C09–10); oesophageal cancer (C15); stomach cancer (C16); colon cancer (C18); rectal cancer (C19–20); liver cancer (C22); pancreatic cancer (C25); laryngeal cancer (C32); breast cancer (C50, females only). Due to the specific causal association with hepatocellular carcinoma (HCC) and oesophageal squamous cell carcinoma (SCC), national estimates of the proportion of HCC (International Classification of Diseases for Oncology, 3rd edition [ICD-O-3] morphology codes 8170–8175) and oesophageal SCC (ICD-O-3 8050–8078, 8083–8084) cases among all liver cancer or oesophageal cancer cases, respectively, by sex in 2018 were obtained from two studies [13,14], and applied to the GLOBOCAN estimates of liver cancer and oesophageal cancer deaths. Alcohol-attributable mortality was thus estimated for HCC and oesophageal SCC specifically.

Assuming a 10-year latency between year of alcohol exposure data and cancer death, as in previous alcohol PAF studies [6,15], we extracted alcohol prevalence data as litres of alcohol per capita in 2008 by country, disaggregated by age (15–19, 20–24, 25–34, 35–49, 50–64 years) and sex, from the Global Information System on Alcohol and Health [16]. We then converted this to grams of alcohol per day. The distribution of daily adult alcohol consumption was modelled using a Gamma distribution where the scale parameters were estimated from the mean consumption and standard deviation [17,18]. We assumed there were no differences between risk of cancer incidence or mortality from alcohol consumption nor by age or sex, and used cancer relative risk estimates per 10 g increase in alcohol consumed per day from the World Cancer Research Fund Continuous Update Project [12], as obtained by Rumgay and colleagues [6], which were adjusted for sex, age, and other confounders. The relative risk estimates used are presented in Supplementary Table 1.

PAFs were calculated for each age group, sex, country, and cancer site by combining the age-, sex- and country-specific alcohol consumption prevalence of current drinkers (P) for 2008 with estimates of the relative risk (RR) of cancer per 10 g of alcohol per day for all amounts of alcohol consumed (x) from 0.1 to 150 g per day using the following formula:

$$\mathrm{PAF} = \frac{\int_{0\cdot 1}^{150} P(x)(\mathrm{RR}(x) - 1)\mathrm{d}x}{\int_{0\cdot 1}^{150} P(x)(\mathrm{RR}(x) - 1)\mathrm{d}x + 1}$$

To obtain the number of alcohol-attributable cancer deaths per sex, country, and cancer site, age-specific PAFs were applied to number of cancer deaths in 2018 in each five-year age group while factoring in the 10-year latency period; e.g. the PAF for oral cancer in males for the 25–34 age group was applied to the number of deaths from oral cancer in males in the 35–39 and 40–44 age groups in each country. As most economic studies report crude costs as opposed to age-standardised costs, we calculated crude rates of alcohol-attributable premature cancer mortality per 100,000 person-years.

2.2. Productivity lost due to premature mortality

Loss of labour productivity is the loss of production for society due to death or temporary or permanent disability because of an illness [8]. In the case of premature death, loss is estimated using the difference between the age at which a person dies and the age they were expected to work until (years of potential productive life lost [YPPLL]), which is valued using the expected gross wage or income they would have generated if they lived until that age (this is understood as "paid production loss") [8,19,20]. We estimated productivity lost in the productive age group of 25–64 years old assuming alcohol-attributable cancer deaths from age 25 and retirement at age 65. Following a societal perspective, we used the main method to estimate productivity lost, the human capital approach [19,20], to calculate the cost associated with productivity loss assuming that the potential labour productivity was lost towards the end of the working life if a person dies prematurely.

Absolute numbers of alcohol-attributable cancer deaths per five-year age group were derived as above. Deaths were calculated in terms of YPPLL as the difference between the age at death and age 65. We estimated labour productivity cost due to paid work using market annual gross wages by sex, age group (15–29, 30–39, 40–49, 50–59, 60–64) and country, from the Eurostat Structure of Earnings Survey 2014 [21]. Data were inflated to 2018 values using the Harmonized Index of Consumer Price [22]. Earnings were adjusted to each country's economic conditions using country-specific unemployment rates [23] and labour force participation rates [24], disaggregated by sex and age group. The unemployment and labour force participation rate data were available for different age groups than the data on earnings from Eurostat, therefore the average of combined age bands was calculated. The premature mortality productivity cost for each cancer death was valued by multiplying YPPLL by the sex-, age-adjusted and economic condition adjusted wages for each country. These were summed across all alcohol-attributable cancer deaths to provide a total cost by sex, country, and region within Europe, and for Europe as a whole, and expressed as cost per premature death.

We assumed that wages grew at the average Gross Domestic Product (GDP) growth rate between 2000 and 2018 for each European country. GDP growth was calculated based on GDP at current market prices data [25]. Future production costs were discounted at 3.5 % per annum. An incidence approach was used, and all costs were expressed in 2018 euros. For each country, the total costs of productivity lost due to premature mortality from the selected cancer sites are presented as the per capita cost and as a proportion of the country's total GDP. All graphics were built using R (version 3.6.1).

3. Results

3.1. Premature cancer deaths attributable to alcohol in Europe

In the 27 EU countries plus Iceland, Norway, Switzerland, and the UK, an estimated 23,300 cancer deaths among people aged less than 65 in 2018 were attributable to drinking alcohol (Table 1). Males represented 78 % of the total premature cancer deaths attributable to alcohol with approximately 18,200 cancer deaths, and there were 5100 cancer deaths among females. The cancer sites which contributed the most alcohol-attributable deaths among males were cancers of the colorectum (3400 deaths, 18.8 %), liver (3300 deaths, 17.9 %), pancreas (3200 deaths, 17.7 %) and oesophagus (3200 deaths, 17.3 %). Among females, breast cancer contributed more than half of alcohol-attributable deaths (2600 deaths, 50.7 %), and was followed by colorectal cancer (770 deaths, 15.1 %) and pancreatic cancer (510 deaths, 10.0 %).

Within Europe, countries in Western Europe contributed the largest number of premature cancer deaths attributable to alcohol with a total of 8800 cancer deaths (37.9 % of all deaths in the 27 EU countries plus Iceland, Norway, Switzerland, and the UK) (Table 2). Relative to population size, Central and Eastern Europe had the highest burden of premature cancer mortality attributable to alcohol consumption (10.8 deaths per 100,000 people); this was also the case when comparing rates for males and females (17.3 and 4.2 deaths per 100,000 men and women, respectively, in Central and Eastern Europe).

3.2. Productivity losses due to premature cancer deaths attributable to alcohol in Europe

The total value of productivity losses due to premature cancer deaths attributable to alcohol in 2018 was €4.58 billion. Premature cancer deaths among males contributed €3.69 billion in productivity losses (81 %) with the remaining €890 million from females (19 %). The costliest cancer sites in terms of total productivity losses were cancers of the colorectum (€799 million), pancreas (€740 million), liver (€717 million), and oesophagus (€697 million) (Table 1).

The average cost per alcohol-attributable premature cancer death was €196,000. The costliest cancer sites among males were cancers of the oral cavity (€219,000/death) and oropharynx (€216,000/death) (Fig. 1). Among females, the costliest cancer site per premature death was breast cancer (€196,000/death) followed by oral cavity cancer (€163,000/death) and oesophageal cancer (€162,000/death).

3.3. Regional and national productivity losses due to premature cancer deaths attributable to alcohol

The burden of alcohol-attributable cancer deaths and productivity lost differed between countries and regions within Europe (Fig. 2). The total productivity lost to premature mortality from alcohol-attributable cancer was largest in Western Europe at €2.37 billion (Table 2), 76 % of which was represented by Germany (€1.12 billion) and France (€695 million). The total cost of alcohol-attributable cancer mortality among the European regions was lower in Northern Europe (€877 million) and Southern Europe (€801 million), and Central and Eastern Europe (€529 million). Relative to population size, total productivity cost per capita was highest in Switzerland (€18.90 per person), Germany (€13.60), and Austria (€13.00), resulting in Western Europe as the region with the highest productivity cost per capita (€12.20) (Supplementary Table 2, Supplementary Figs 1 and 2). Conversely, countries in Southern and Central and Eastern Europe had the lowest cost per capita including Malta, Bulgaria, Cyprus, Greece, Croatia, and Italy which had productivity costs less than €5 per capita. In all countries, the cost of productivity lost to premature death from alcohol-attributable cancer per capita was higher for males than females. The countries with the largest cost per premature death from alcohol-attributable cancer were Switzerland (€582,600/death), Norway (€418,000/death), Ireland (€374,000/death), and Denmark (€358,700/death) (Supplementary Table 2).

The total cost of productivity lost to alcohol-attributable cancer as a share of the combined GDP of the EU plus Iceland, Norway, Switzerland, and the UK was 0.027 %. The countries with the highest cost of productivity lost as a share of national GDP were Hungary, Romania, Slovakia, Latvia, Lithuania, and Portugal (all between 0.045 % and 0.069 % of GDP) which corresponded with the countries which had the highest rate of premature cancer death attributable to alcohol (Fig. 2B and C, Supplementary Table 2). The countries with the lowest cost of productivity as a share of GDP were Malta (0.001 %), Luxembourg (0.008 %), and Norway and Sweden (both 0.011 %).

4. Discussion

In the 27 EU countries plus Iceland, Norway, Switzerland, and the UK in 2018, more than 23,300 cancer deaths among people aged less than 65 were attributable to alcohol consumption, resulting in €4.58 billion in total productivity losses in the region. Premature cancer death from

Table 1
Premature deaths from alcohol-attributable cancers and productivity lost (in €) to alcohol-attributable cancer death in the 27 countries in the European Union plus Iceland, Norway, Switzerland, and the United Kingdom in 2018, overall and by cancer site and sex.

	Males		Females		Both sexes	
Cancer site (ICD-10)	Number of deaths attributable to alcohol	Productivity cost (million €)	Number of deaths attributable to alcohol	Productivity cost (million €)	Number of deaths attributable to alcohol	Productivity cost (million €)
Oral cavity (C00–C06)	2200	490	250	41	2500	531
Oropharynx (C09–C10)	1500	330	130	21	1700	351
Oesophagus (C15)[a]	3200	621	470	76	3600	697
Stomach (C16)	340	67	30	4	360	71
Colorectum (C18–C20)	3400	678	770	121	4200	799
Liver (C22)[b]	3300	675	300	43	3600	717
Pancreas (C25)	3200	666	510	74	3700	740
Larynx (C32)	1100	161	50	6	1100	167
Breast (C50)	-	-	2600	505	2600	505
All alcohol-related cancers[c]	18,200	3690	5100	890	23,300	4580

ICD-10, International Classification of Diseases (tenth revision).
[a] Oesophageal squamous cell carcinoma (ICD-10 code C15; ICD-O-3 codes 8050–8078, 8083–8084).
[b] Hepatocellular carcinoma (ICD-10 code C22; ICD-O-3 codes 8170–8175).
[c] All alcohol-related cancers: total of all cancer sites associated with alcohol drinking.

Table 2
Premature deaths from cancer attributable to alcohol and productivity lost (in €) to alcohol-attributable cancer death, and cost of lost productivity per premature death (€), in the 27 countries in the European Union plus Iceland, Norway, Switzerland, and the United Kingdom in 2018, by sex and European region.

Region/Country	Males				Females				Both sexes				
	Number of deaths attributable to alcohol	Mortality rate per 100,000	Productivity cost (million €)	Cost per death (€)	Number of deaths attributable to alcohol	Mortality rate per 100,000	Productivity cost (million €)	Cost per death (€)	Number of deaths attributable to alcohol	Mortality rate per 100,000	Productivity cost (million €)	Productivity cost per capita (€)	Cost per death (€)
Central-Eastern Europe	5200	17.3	451	86,200	1300	4.2	78	61,800	6500	10.8	529	5.80	81,400
Northern Europe	2400	7.2	653	277,300	940	2.9	224	239,100	3300	5.1	877	8.40	266,400
Southern Europe	3800	8.8	682	179,300	890	2.1	119	134,400	4700	5.4	801	5.90	170,800
Western Europe	6800	10.9	1900	278,600	2000	3.3	469	234,000	8800	7.1	2370	12.20	268,500
EU-27+ Iceland, Norway, Switzerland, UK	18,200	10.8	3690	202,400	5100	3.1	890	174,800	23,300	6.9	4580	8.70	196,400

EU, European Union; UK, United Kingdom.

drinking alcohol equated to 0.027 % of the European GDP. Productivity lost to premature mortality from alcohol-attributable cancer per capita was largest in Western Europe, but some countries in Northern, Southern, and Central and Eastern Europe had the highest rate of premature mortality from alcohol-attributable cancer and the highest productivity lost in terms of the share of their national GDP.

Europe has the highest levels of alcohol consumption per capita in the world which has led to a substantial burden of cancer attributable to alcohol [4,6]. Previous studies have not identified the specific cost of productivity lost to alcohol-attributable cancers, but we have recently estimated that paid productivity losses due to premature mortality from cancer reached a total of €52.9 billion in the EU plus Iceland, Norway, Switzerland, and the UK in 2018 [8]. Our main finding of €4.58 billion lost to alcohol-attributable cancer represents 9 % of this total, yet we found a higher average cost per death here than in the earlier study (€196,000 versus €152,000) [8]. As the same data sources and methodology were used to calculate productivity losses in both studies, the higher cost per death could be a result of younger age at death from alcohol-attributable cancers and the combination of a predominantly male burden of alcohol-attributable cancer deaths – largely due to men in Europe consuming around three times the volume of alcohol per person as women [4] – with higher rates of labour market participation and wages among men than women in Europe [8]. In another study, Łyszczarz used number of deaths attributable to alcohol from the Global Burden of Disease Study 2016 and income data from Eurostat to estimate a total €32.1 billion production losses associated with all alcohol-related deaths in the EU plus the UK in 2016 [9]. The sex-distribution of productivity losses was similar to our estimate (81 % of productivity losses from male deaths in both studies), again demonstrating the influence of higher alcohol consumption among males than females on disease burden and productivity lost in Europe [9]. The study by Łyszczarz reported the highest burden of productivity lost to alcohol-attributable death from all causes as a share of national GDP in Lithuania (0.875 % of GDP), Latvia (0.751 %), Estonia (0.640 %) and Romania (0.626 %) [9], which was a similar pattern to our cancer-specific findings.

In our study, alcohol-attributable cancer mortality represented 0.027 % of the total GDP in the EU plus Iceland, Norway, Switzerland, and the UK in 2018. The regional patterns we observed were due to disparities in alcohol intake between countries; for example, the highest per capita alcohol consumption in Europe in 2008 was in Romania where 18.7 litres of alcohol were consumed per capita compared with 9.3 litres in Norway [16]. We found that the pattern of countries with a larger share of GDP lost to paid productivity was similar to that of countries which had the highest rates of premature mortality from alcohol-attributable cancers. However, productivity lost to alcohol-attributable cancers per capita was greater in Western Europe, reflecting higher average incomes than other regions and thus a greater loss of potential income. We believe that reporting both cost as a share of GDP and cost per capita is therefore important to better understand the societal cost of alcohol-attributable cancer deaths.

Our results are certainly an underestimate of the total loss of productivity due to alcohol-attributable cancer deaths. Ortega-Ortega et al. found that losses in unpaid employment due to premature cancer death contributed nearly 50 % of the total losses in productivity, taking the total cost of productivity lost due to cancer up to €104.6 billion [8]. We did not estimate unpaid productivity costs because we did not have access to estimates of unpaid production and time spent on unpaid tasks, but we would expect the total cost of productivity lost to markedly increase if including unpaid employment. Other productivity losses which could be considered in future analyses — if appropriate data become available — are losses due to impaired working and absenteeism of an employee, such as temporary work absences or reduced working capacity due to cancer symptoms or treatment, as well as wider productivity loss among cancer caregivers e.g. close family members while they accompany cancer patients during their treatments or provide care at other times. Other productivity loss analyses could include use of the

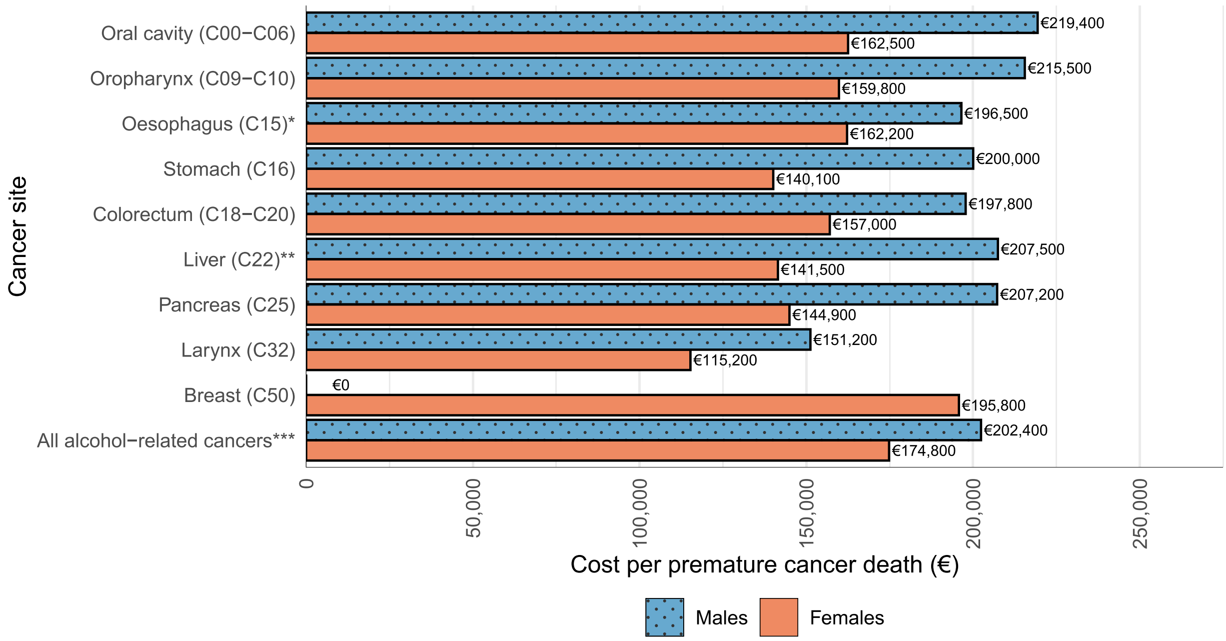

Fig. 1. Cost per premature death (in €) from alcohol-attributable cancers in the 27 countries in the European Union plus Iceland, Norway, Switzerland, and the United Kingdom in 2018, by cancer site and sex. *Oesophageal squamous cell carcinoma (ICD-10 code C15; ICD-O-3 codes 8050–8078, 8083–8084). **Hepatocellular carcinoma (ICD-10 code C22; ICD-O-3 codes 8170–8175). ***All alcohol-related cancers: total of all cancer sites associated with alcohol drinking.

friction cost approach which assumes the economy replaces those who die or are unable to work due to illness, thus the productivity lost by the employer only occurs at the time when the work isn't done or while replacing the worker [26]. As has been shown previously [27], using the friction cost approach is likely to produce lower estimates than the human capital approach, but it could provide a useful comparison to our findings on societal losses of potential labour productivity.

While productivity losses due to premature mortality pose an indirect cost to society, direct costs include cost of cancer care and treatment. A further study on the cost of cancer in Europe included additional economic measures and estimated that the total cost of cancer in the EU plus Iceland, Norway, Switzerland, and the UK in 2018 reached €199 billion which composed of €103 billion from health expenditure on cancer care, €26 billion from informal care, and €70 billion in loss of paid productivity (€50 billion from premature mortality and €20 billion from morbidity) [7]. For overall alcohol-related costs, a systematic review of mainly European and North American studies found a third of the economic costs of alcohol use to society were direct, including the cost of health care, the criminal justice system, and road traffic accidents, but productivity losses including premature mortality and impaired productivity in the workplace were the main driver of cost (61.2 % of estimated cost) [28]. Future studies on the cost of alcohol-attributable cancers which incorporate both direct and indirect costs would be of value to estimate their full economic and societal impact.

Our study adds a new perspective to assessments of alcohol-attributable cancer burden which will assist priority setting for alcohol and cancer control. This economic assessment complements — and provides an important backdrop for — cost-effectiveness analyses conducted to set priorities in alcohol control, such as policies proposed by the WHO as part of their 'best buys' for tackling non-communicable diseases [29]. The most cost-effective policies were determined through weighing up dollars spent on policy implementation versus gain in healthy life year [30]; the policies deemed most cost-effective were an increase in excise taxes and the enactment and enforcement of restrictions to purchasing availability and marketing. As part of Europe's Beating Cancer Plan, the EU commission has committed to review EU legislation on alcohol taxation and alcohol marketing to young people [3]. Other WHO-recommended alcohol policy strategies include minimum unit pricing [31], adding cancer warning labels to alcohol products [32], and giving brief advice to patients in primary care [33]. Minimum unit pricing principally affects low-cost high-strength alcohol and has been shown to reduce alcohol consumption among heavy drinkers in lower socioeconomic groups in Scotland [31]. The EU Commission also indicated that it will review its policy on pricing of alcoholic beverages and propose mandatory health warnings on labels on alcoholic beverages before the end 2023, and provide support for Member States to implement evidence-based brief interventions on alcohol in primary care as well as the workplace and through social services [3]. Additionally, measuring the impact of changes in alcohol policy on cancer burden would provide further evidence for prioritisation of cancer prevention strategies. The impact of increases in alcohol excise taxes on cancer burden in Europe has already been modelled [34,35], but these assessments have not yet been supplemented with the costs of alcohol-attributable cancers which could expand future cost-effectiveness analyses of alcohol control or cancer prevention policies.

There are several limitations to our study including the number of assumptions in the model used to calculate the alcohol-attributable cancer deaths. In these calculations we used relative risk estimates for cancer incidence which we applied to cancer deaths; while this requires the assumption that alcohol consumption has no relevant influence on the prognosis of the cancers analysed, and across different levels of intake, this assumption has been used in other comparative risk assessment studies of alcohol and cancer death [15,36]. Similarly, the relative risk estimates were not specific to the European population nor for sex or age, thus heterogeneity in cancer risk between world populations and between sexes and age groups were not considered, although sex and age were adjusted for in each of the relative risk estimates used. Finally, we computed lost productivity to the age of 65 because this represents the time when many people in Europe retire from the workforce. Assuming that productivity lost ends at age 65 may underestimate the true cost, as some older people remain in the workforce. However, there are insufficient data on participation rates and wages in different European countries beyond the age of 65 to produce reliable estimates therefore this was not considered.

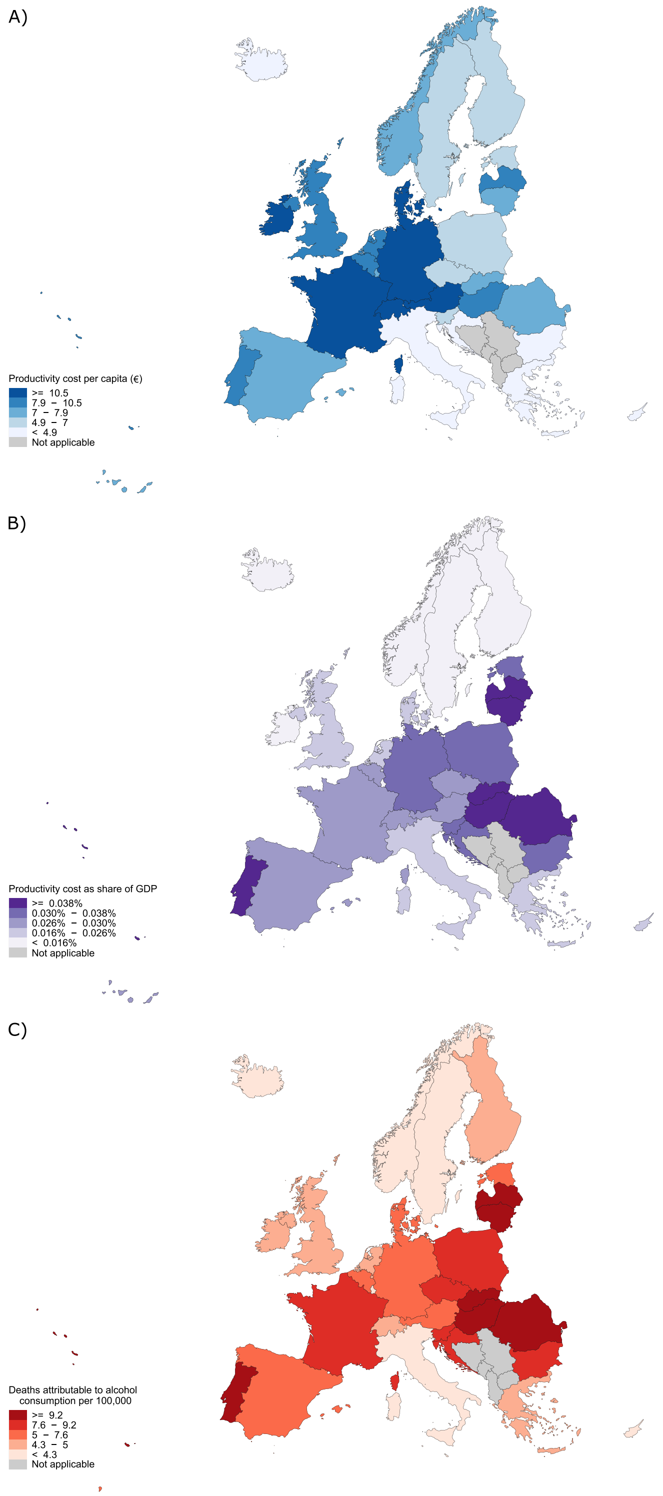

Fig. 2. Productivity lost to premature death from alcohol-attributable cancer in the 27 countries in the European Union plus Iceland, Norway, Switzerland, and the United Kingdom in 2018, by country. A) Productivity cost of premature death from alcohol-attributable cancer per capita (€), B) Cost of productivity lost as a share of national gross domestic product (GDP, %), and C) Crude rate of premature death from alcohol-attributable cancer per 100,000 people.

5. Conclusions

We conclude that more than 23,300 premature cancer deaths in the EU plus Iceland, Norway, Switzerland, and the UK in 2018 were attributable to alcohol use. Our study provides further economic reasoning to curb the burden of alcohol-attributable cancer and drive action to achieve the reduction in alcohol use set out in Europe's Beating Cancer Plan [3]. At least €4.58 billion in productivity losses due to alcohol-attributable cancers in one year represents a huge loss to society which cannot be ignored. Our analysis adds a new perspective to assessments of alcohol-attributable cancer burden, and complements policy impact assessments such as those carried out on the potential reduction in cancer burden following increases in alcohol excise taxes [34,35]. The implementation of cost-effective policies to reduce alcohol consumption and prevent alcohol-attributable cancer deaths could result in economic benefits for society and must be prioritised.

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CRediT authorship contribution statement

HR, IS, MOO, LS conception of the study; HR, MOO study design and analysis; HR, MOO data collection and verified the underlying data; HR, IS, MOO, LS, NL interpretation of the results; HR wrote the first draft of the manuscript. All authors critically reviewed the manuscript and agreed with the decision to submit for publication.

Declaration of Competing Interest

The authors declare no competing interests.

Data Availability

All cancer mortality and population estimates are available to the public through the Global Cancer Observatory (https://gco.iarc.fr/). All statistical code (i.e., R code) and input files used to produce the results presented in this paper are available to the public upon request to the corresponding author.

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Disclaimer

Where authors are identified as personnel of the International Agency for Research on Cancer and WHO, the authors alone are responsible for the views expressed in this Article and they do not necessarily represent the decisions, policy, or views of the International Agency for Research on Cancer and WHO.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.canep.2023.102365.

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