

# Alcohol accounts for a high proportion of premature mortality in central and eastern Europe

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**Background** There is a west–east mortality gradient in Europe, more pronounced in men. The objective of this article was to quantify the contribution of alcohol use to the gap in premature adult mortality between three old (France, Sweden and United Kingdom) and four new (Czech Republic, Hungary, Lithuania and Poland) European Union (EU) member states for the year 2002. Russia was added as an external comparator.

**Methods** Exposure data were taken from surveys and per capita consumption records from the World Health Organization (WHO) Global Alcohol Database. Mortality data were taken from the WHO databank. The risk relationships were taken from published meta-analyses and from the WHO Comparative Risk Assessment project. Alcohol exposure and relative risk information was combined to derive alcohol-attributable fractions for relevant causes of premature mortality.

**Results** Alcohol consumption was responsible for 14.6% of all premature adult mortality in the eight countries, 17.3% in men and 8.0% in women. This proportion was clearly higher in the new EU member states and Russia compared with the comparison countries from the old EU. For men, Russia with 29.0 alcohol-attributable premature deaths per 10 000 population had a more than 10-fold higher rate compared with Sweden (2.7 deaths/10 000). For women, the ratio between Hungary (5.0 alcohol-attributable deaths/10 000) and Russia (4.7 deaths/10 000) compared with Sweden (0.5 deaths/10 000) was almost as high, but the rates were much lower. The Czech Republic and Poland showed proportionally less alcohol-attributable premature mortality than the other new EU member states or Russia for both genders, which, however, was still higher than in any of the old EU member states.

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**Conclusions** Alcohol is a strong contributor to the health gap between western and central and eastern Europe, with both average volume of consumption and patterns of drinking contributing to burden of disease and injury. Alcohol also contributes substantially to male–female differences in mortality and life expectancy. However, there are feasible and cost-effective measures to reduce alcohol-related burden that should be implemented in central and eastern Europe.

**Keywords** Premature mortality, alcohol consumption, drinking behaviour, central and eastern Europe

## Background

Even though there have been health gains in central and eastern Europe, there is still a mortality gradient in Europe: life expectancy is highest in the old European Union (EU) countries, and lowest in the most eastern countries such as Russia, with the new central and eastern EU member states in between.<sup>1,2</sup> In 2002 [all data taken from the World Health Organization (WHO)]<sup>3</sup> the old EU countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and UK) had an average life expectancy of 75.7 for men and 81.5 for women; the central European new member states (Czech Republic, Hungary, Poland, Slovakia, and Slovenia) one of 70.9 for men and 78.7 for women; the Baltic new member states (Estonia, Latvia, and Lithuania) 65.3 for men and 76.8 for women; and life expectancy in the Russian Federation was 58.3 for men and 71.8 for women. Thus, for men, life expectancy dropped by about 5 years for each of these successively more easterly groups of countries, with the overall gap between the old EU and Russia being 17.4 years. For women, the overall gap was much smaller and amounted to 9.7 years but the pattern was the same. Each of these groupings is relatively homogeneous in mortality levels: in fact, none of central European new EU member states had a life expectancy above the average of the old EU member states; for the Baltic countries, none exceeded the average life expectancy of the central European countries. In 2005, while life expectancies were higher, the same pattern between regions prevailed (<http://www.cia.gov/cia/publications/factbook/geos/lh.html>). Alcohol use, in addition to smoking and poor nutrition, has been pointed out as one of the main determinants underlying these differences.<sup>4–7</sup> In all of the European regions, alcohol use was identified as one of the major risk factors for burden of disease and injury with especially high levels of alcohol-attributable burden in Russia and surrounding countries.<sup>6,8,9</sup> Henceforward in this report disease will generally be used as a convenient shorthand for ‘disease and injury’.

However, no systematic analyses of alcohol-attributable mortality and disease burden have been undertaken on the country level. The present contribution aims to fill this gap and presents a systematic analysis of the role of alcohol use in premature mortality for four new Member States in the EU (Czech Republic, Hungary, Lithuania and Poland), three countries from the old EU (France, Sweden and UK) and one

comparison country from eastern Europe (Russia). Based on the results of the comparative risk assessment (CRA) of the WHO, two dimensions of alcohol were hypothesized to impact on mortality: level of consumption and patterns of drinking, the latter mainly referring to irregular heavy drinking occasions.

The countries were selected to reflect the variations in mortality as well as differences in drinking level and patterns. France and Sweden represent the countries in the old EU with the highest life expectancy for men (Sweden: 78.0) and women (France: 83.6), but have very different drinking styles. While France has a traditional wine drinking culture with high overall level of consumption and relatively low proportion of people drinking to intoxication, Sweden has an increasing, but still relatively low level of overall consumption and a tradition of irregular heavy drinking. The UK also reports increased levels of consumption in recent years, and was selected because there are indications that alcohol-related harm, especially liver cirrhosis, has been increasing in recent years.<sup>10</sup>

The Czech Republic and Poland were selected as members from central Europe with similar life expectancy but different drinking styles (see further). Hungary is the country in this group with the lowest life expectancy and also has the highest mortality rates in the EU for several alcohol-related conditions such as liver cirrhosis, and malignant neoplasms of lip, oral cavity and pharynx. Lithuania as the largest Baltic republic was selected to represent this region, and Russia was chosen as a comparison country from eastern Europe. The life expectancy in Russia dropped markedly in the 1990s,<sup>11</sup> and continues to be at a comparatively low level until today. Both Lithuania and Russia have relatively high levels of consumption and a high proportion of irregular heavy drinking occasions. Overall, alcohol exposure in the countries of interest differs markedly in the main dimensions relevant for alcohol-attributable burden of disease, i.e. average volume of consumption and in amount of irregular heavy drinking occasions<sup>12,13</sup> (see also further).

## Methods

The aim of the present study was to estimate the premature adult mortality attributable to alcohol use (net of mortality prevented) in the eight countries for the year 2002. Premature adult mortality was defined as all deaths occurring between 20 and 64 years of age. In the following paragraphs, three elements necessary for this estimate are described: (i) measurement of exposure; (ii) determination of risk relationships and

attributable fractions and (iii) calculation of attributable deaths and years of life lost.

### Alcohol consumption

The relationship between average volume of alcohol consumption, disease and injury risks is dose-dependent in most cases,<sup>6</sup> but not necessarily in a linear fashion. Thus, different strata of average consumption were distinguished to allow for the modelling of different shapes of relationships: current abstainer (drinking up to 0.25 g pure alcohol per day), 0.25 to <20, 20 to <40, 40 to <60 and  $\geq 60$  g/day. One standard drink of alcoholic beverages such as one 0.33 l can or beer, one 0.1 l glass of wine or one single shot of spirits correspond to  $\sim 12$  g.

To determine the distribution of consumption levels across these strata, the following large representative surveys was identified with the help of the Global Alcohol Database (GAD; [www.who.int/whosis](http://www.who.int/whosis))<sup>3</sup>: Czech Republic (World Health Survey<sup>14</sup>); France (abstainers;<sup>15</sup> distribution between sex and age from<sup>16</sup>); Hungary;<sup>14,17</sup> Lithuania (abstainers;<sup>18</sup> distribution between sex and age from<sup>19,20</sup>); Poland;<sup>21</sup> data provided by J. Moskalewicz); Russia;<sup>14</sup> Sweden;<sup>22</sup> and UK.<sup>16</sup>

Survey data give reliable information about abstention rates and some indication of drinking in men vs women, as well as the distribution of consumption by age group. However, they underestimate true consumption in most instances, and they underestimate it to a different degree by country.<sup>6,23</sup> Thus, in comparative research, the survey estimates have to be triangulated using independent estimates of the overall true level of alcohol consumption in each country, including 'unrecorded' consumption.<sup>24</sup> Triangulation was undertaken based on the following assumptions: (i) Overall per capita consumption, including unrecorded consumption, is the best indicator of the level of consumption in a country. (ii) Survey data give the best approximation for prevalence of abstention, and the proportional distribution by sex and age. (iii) The prevalence of drinkers in different drinking categories is then estimated within age-sex categories adjusted upwards for the prevalence in the two highest drinking categories based on the overall consumption level.<sup>6</sup>

Estimates of per capita consumption, including unrecorded consumption (for definitions see<sup>13</sup>), were obtained for 2002 from the GAD (<http://www3.who.int/whosis>). The GAD estimates are based on industry publications on alcohol produced and sold, as well as on data from the Food and Agriculture Organization (FAO) and national sources.<sup>13</sup> No estimates were available of non-beverage ('surrogate') alcohol consumption which may be contributing importantly to mortality risks in Russia and surrounding countries.

### Selection of alcohol-related diseases

To select the disease and injury categories which are causally influenced by alcohol, the usual epidemiological criteria were used<sup>25–27</sup> with particular emphasis on biological plausibility, consistency and strength of association.

All of the major overviews used concluded that the relationships between alcohol and the selected disease and injury categories were causal,<sup>12</sup> except for colorectal cancer, where some of the evidence is newer.<sup>28,29</sup>

### Computing alcohol-attributable deaths

The effects of the current (actual) distribution of alcohol consumption were compared with the deaths expected under a chosen counterfactual of zero consumption (see<sup>30,31</sup> for a discussion of this choice). The alcohol-attributable fraction (AAF) is generally defined as the proportion of the disease in the population that would not occur if lifetime exposure to alcohol were hypothetically changed to the counterfactual level of zero (whilst leaving the age/sex structure of the population constant).<sup>32,33</sup> Since alcohol may 'cause' or 'prevent' deaths, the AAF can be positive or negative. AAFs were assessed for different specific causes of disease and injury deaths by three methods:

- For conditions that are attributed to alcohol by definition (e.g. mental disorders due to alcohol, alcohol poisoning), the attributable fraction was 1 or 100%.
- AAFs for other conditions were derived using exposure stratum-specific relative risk estimates from meta-analyses separate by sex, where applicable (i.e. when the relative risk values differed more than by chance). Relative risk here denotes the ratio of the probability of developing, in a specified period of time, a disease or injury among those at a specified exposure level, compared with the probability of developing this condition under the counterfactual (i.e. among abstainers). Please note that for ischaemic heart disease this procedure deviates from the CRA, where AAFs for eastern European countries were based on a pooled cross-sectional time series analysis.<sup>6</sup> This deviation was undertaken for two reasons: (1) It introduces a consistent methodology for estimating all alcohol-attributable chronic disease categories. (2) It clear underestimates alcohol-attributable net disease burden and thus is conservative. More discussion of this question can be found further on.
- For injuries, the AAFs were also taken from the respective regions in the CRA.<sup>6</sup> These AAFs were based on both volume and pattern dimensions of drinking.

Thus, for most conditions, the AAFs for each exposure stratum were calculated from the prevalence proportion and the pooled relative risks for that stratum, with the latter being derived from comprehensive meta-analyses. We used the most recent comprehensive meta-analysis that we could identify for each condition, as indicated in Table 1 (see,<sup>12</sup> for an overview on meta-analyses). Where meta-analyses used other cut-points for defining exposure strata, we interpolated the respective regression coefficients to the midpoints of our exposure strata.

The AAFs were obtained by summing across all exposure strata using the following formula.<sup>32,33</sup>

$$AAF = \left[ \sum_{i=1}^k P_i(RR_i - 1) \right] / \left[ \sum_{i=0}^k P_i(RR_i - 1) + 1 \right]$$

$i$  to  $k$ : exposure strata with  $i=0$  for baseline (zero) exposure.

$RR(i)$ : relative risk at exposure level  $i$  compared with no consumption.

$P(i)$ : prevalence of the  $i$ -th stratum of exposure.

The AAFs were then applied to the mortality data to estimate the number of alcohol-attributable deaths by age and sex.

**Table 1** Relative risks for alcohol-attributable diseases and injuries by consumption stratum (reference group is current abstainers)

Disease	ICD-10	1–19 (10 g/day)	20–39 (30 g/day)	40–59 (50 g/day)	60+ (75 g/day)	Sources and comments
Malignant neoplasms of lip, oral cavity and pharynx	C00–C06,C09, C10, C12–C14	M 1.31 F 1.33	M 2.08 F 2.18	M 3.02 F 3.26	M 4.32 F 4.85	<sup>50</sup>
Malignant neoplasm of oesophagus	C15	1.17	1.61	2.19	3.18	<sup>50</sup>
Malignant neoplasms of colon, rectum and anus	C18–C21	NA	M 1.08 F 1.11	M 1.30 F 1.33	M 1.72 F 1.62	<sup>29</sup>
Malignant neoplasm of liver	C22	1.08	1.23	1.40	1.60	<sup>50</sup>
Malignant neoplasm of larynx	C32	1.08	1.27	1.49	1.82	<sup>50</sup>
Malignant neoplasm of breast	C50 (F)	NA	1.23	1.42	1.68	<sup>51</sup>
Diabetes	E10–E14	0.72	0.86	1.00	1.00	<sup>52</sup>
Mental and behavioural disorders due to use of alcohol	F10	–	–	–	–	AF 100%
Alcohol-related degeneration of nervous system	G31.2	–	–	–	–	AF 100%
Epilepsy	G40, G41	M 1.23 F 1.34	M 4.11 F 7.22	M 7.28 F 7.46	M 6.72 F 7.77	<sup>12,53</sup>
Alcoholic polyneuropathy	G62.1	–	–	–	–	AF 100%
Essential hypertension	I10–I14	1.15	1.53	2.04	2.91	<sup>50</sup>
Ischaemic heart disease	I20–I25	0.82	0.82	0.87	1.13	<sup>54</sup>
Alcoholic cardiomyopathy	I42.6	–	–	–	–	AF 100%
Cardiac arrhythmias	I47–I49	M 1.51 F 1.51	M 1.96 F 2.23	M 2.23 F 2.23	M 2.23 F 2.23	<sup>12,53</sup>
Haemorrhagic stroke	I60–I62	M 0.95 F 0.73	M 1.17 F 0.94	M 1.44 F 1.59	M 1.33 F 2.41	<sup>55</sup> <sup>55</sup>
Ischaemic stroke	I63	M 0.86 F 0.66	M 0.94 F 0.74	M 1.14 F 1.04	M 1.17 F 2.08	<sup>55</sup>
Stroke, not specified as haemorrhage or infarction	I64	M 0.91 F 0.70	M 1.01 F 0.79	M 1.18 F 1.08	M 1.55 F 2.74	<sup>55</sup>
Oesophageal varices	I85	M 1.21 F 1.32	M 1.72 F 2.25	M 2.35 F 3.68	M 3.20 F 6.46	Same as liver cirrhosis <sup>50</sup>
Alcoholic gastritis	K29.2	–	–	–	–	AF 100%
Alcoholic liver disease	K70	–	–	–	–	AF 100%
Fibrosis and cirrhosis of liver	K74	M 1.21 F 1.32	M 1.72 F 2.25	M 2.35 F 3.68	M 3.20 F 6.46	<sup>50</sup>
Cholelithiasis	K80	M 0.82 F 0.82	M 0.72 F 0.68	M 0.61 F 0.53	M 0.48 F 0.39	<sup>12,53</sup>
Acute pancreatitis	K85	1.12	1.42	1.79	2.39	Same as other chronic pancreatitis <sup>50</sup>
Alcohol-induced chronic pancreatitis	K86.0	–	–	–	–	AF 100%
Other chronic pancreatitis	K86.1	1.12	1.42	1.79	2.39	<sup>50</sup>
Fetal alcohol syndrome	Q86.0	–	–	–	–	AF 100%
Finding of alcohol in blood	R78.0	–	–	–	–	AF 100%
Injuries and adverse effect (poisonings, fires, drownings and other unintentional injuries)		1.15	1.51	1.99	2.80	<sup>50</sup>
Suicides, homicides and other intentional injuries		1.15	1.50	1.98	2.78	<sup>50</sup>
Road injuries		1.15	1.51	1.99	2.80	<sup>50</sup>
Fractures (Falls)		1.15	1.51	1.99	2.80	<sup>50</sup>

For injuries, the approach assuming that consumption strata specific RRs are generalizable across countries was only used as a sensitivity analysis. The main analyses used region-specific alcohol-attributable fractions, based on both the level of consumption and drinking pattern (see text).

The following alcohol-related diseases were excluded from the analysis: psoriasis and gout <sup>56</sup> because of small numbers of deaths; depression because it mainly applies to morbidity; low birth weight because there were no reliable estimates for drinking during pregnancy in different countries.

RR, relative risk; g/d, gram per day; NA, not applicable, as it is not established that alcohol in low doses has an influence on disease risk.

### Years of life lost

To more adequately capture the social significance of deaths at different ages, deaths in each age-sex cell were assigned corresponding years of life lost (YLL) based on the values used in the CRA.<sup>8,34</sup>

These derive from model life tables with life expectancies at birth of 82.5 for women and 80.0 for men. The flows of lost life were not truncated at age 65 and were discounted at a default rate of 3% with age-weighting, thus making our estimates comparable to all WHO statistics. Discounting assigns lower values to health effects in the future than those in the present, thus reflecting valuation in our society for more immediate benefits.<sup>35</sup>

### Mortality data

In all analyses of mortality we used the WHO database, which is available at WHO website (<http://www3.who.int/whosis/menu.cfm?path=whosis,search,mort&language=english>).

Details can be obtained from the WHO mortality database documentation, also available from the WHO website. Deaths on specific causes according to International Classification of Diseases, version 10 (ICD-10) codes as well as population are derived from aforementioned source in 5 years age groups, according to sex. Please note, that for Russia, we did not have usual ICD-10 diagnoses available as for the other countries but ICD-10 MTL 1. This resulted in an underestimate of the alcohol-attributable mortality for Russia, as the following disease categories were not included: degeneration of nervous system due to alcohol, alcoholic polyneuropathy, alcoholic cardiomyopathy, cardiac arrhythmias, oesophageal varices, alcoholic gastritis, cholelithiasis, acute pancreatitis, alcohol induced chronic pancreatitis, other chronic pancreatitis, fetal alcohol syndrome and different categories of alcohol poisoning (i.e. accidental poisoning by and exposure to alcohol; intentional self-poisoning by and exposure to alcohol and poisoning by and exposure to alcohol, undetermined intent). One of the sensitivity analyses addressed this problem, and tried to quantify the underestimate for Russia.

### Specification of analyses

All analyses were conducted separately by sex. As the present project deals with adult premature mortality, the age range of most interest is 20–64. However, to show important age relationships for some conditions we have divided this age range into young (20–44) and middle-aged adults (45–64).

### Regression analyses

Regression analyses were conducted to test the hypotheses that both level of consumption and patterns of drinking independently impacted on mortality and YLL.

### Sensitivity analyses

Several sensitivity analyses were conducted. First, we compared the approach used with the CRA approach, i.e. the potential effect of varying the choice of exposure strata and of underlying meta-analyses<sup>6</sup> in one country (Poland). Second, for all countries, we based the AAFs for injuries only on level of consumptions with relative risks for strata derived from

meta-analyses as an alternative to the current method based on CRA (Table 1). In addition, we calculated the YLL with and without age-weighting. Finally, we tried to estimate the degree of underestimation for Russia arising from the lack of mortality data for some of the categories of interest, by assuming that exposure/risk relationships for these disease categories in Russia are the same as in other countries. In a prior publication, the effect of calibrating survey research to per capita consumption on attributable mortality estimates (via changes to exposure estimates), had been examined.<sup>36</sup>

### Role of the funding source

The sponsor of the study had no role in study design, data collection, data analysis, data interpretation or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

## Results

Table 2 gives an overview of the drinking indicators in the eight countries. While in all countries the volume of consumption is above the global average of ~61 pure alcohol per capita total consumption, i.e. recorded plus unrecorded,<sup>37</sup> there are striking differences both in overall volume and in patterns of drinking. The Czech Republic is a new Member State with regular beer drinking, one of the highest overall consumption levels in Europe and a relatively less detrimental pattern of drinking. The patterns of drinking displayed in Table 2 are a composite measure mainly based on heavy drinking and drinking to intoxication per occasion.<sup>6,13</sup> Independent of volume, these patterns have been shown to be related to burden of cardiovascular disease and injury.<sup>6</sup>

The other new EU Member States included here, Hungary, Lithuania and Poland, have more detrimental drinking patterns, and Russia has the most detrimental drinking patterns of all countries examined. Hungary has an almost equal distribution of beer, wine and spirits, whereas Lithuania and Poland have a traditional spirits culture, even though by now each drink about an equal proportion of alcohol from beer. France and Sweden differ both in volume of alcohol consumption and in drinking patterns; in 2002, the overall consumption of France was still almost 50% higher than in Sweden, but with less detrimental drinking patterns. Finally, the UK has a beer drinking culture, and in recent years heavy irregular drinking seems to have increased.

Table 3 shows alcohol-attributable mortality and death rates in the eight countries in 2002. Overall, the rate of alcohol-attributable mortality in men was highest in Russia (29.0/10 000 person-years; see also the sensitivity analyses subsequently). All of the new EU Member States showed considerably higher rates of alcohol-attributable mortality in men compared with the countries from the old EU. For women, France and the UK show higher rates of alcohol-attributable mortality than some of the new EU Member States (e.g. Poland and Czech Republic). Overall, as expected, alcohol-attributable mortality affects men more than women, with the ratio being much more pronounced in the new EU Member States, where a



**Table 2** Indicators of alcohol drinking in eight European countries for the year 2002

	New EU member states				Old EU member states			
	Czech Republic	Hungary	Lithuania	Poland	France	Sweden	UK	Russia
Adult per capita in l pure alcohol	17.0	14.9	17.2	11.7	14.5	9.9	13.4	15.5
Recorded in l pure alcohol	16.0	11.9	12.3	8.7	13.5	6.9	11.4	10.6
Unrecorded in l pure alcohol	1.0	3.0	4.9	3.0	1.0	3.0	2.0	4.9
Patterns of drinking <sup>a</sup>	2	3	3	3	1	3	3	4
Preferred beverage	beer	wine/beer/spirits	beer/spirits	spirits/beer	wine	beer	beer	spirits
<b>Men</b>								
% abstention/very light drinking	9.0	12.0	10.0	16.4	7.3	10.0	9.2	13.8
% >40 g/day <sup>b</sup>	59.4	47.0	41.0	38.5	50.8	18.3	38.6	53.1
<b>Women</b>								
% abstention/very light drinking	19.1	27.0	28.0	34.3	11.1	16.0	14.3	27.5
% >40 g/day	7.0	16.0	8.0	9.0	7.0	3.8	10.3	8.4

<sup>a</sup> Estimated average pattern of drinking (1–4 with 4 being the most detrimental pattern; see text for more explanation and<sup>13</sup> for the full algorithm used).

<sup>b</sup> >40 g/day on average correspond to more than 3–4 drinks on average per day (1 drink is one can of beers of 0.33 l or one small glass of wine or one shot of spirits).

**Table 3** Premature alcohol-attributable deaths and crude rates per 10 000 population per year in eight European countries, for ages 20–64, 2002

Deaths		New EU member states				Old EU member states			Russia <sup>b</sup>
		Czech Republic	Hungary	Lithuania	Poland	France	Sweden	UK	
Malignant neoplasms	M	690	1167	171	1304	3217	93	1431	6809
	F	129	297	48	270	730	45	768	2403
Cardiovascular diseases	M	101	229	6	150	481	–177	–1043	–4056
	F	–159	–97	–42	–411	–141	–110	–681	–8907
Liver cirrhosis	M	778	3077	290	1708	3185	163	2768	9680
	F	237	1016	122	355	1250	59	1369	5572
Unintentional injuries	M	881	1157	1122	4077	2704	293	1608	77 418
	F	170	208	232	533	466	55	337	15 522
Intentional injuries	M	259	626	485	1280	1112	153	805	30 188
	F	51	142	59	198	303	48	172	6040
All alcohol-attributable deaths <sup>a</sup>	M	2912	6665	2156	9923	12 984	723	6478	123 323 <sup>c</sup>
	F	459	1625	434	1032	3106	135	2258	21 619 <sup>c</sup>
All deaths from all causes	M	17 820	26 448	9440	72 950	72 009	7770	60 511	689 783
	F	7872	11 872	3500	28 998	31 428	4714	37 452	255 446
<b>Death rates at ages 20–64 per 10 000 person years</b>									
Alcohol-attributable	M	9.0	21.6	22.1	8.7	7.5	2.7	3.7	29.0 <sup>c</sup>
	F	1.4	5.0	4.1	0.9	1.8	0.5	1.3	4.7 <sup>c</sup>
All causes	M	54.8	85.9	96.8	63.7	41.5	29.2	34.8	162.1
	F	24.2	36.8	32.8	24.7	17.9	18.2	21.2	55.6

Negative numbers denote beneficial health effects of alcohol, i.e. causal effects with Relative Risk < 1.

<sup>a</sup> Only major disease categories are included, thus the number of deaths from only these disease categories does not add up to all alcohol-attributable deaths.

<sup>b</sup> The estimates for Russia are underestimates, as several disease categories could not be included because of the different classification system of diseases (see text in methods section, mortality data).

<sup>c</sup> Results from sensitivity analysis demonstrated that if we assume the relation between these missing and the rest of alcohol-attributable disease categories are the same for Russia as in all of the countries examined, we would underestimate alcohol-attributable premature mortality by 11.2% for men and by 14.7% for women. Under the same assumption, the corresponding crude rate of alcohol-attributable deaths per 10 000 population in the age category between 20 and 64 years in Russia would be 32.6 in men and 5.5 in women.

smaller proportion of alcohol is consumed by women. In a linear regression analysis with the rate of alcohol-attributable mortality as dependent variable, both prevalence of consumption >40 g pure alcohol per day (standardized regression

coefficient: 0.74;  $t = 4.50$ ;  $P < 0.001$ ) and patterns of drinking (standardized regression coefficient: 0.37;  $t = 2.22$ ;  $P < 0.044$ ) had significant effects, and together explained 64.9% of the variation in mortality rates.

**Table 4** Premature alcohol-attributable deaths in eight European countries by sex and age groups as proportions (in %) of all deaths, for the year 2002<sup>a</sup>

Age group	New EU member states				Old EU member states				Russia <sup>b</sup>
	Czech Republic	Hungary	Lithuania	Poland	France	Sweden	UK		
Men									
20–44	28.5	39.4	38.4	26.0	22.9	19.2	22.2	30.7	
45–64	14.0	22.2	16.4	10.2	16.6	7.1	7.6	11.9	
20–64	16.3	25.2	22.8	13.6	18.0	9.3	10.7	17.9	
Women									
20–44	14.2	19.5	21.4	10.7	10.9	6.9	12.5	19.9	
45–64	4.5	12.7	10.1	2.1	9.6	2.2	4.6	4.9	
20–64	5.8	13.7	12.4	3.6	9.9	2.9	6.0	8.5	

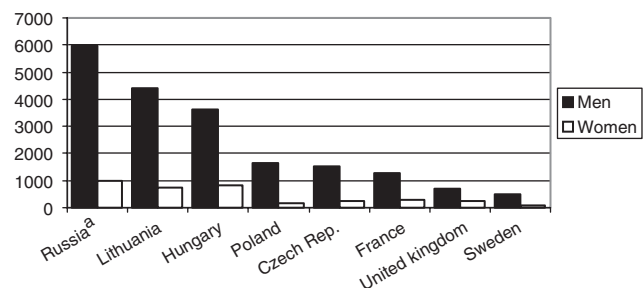
<sup>a</sup> Rates by disease category are available from the authors.

<sup>b</sup> The estimates for Russia are underestimates, as several disease categories could not be included because of the different classification system of diseases (see text in methods section, mortality data).

Comparing the rates of premature mortality for the four new EU Member States to the three old EU Member States shows a clear gap, which is again larger for men with 80% higher rates compared with women with 40% higher rates. Taken away the alcohol-attributable mortality in all countries, the difference in rates between new EU Member States and old EU Member States would shrink considerably: >20% of the difference in rate for men and >5% of the difference in rate for women could be attributed to alcohol. Thus, if alcohol is taken away, the rates for premature mortality between the old and the new EU Member States would look much more similar.

Table 4 gives the proportions of deaths attributable to alcohol by gender and age in the eight countries in 2002. Alcohol consumption was responsible for 14.6% of all premature adult deaths in the eight countries, 17.3% in men and 8.0% in women. This proportion was clearly higher in the new EU Member States and Russia compared with the countries from the old EU, especially for men. The highest proportion of alcohol-attributable deaths was found in early adulthood (i.e. between 20 and 44 years of age). This pattern was common for both sexes and all countries.

Figure 1 shows YLL/100 000 total population per year from alcohol-attributable deaths at ages 20–64 in 2002. There is huge variation, with Russia having the highest rates of YLL for both genders, with a rate more than 10-fold higher than Sweden, the country with the lowest rate. Lithuania and Hungary had the next highest rates of alcohol-attributable YLLs for both genders, at between 7- and 9-fold higher than the rate of Sweden. The Czech Republic and Poland have rates in between Sweden and these two countries, in men higher than both France and the UK, in women about on the level of the UK, but lower than France. This is due to the greater differential between genders in alcohol consumption in central and eastern Europe compared with western Europe. Similarly, in a regression with YLL rates as the dependent variable, both indicators for high volume (standardized regression coefficient: 0.71;  $t=4.22$ ;  $P<0.001$ ) and patterns of drinking (standardized regression coefficient: 0.40;  $t=2.39$ ;  $P=0.033$ ) had significant effects (explained variation 63.2%).



<sup>a</sup> The estimates for Russia are underestimates, as several disease categories could not be included because of the different classification system of diseases (see text in methods section, mortality data).

**Figure 1** Years of life lost due to premature alcohol-attributable mortality by sex in eight European countries, from deaths occurring at ages 20–64, 2002 (YLLs per 100 000 population 20–64)

### Sensitivity analyses

Sensitivity analyses showed only a small influence of the number of strata used: five in the present analyses vs the traditional four in the sensitivity analyses based on English *et al.*<sup>26</sup> Overall, the approach used in this article was more conservative, reducing estimates for premature mortality by 8.9%. The effect was more pronounced for women, where the more differentiated strata more markedly reduced the estimates for alcohol-attributable mortality. With respect to different ways of calculating injury mortality, there were also no substantial differences. The CRA numbers used here yielded lower numbers, except for Russia, which was expected, as Russia has a drinking style where a lot of alcohol is consumed in irregular heavy drinking occasions (binge drinking; Table 2). With respect to the application of age-weighting, it could be shown that the rate ratios between western and eastern countries were slightly larger if YLLs were age-weighted (4.13-fold in men and 2.82-fold in women vs 4.01 in men and 2.78 in women). The absolute difference was higher in the non-age weighted comparisons, as the majority of alcohol-attributable deaths occurred in the age group 45–64.

Sensitivity analyses showed that the underestimate for Russia arising from missing cause of death categories was quite

substantial. If we assume, that the relation in mortality between the disease categories with missing codes in Russia and the rest of alcohol-attributable disease categories is the same for Russia as in all of the countries examined, we would underestimate alcohol-attributable premature mortality by 8.7% for men and by 14.3% for women. If we base our estimates only on the pattern of alcohol-attributable mortality from Lithuania, the respective degree of underestimation amounts to 20.6% for men and 30.9% for women. The corresponding crude rates of alcohol-attributable deaths per 10000 population per year in the age category between 20 and 64 years of age would be 31.7 in men and 5.5 in women, when based on mortality patterns of all countries; and 36.5 in men and 6.8 in women, when based on Lithuania only. In both scenarios, Russia has the highest alcohol-attributable mortality rates of all countries examined.

With respect to re-calibration of per capita consumption to allow for under-reporting, it could be shown that this led to a 22% higher estimate of alcohol-attributable deaths in men, and a 5% higher estimate in women in the extreme case where only 36.6% of the per capita consumption was covered by surveys. In other words, the re-calibration may, if unrecorded consumption was overestimated, have contributed to an overestimation of alcohol-attributable mortality.

## Discussion

Before discussing findings, we would like to acknowledge the limitations of this study. First, we used relative risks for chronic diseases from meta-analyses and assumed that these risks were applicable in different countries. This may not be the case, especially if there are interactions with other risk factors such as tobacco smoking, nutritional deficiencies or hepatitis C virus. However, the methodology used is conservative, as interactions with other risk factors lead to higher disease burden, given a higher prevalence of these risk factors. In addition, there is evidence that patterns of drinking change the relative risk for a given consumption level for cardiovascular outcomes, especially heart disease.<sup>38,39</sup> While drinking moderate amounts of alcohol regularly has been linked to cardioprotective effects, irregular heavy drinking occasions adding up to the same average volume of drinking are associated with increased risk of vascular events. Thus, recent studies have found no protective effects of beverage alcohol on all-cause mortality or vascular mortality in Russia,<sup>40–42</sup> a finding which could be in part explained by irregular heavy drinking patterns.<sup>43</sup> In the current analyses, we conservatively assumed that the protective effects of on-average moderate drinking apply similarly to all countries and thus probably underestimated the detrimental impact of alcohol in countries where, on average, moderate consumption (on the volume dimension) is made up of infrequent and irregular heavy drinking occasions. Second, to achieve comparability, we adjusted survey derived estimates using estimates of total volumes available per capita for consumption. Whilst volume available per capita is generally recognized as the most valid estimate for level of drinking in society,<sup>24</sup> and while this procedure is necessary because of the wide variation between countries in the extent to which consumption reported in surveys can account for alcohol sold or otherwise available for

consumption, this may introduce bias, because the epidemiological studies on risk relations are not similarly adjusted. In sensitivity analyses it was found that the bias in an extreme case of underreporting in surveys amounted to an overestimation of 22% for men and 5% for women. However, even if bias was introduced this way, it should not affect the comparison between countries. Thirdly, the estimates of unrecorded consumption are, by nature, more uncertain and more vulnerable to bias than sales or production data. This especially affects the estimates for Lithuania and Russia. However, we used rather conservative estimates of unrecorded consumption, so again may have underestimated the mortality burden. Moreover, all available sources indicate that the level of unrecorded consumption is considerable in central and eastern European countries, so potential bias more likely points into an underestimation of the gap between the old EU and other countries. Finally, the current analyses do not take into account surrogate alcohol, which in some countries, especially Russia may have more detrimental effects on health.<sup>44</sup>

Overall, alcohol plays a substantial role in premature adult mortality in Europe. Almost 15% of all the deaths in the age group between 20 and 64 were attributable to this risk factor in the eight countries analysed. In men, the proportion of alcohol-attributable death is even higher. For example, among Hungarian men this proportion reaches 25%. Liver cirrhosis is especially high in this country, and consumption of home-made spirits may make a specific contribution to this,<sup>45</sup> in addition to the high level of drinking with many heavy drinking occasions. However, the very high liver cirrhosis rates in Hungary await definitive explanation.

In Russia and Lithuania, both former Soviet Union countries, there is a high alcohol-attributable mortality due to intentional and unintentional injuries, especially for men. Binge drinking has been strongly linked to injury and aggression<sup>12,46</sup> and has contributed to this mortality pattern.

Alcohol-attributable premature mortality is significantly higher among men compared with women, and amounts to high proportions of overall premature mortality. Given the fact, that the differences in life expectancy between countries in the east and west of Europe are much bigger for men, the role of alcohol in explaining these differences becomes evident. In women, alcohol consumption is lower than in men in all regions of Europe, but this difference is more pronounced in eastern Europe. This leads to a picture, where the rate of alcohol-attributable premature mortality in French women is higher than in Czech or Polish women, while the rate in UK women is comparable for women in these countries (Table 3).

Given the role of alcohol use in premature mortality in the new EU Member States and Russia, public health measures should be taken to reduce alcohol-attributable burden. There are feasible and cost-effective policies to reduce alcohol-related burden such as taxation and drinking driving measures at a population level and brief preventive counselling at a personal level.<sup>47,48</sup> Recent history in eastern Europe has shown that alcohol-attributable mortality can respond strongly to control measures.<sup>47–49</sup> Such measures are central to strategies to reduce alcohol-attributable mortality and thus to also reduce the mortality gap between new and old EU Member States.<sup>37</sup>



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### KEY MESSAGES

- Alcohol consumption explains a substantial part of the east-west difference in mortality in Europe (20% of the difference in men and 5% of the difference in women).
- Alcohol plays an especially important role in premature deaths in men.
- Both average volume of alcohol consumption and patterns of drinking contribute to premature mortality.
- Alcohol-attributable premature mortality rates varied 10-fold between countries examined.

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