

Estimation of cancers caused by light to moderate alcohol consumption in the European Union

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Background: Research has identified alcohol to be an important risk factor for several types of cancers. This study estimates the number of incident cancers attributable to alcohol consumption in the European Union (EU) in 2017, with a special focus on those caused by light to moderate drinking levels. **Methods:** The attributable-fraction methodology is used to estimate the number of new cancer cases in the year 2017 in the EU caused by alcohol use, and further examines those due to light to moderate drinking levels, defined here as alcohol consumption of <20 g of pure alcohol per day. **Results:** Light to moderate drinking levels of alcohol caused almost 23 000 new cancer cases in the EU in 2017, and accounted for 13.3% of all alcohol-attributable cancers, and 2.3% of all cases of the seven alcohol-related cancer types. Almost half of these (~11 000 cases) were female breast cancers. Also, more than a third of the cancer cases due to light to moderate drinking resulted from a light drinking level of <1 standard drink per day (total: 37%; women: 40%; men: 32%). **Conclusions:** Alcohol use, including light to moderate drinking, continues to cause considerable cancer burden, and efforts should be made to reduce this burden. In addition to the alcohol control policies suggested by the World Health Organization, public information campaigns and the placement of warning labels on alcohol containers advising of the cancer risk associated with alcohol use should be initiated to increase knowledge about the alcohol-cancer link.

Introduction

Alcohol consumption is a major risk factor for burden of mortality and disease,¹ and chronic diseases are one of the major alcohol-attributable disease outcomes.^{2,3} Alcohol-attributable cancers are one of the most important subcategories of alcohol-attributable chronic disease; in some regions, such as the European Union (EU), cancers have been identified as the most important subcategory responsible for alcohol-attributable disease burden overall.^{4,5} The term alcohol-attributable cancers is used here as defined in epidemiology⁶—i.e. these cancers would not have developed without the use of alcohol.

The causal relationship between alcohol use and various cancer subcategories has been established based on epidemiological evidence, animal bioassays, mechanistic and other relevant data.^{7–10} Based on these considerations, the International Agency for Research on Cancer deemed the following cancer types to have sufficient evidence for carcinogenicity in humans^{7,8}:

- Lip and oral cavity cancer (ICD-10 codes: C00–08)
- Other pharyngeal cancers (mainly oropharyngeal cancers; ICD-10 codes: C09–10, C12–14)
- Oesophagus cancer (ICD-10 codes: C15)
- Colon and rectum cancers (ICD-10 codes: C18–21)
- Liver cancer (ICD-10 codes: C22)

- Breast cancer (ICD-10 codes: C50)
- Larynx cancer (ICD-10 codes: C32)

In the following, the above-noted cancer types will be grouped together and referred to as alcohol-related cancers. All of these cancers have shown dose–response relationships between the level of alcohol consumption and the probability of developing cancer with no lower threshold of alcohol use identified.^{7,9} In other words: even for alcohol use with less of one standard drink per day, significantly elevated risks for cancer were detected (e.g. References^{11,12}; Reference⁷ for the general concept).

In addition, pure alcohol (ethanol) was identified as the main ingredient of alcoholic beverages that causes cancer.¹³ While alcohol use has been identified as a cause of the cancer subcategories listed above, not all of the cancers in these subcategories are caused by alcohol use. For all of these subcategories, alcohol use is one of several potential causes, and while the overall incidence and mortality of cancer would be reduced in an alcohol-free world, cancer would not be eradicated (for the theoretical framework of risk relations see below and References^{6,14}).

Although the role of alcohol use as a carcinogen causing certain types of cancer is scientifically well established, this knowledge has still not entered into broad public awareness in most countries.¹⁵ Even individuals who indicated an awareness of such an impact, did not necessarily know of the link between cancer and alcohol, rather they reported a general belief that ‘everything causes cancer’.¹⁶ Of

those with knowledge of the alcohol-cancer link, many believed that it applied only to heavy drinking, even though no lower threshold for the impact of alcohol on cancer has been established.⁷

This publication will estimate the number of alcohol-attributable cancers in the EU, by cancer type, with special emphasis on cancers caused by light to moderate drinking levels—and thereby determine how many could have been avoided in a world in which there was no alcohol use.^{6,14}

Methods

We used the attributable-fraction approach to estimate all alcohol-attributable cancers, and alcohol-attributable cancers among those drinking up to 20 g pure alcohol per day.^{17,18} The attributable-fraction approach requires information on alcohol exposure and risk relations (in this case, relative risk estimates compared to abstinence), with the resulting fraction applied to the incident cancer cases.¹⁹

Alcohol exposure

For exposure, we used data on alcohol consumption for 2008, since the lag time between exposure and disease incidence must be taken into account.²⁰ The alcohol exposure data for each country were taken from Manthey et al.²¹ and the continuous distribution of exposure was based on the mean and the gamma distribution.²²

Light to moderate drinking was defined here as consumption of <20 g of pure alcohol per day, ≤ 2 standard drinks in most European countries.²³ As such, a standard drink is equivalent to a small can or bottle of beer (about 300 ml), one decilitre of wine, or one shot of spirits. Please note that, our definition of light to moderate drinking is restrictive; other authors have defined drinking of more than 20 g of pure alcohol per day as a moderate drinking level (e.g. Reference²⁴) However, to avoid overclaiming harm, we elected to be conservative by selecting a relatively low threshold.

Data cancer incidence and population

We have evaluated alcohol-attributable incident cancers for 2017 within the EU; the UK was included in this evaluation as it was still part of the EU at that time (for a list of current countries, see Reference²⁵) However, in the [Supplementary appendix](#), we present data separately by country, so readers interested in doing so can determine the numbers for the EU alone.

Population data were taken from the UN 2019 Revision of World Population Prospects.²⁶ Data on incident cancers for 2017 were obtained from the Global Health Data Exchange website, based on the Global Burden of Disease 2017 Study.²⁷

Risk relations

The risk relations used are based on the last comparative risk analyses of Shield et al.⁵ All the relative risk functions can be seen in [Supplementary Appendix table S1](#).

Statistical procedures

We used a modified Comparative Risk Assessment approach to calculate the number of alcohol-attributable cancers,¹⁹ and the cancer attributable to an average consumption level of 0–20 g of pure alcohol per day (for an overview on preparing exposure for burden calculations and how to apply exposure to derive alcohol-attributable fractions, see References^{18,22}). All calculations were conducted separately by sex, age and cancer type, and the results were then aggregated. Age-adjusted population rates were calculated based on the WHO Standard Population.²⁸ The 95% confidence intervals (95% CI) have been evaluated using a Monte Carlo simulation repeated 1000 times.

Results

Alcohol exposure

Table 1 summarizes indicators of alcohol use for the 28 countries within the EU. The proportion of abstainers is higher in women, with a difference of proportions between sexes of over 10% for lifetime abstainers, and around 4% for former drinkers. Men have a higher average level of use, which can be seen by looking at the proportion of drinkers in different use ranges, where men have a higher proportion in the 20–40 g/day range, and specifically in the 40–150 g/day range. In this last group, where the gender difference is greatest, the number of men is triple that of women even though the population of women is larger.

Cancer and alcohol-attributable cancer burden in the EU

The total number of incident cancers Europe in 2017 was 3 723 600 (95% CI, 3 359 100–4 179 500), and 988 500 for alcohol-related cancer types (95% CI: 976 600–999 700), of which 172 600 (95% CI: 151 600–193 100) were due to alcohol consumption. **Table 2** shows that the number of incident cancers in the EU due to light to moderate alcohol drinking was 23 000 (95% CI: 20 000–26 100). The proportion of cancers due to light to moderate alcohol drinking can be seen graphically in [figure 1](#). The number of incident cancers due to light to moderate alcohol drinking by sex was 15 900 (95% CI: 13 700–18 200) for women and 7100 (95% CI, 6000–8300) for men. In other words, alcohol use caused 17.5% (95% CI: 15.4–19.3%) of all incident cancers in alcohol-related categories in the EU in 2017, and light to moderate drinking caused 13.3% (95% CI: 12.5–14.0%) of all alcohol-attributable cancers and 2.3% (95% CI: 2.0–2.6%) of all new cancer cases in alcohol-related cancer categories of in that year.

Dividing the category of light to moderate drinking into two subcategories based on drinking of 0–10 g/day and 10–20 g/day, shows that 37% of the 23 000 alcohol-attributable cancer cases arose as a result of the lower drinking level subcategory (0–10 g/day). For women, the percentage caused by the lower of the two light to moderate drinking categories was 40%, and for men it was 32% (see [Supplementary appendix](#) for details on each of the alcohol-related cancer categories in [tables S10 and S11](#)).

Women show a higher number of incident cancers than men due to their much higher incidence of breast cancer—as breast cancer has only been evaluated for women due to the very small numbers and different aetiology of this cancer type in men. In total, the majority of all cancer cases due to light to moderate drinking was in the breast cancer category: 68.7% (95% CI: 62.5–74.4%), corresponding to 10 900 (95% CI: 9000–13 000) incident cases in 2017 (see [Supplementary Appendix figure S1](#)). Female breast cancers also constitute 47.6% (95% CI: 41.0–53.7%) of all alcohol-attributable cancers for both sexes.

For both sexes, after breast cancer, the category of cancers caused by light to moderate drinking with the second-highest incidence is colon and rectum cancers, making up 28.1% of all incident alcohol-attributable cancers in the EU (95% CI: 21.1–34.5%). For men, this is the category with the highest incidence and accounts for about 50% of all incident cases in men (48.2%, 95% CI: 39.2–55.3%). For women, it is the category with the second-highest incidence at 19.2% (95% CI: 13.6–24.7%).

For both sexes, lip and oral cavity cancers have the second-highest incidence, at 7.9% (95% CI: 6.8–9.5%) of total alcohol-attributable cancers. The remaining categories of alcohol-attributable cancers total ~4% of the total as follows: other pharyngeal cancers at 4.3% (95% CI: 3.8–5.1%), oesophagus cancer at 4.5% (95% CI, 4.0–5.2%), liver cancer at 3.6% (95% CI: 1.1–6.2%) and larynx cancer at 4.0% (95% CI: 3.2–5.0%).

Table 1 Alcohol consumption in the EU in 2008

| Drinking category | Women | | Men | | Total | |
|--------------------|---------------------------------------|-------------------|------------------------------------|-------------------|---------------------------------------|-------------------|
| | Number ^a | Proportion (%) | Number | Proportion (%) | Number | Proportion (%) |
| Lifetime abstainer | 40 084 800 (35 764 300–44 491 900) | 18.5 (16.5–20.5%) | 16 047 200 (14 126 500–17 999 800) | 7.9(6.9–8.2%) | 56 132 000 (49 890 800–62 491 800) | 13.3 (11.9–14.9%) |
| Former drinker | 22 817 900 (16 526 400–29 157 400) | 10.5 (7.6–13.4%) | 13 462 000 (10 224 800–16 588 200) | 6.6(5.0–8.2%) | 36 279 900 (26 767 000–45 736 300) | 8.6(6.4–10.9%) |
| 0–20 g/per day | 108 828 900 (106 813 800–111 721 000) | 50.1 (49.2–51.5%) | 76 731 900 (75 583 800–80 249 000) | 37.7 (37.1–39.4%) | 185 560 800 (182 306 100–192 023 600) | 44.1 (43.3–45.6%) |
| 20–40 g/per day | 26 556 500 (25 557 100–27 794 300) | 12.2 (11.8–12.8%) | 35 682 200 (34 984 000–36 339 200) | 17.5 (17.2–17.8%) | 62 238 700 (60 523 300–64 203 600) | 14.8 (14.4–15.3%) |
| 40–150 g/per day | 18 877 100 (18 016 600–19 987 900) | 8.7(8.3–9.2%) | 61 730 000 (59 287 500–63 849 100) | 30.3 (29.1–31.4%) | 80 607 100 (76 897 400–84 023 200) | 19.2 (18.3–20.0%) |
| Total | 217 165 200 | 100 | 203 653 300 | 100 | 420 818 500 | 100 |

a: Due to the constant fluctuations in populations, we have rounded the number of inhabitants in each group to the nearest hundred.

Table 2 Cancers in 2017 caused by alcohol consumption of up to 20 g/day in the EU

| Cancer type | Number of alcohol-attributable incident cancers | | | % of alcohol-attributable cancers | | | Rate per million | | |
|---|---|------------------|------------------------|-----------------------------------|-------------------|-------------------|---------------------|---------------------|---------------------|
| | Women | Men | Total ^a | Women | Men | Total | Women | Men | Total |
| Lip and oral cavity (ICD-10 codes: C00–08) | 877 (763–1013) | 939 (852–1050) | 1816 (1619–2045) | 5.5 (4.6–6.7%) | 13.3 (11.2–16.3%) | 7.9 (6.8–9.5%) | 2.49 (2.15–2.87) | 3.22 (2.93–3.58) | 2.85 (2.54–3.21) |
| Other pharyngeal (ICD-10 codes: C09–10, C12–14) | 303 (265–348) | 684 (623–759) | 988 (891–1102) | 1.9 (1.6–2.3%) | 9.7 (8.2–11.9%) | 4.3 (3.8–5.1%) | 0.92 (0.78–1.05) | 2.50 (2.27–2.76) | 1.71 (1.54–1.90) |
| Oesophagus (ICD-10 codes: C15) | 339 (315–364) | 707 (661–759) | 1045 (982–1119) | 2.1 (1.8–2.5%) | 10.0 (8.5–12.0%) | 4.5 (4.0–5.2%) | 0.81 (0.76–0.87) | 2.27 (2.15–2.42) | 1.54 (1.45–1.64) |
| Colon and rectum (ICD-10 codes: C18–21) | 3047 (2095–3994) | 3415 (2381–4777) | 6462 (4520–8455) | 19.2 (13.6–24.7%) | 48.2 (39.2–55.3%) | 28.1 (21.1–34.5%) | 8.28 (5.53–10.69) | 11.45 (7.75–14.68) | 9.86 (6.64–12.69) |
| Liver (ICD-10 codes: C22) | 274 (74–484) | 546 (154–950) | 820 (229–1424) | 1.7 (0.5–3.1%) | 7.7 (2.3–13.1%) | 3.6 (1.1–6.2%) | 0.67 (0.21–1.14) | 1.52 (0.48–2.55) | 1.10 (0.34–1.84) |
| Breast (ICD-10 codes: C50) | 10 932 (9015–12 972) | 0 (0–0) | 10 932 (9015–12 972) | 68.7 (62.5–74.4%) | 0 (0–0%) | 47.6 (41.0–53.7%) | 34.91 (28.81–41.51) | 0 (0–0) | 17.45 (14.41–20.76) |
| Larynx (ICD-10 codes: C32) | 130 (99–166) | 794 (632–961) | 924 (735–1124) | 0.8 (0.6–1.1%) | 11.2 (8.8–14.2%) | 4.0 (3.2–5.0%) | 0.39 (0.30–0.49) | 2.73 (2.22–3.24) | 1.56 (1.26–1.87) |
| All alcohol-attributable cancers | 15 902 (13 685–18 213) | 7085 (5967–8285) | 22 987 (19 974–26 122) | 100 | 100 | 100 | 48.47 (41.68–55.41) | 23.69 (19.81–27.26) | 36.08 (31.46–40.51) |

Parenttheses indicate 95% Confidence Intervals.

a: If aggregations of values do not appear to correspond exactly it is because the numbers have been rounded to the nearest hundred.

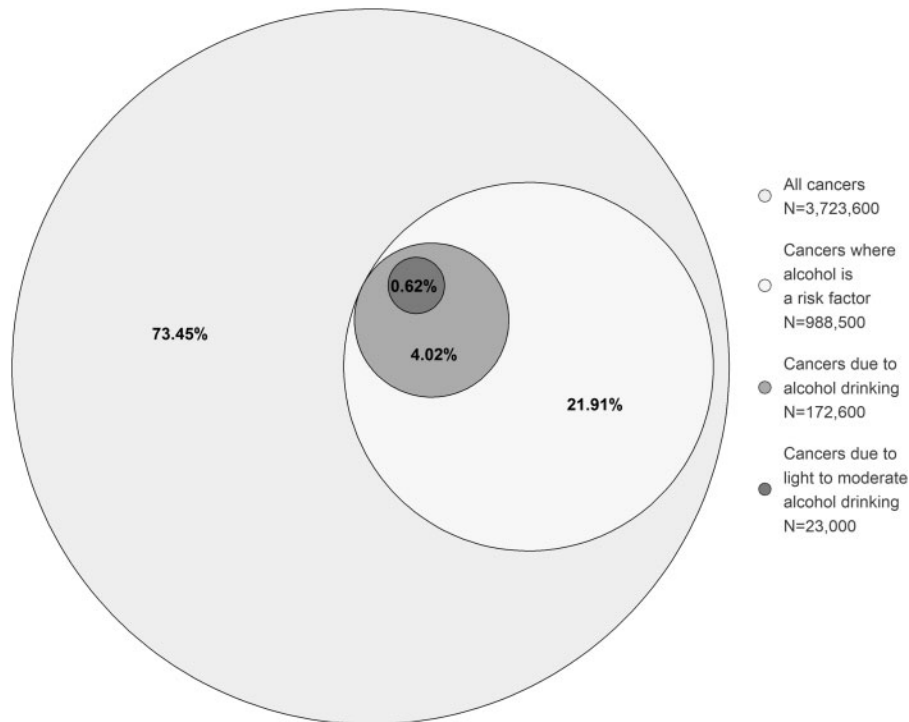


Figure 1 Venn diagram of all cancer types, including those where alcohol is a risk factor, cancers due to any level of alcohol consumption and cancers due to light to moderate alcohol consumption

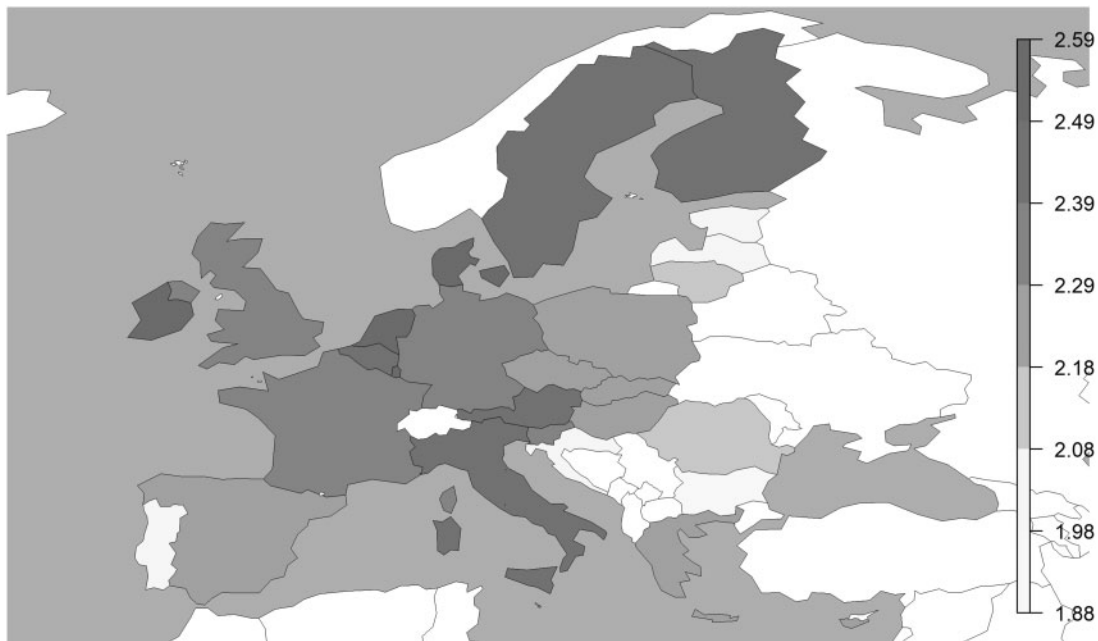


Figure 2 Proportion of cancers in the EU in 2017 due to light to moderate drinking of alcohol in % of all cancers where alcohol is a risk factor

Other differences are evident between the sexes in terms of the types of incident cancers they most commonly experience. Only two types—lip and oral cavity cancer and colon and rectum cancers—have similar values for both. In three of the cancer types—other pharyngeal cancers, oesophagus cancer and liver cancer—the numbers for men were at least double those reported in women. Larynx cancer shows an even greater disparity between the sexes; it is more than six times more common in men than in women.

The overall impact of light to moderate drinking on cancer is relatively uniform in countries of the EU. For each of the alcohol-related cancer types, between 1% and 4% were caused by light to moderate drinking (see [Supplementary Appendix tables S2–S8](#)). In [figure 2](#) (see also [Supplementary Appendix table S9](#)), the proportions of all cancers caused by light to moderate drinking among all alcohol-related cancer types are shown by country, ranging from 1.88% to 2.59%. The average proportion was 2.28%, and the 95% CI for this proportion overlapped for all countries.

Discussion

Principal findings

Our analysis showed that light to moderate drinking of alcohol, defined by most European countries as being daily alcohol intake of no more than 2 standard drinks, caused almost 23 000 new cancers in the EU in 2017, accounting for 13.3% of all alcohol-attributable cancers, and 2.3% of the 7 alcohol-related cancer types. More than one-third of these cases were caused by drinking <1 standard drink per day (total: 37%; women: 40%; men: 32%). Female breast cancer accounted for almost half of the incident cancer cases due to light to moderate drinking of alcohol, with almost 11 000 cases.

Comparison with previous findings

The study, we identified as being most similar to this one, by Bagnardi et al.²⁹ estimated the number of alcohol-attributable cancers due to light drinking on a global scale. While the results were generally in line with the main findings of our study, Bagnardi et al. only included a single drinking level, of <10 g/day (for exact comparisons see separate tables for 0–10 g/day in the [Supplementary appendix](#)). They conducted a meta-analysis of original studies before December 2010 and found significant risk relations for oropharyngeal, oesophageal and breast cancers. The slight differences between the risk relations reported in their study and those reported in our study are because our calculations were actually based on a later study by the same group of researchers,²⁹ which included a considerably higher number of studies than the 2013 study and a refined methodology.

A more recent study on light to moderate drinking by Choi et al.³⁰ provides evidence on cancer risk associated with alcohol consumption. They concluded that for the range of <20 g/day, only female breast and male colorectal cancers were significantly associated with alcohol use. However, in this study, the authors did not control for the ‘sick-quitter effect’—a specific effect on the risk of developing cancer since the control group of abstainers is in fact composed of two distinct subgroups: lifetime abstainers and former drinkers. Members of the former drinkers subgroup may now be abstainers after giving up drinking for health-related reasons, and are therefore potentially at greater risk of developing cancer than the lifetime abstainers.³¹

Limitations

Any publication, which is based on systematic reviews and meta-analyses, such as the current publication (based on Reference²¹ for exposure; on References^{32,33} for risk relations), will have the same problems that already exist in the underlying data. For the current publication, this means that we need to take the limitations of these reviews into consideration. As for exposure, in the EU, there are enough surveys and good measurements of all components of alcohol consumption in the general population that the underlying data on the consumption estimates here are quite reliable. As for the triangulation of *per capita* alcohol consumption with survey data,^{18,22} this procedure leads to smaller proportions in the light to moderate drinking category, and thus to lower estimates of alcohol-attributable cancer in this drinking category; it is therefore quite a conservative approach.

The biggest potential controversy may involve risk relations. It has already been mentioned that some of the underlying studies may not have separated former drinkers (‘sick quitters’) from lifetime abstainers in their control groups. Again, any resulting bias may be overly conservative. Finally, most of the impact of light to moderate alcohol consumption on incident cancers is on female breast cancer (see [table 2](#) above). The relationship between light and moderate drinking and female breast cancer is the least contested of all alcohol use and cancer relationships. Even authors who did not find an impact of light to moderate drinking on other cancer categories found evidence of the effect of this drinking pattern on female breast cancer (References ^{30,34}; see also References ^{12,35}) Thus, while there may be debate on the overall level of light to moderate

drinking on incident cancers (for the conservative assumptions used here, see above), the existence of such an impact seems to be uncontroversial.

Conclusions for public health interventions

Light to moderate drinking was identified as being the cause of nearly 23 000 new cancers in Europe in 2017, confirming the fact that alcohol use at all levels is associated with cancer to a degree that it is of public health relevance. As both alcohol consumption and cancer incidence are relatively stable in the EU, the number of alcohol-attributable cancers will remain at similar levels if no interventions aimed at changing either of these numbers are put into place.

Given the current situation—that the link between alcohol use and cancer is not common knowledge to the public—better dissemination of such knowledge is necessary. One method would involve adding warning labels to alcoholic beverages stating that ‘alcohol can cause cancer’, e.g. Reference ³⁶ a practice, which has previously been proposed by several organizations in the EU (for evidence of effectiveness, see Reference ³⁷). In addition, given that all levels of alcohol use causally linked to cancer incidence, with effect sizes, which are of public health relevance, alcohol control policy measures directed at the whole population should be undertaken (see References ^{38,39}). Among such policies are the three ‘best buys’, alcohol policy measures identified by the WHO as being the most effective and cost-effective for governments to put in place. These measures include increasing the price and thereby reducing the affordability of alcoholic beverages via tax hikes, decreasing the availability of alcoholic beverages, and banning the advertisement and marketing of them.^{39,40} The implementation of such policies would not only lead to reductions in alcohol consumption and cancer incidence but would also serve to reduce alcohol-attributable mortality and burden of disease overall.

Supplementary data

Supplementary data are available at *EURPUB* online.

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Conflicts of interest

None declared.

Key points

- Alcohol use is a major risk factor for cancer, and more than 26% of all cancers in the EU in 2017 were alcohol-related cancer types.
- A total of 23 000 or 13% of incident alcohol-attributable cancers in the EU in 2017 were due to light to moderate drinking, defined here as alcohol intake of up to 20 g pure alcohol per day.
- By far, the largest number of incident cancers caused by light to moderate alcohol consumption is breast cancers.
- As most of the public is not aware of the fact that alcohol use is carcinogenic, public education including the placement of standard information on warning labels affixed to alcohol containers, should be initiated.
- If proven measures to reduce alcohol-attributable disease burden, such as increases in alcohol taxation, limitations on its availability and bans on its advertising and marketing are initiated, a reduction in the incidence of light to moderate alcohol-attributable cancer would be achieved.

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