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# The Global Distribution of Average Volume of Alcohol Consumption and Patterns of Drinking

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## Key Words

Comparative risk analysis · Alcohol · Exposure · Average volume · Patterns of drinking · Regional differences · Time trends

## Abstract

**Aims:** To make quantitative estimates on a global basis of exposure of disease-relevant dimensions of alcohol consumption, i.e. average volume of alcohol consumption and patterns of drinking. **Design:** Secondary data analysis. **Measurements:** Level of average volume of drinking was estimated by a triangulation of data on per capita consumption and from general population surveys. Patterns of drinking were measured by an index composed of several indicators for heavy drinking occasions, an indicator of drinking with meals and an indicator of public drinking. Average volume of consumption was assessed by sex and age within each country, and patterns of drinking only by country; estimates for the global subregions were derived from the population-weighted average of the countries. For more than 90% of

the world population, per capita consumption was known, and for more than 80% of the world population, survey data were available. **Findings:** On the country level, average volume of alcohol consumption and patterns of drinking were independent. There was marked variation between WHO subregions on both dimensions. Average volume of drinking was highest in established market economies in Western Europe and the former Socialist economies in the Eastern part of Europe and in North America, and lowest in the Eastern Mediterranean region and parts of Southeast Asia including India. Patterns were most detrimental in the former Socialist economies in the Eastern part of Europe, in Middle and South America and parts of Africa. Patterns were least detrimental in Western Europe and in developed countries in the Western Pacific region (e.g., Japan). **Conclusions:** Although exposure to alcohol varies considerably between regions, the overall exposure by volume is quite high and patterns are relatively detrimental. The predictions for the future are not favorable, both with respect to average volume and to patterns of drinking.

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## Introduction

The global burden of disease (GBD) study tries to quantify GBD by using four main measures: deaths, years of life lost due to premature mortality, years of life lost due to disability, and disability-adjusted life years (DALYs), which is a compound measure adding all years of life lost [for an overview on the 1990 GBD study, see 1]. One component of GBD, the Comparative Risk Analysis (CRA) attempts to quantify the burden associated with different risk factors, and in the current version of the CRA more than 20 risk factors have been comparatively evaluated [for further information, see 2, 3]. One of these risk factors is alcohol, and in the 1990 GBD, alcohol accounted for 3.5% of the GBD as measured in DALYs, more for instance than tobacco (2.6%) [see 4].

In order to measure global alcohol-attributable disease burden, dimensions of alcohol consumption must be found which are (a) related to disease and (b) globally accessible. Based on epidemiological studies of the past decade, two such dimensions were identified: average volume of consumption and patterns of drinking [5].

Overall consumption or average volume of alcohol consumption has been the usual measure of exposure linking alcohol to disease in recent decades [4, 6]. Average volume was linked to more than 60 disease conditions in a series of recent meta-analyses [7–10]. Average volume of consumption works as a risk factor mainly through biological and biochemical effects, including dependence, to produce long-term health consequences. Although the research demonstrates that average volume of alcohol consumption is correlated with measures of acute consequences such as injury and injury-related death, several studies indicate that the ability to predict these injury measures is improved by taking patterns of drinking into account [11]. For example, the same overall average volume of alcohol (2 drinks a day) can be consumed in relatively small quantities regularly with meals (e.g., 2 drinks a day with meals) or in large quantities on a few occasions (e.g., two bottles of wine on a single occasion every Friday). Data on the influence of patterns of drinking on the burden of disease are less available than data on overall consumption, but evidence is accumulating that patterns of drinking affect the link between alcohol and disease [11–14] and mortality [15]. In other words, the impact of average volume of consumption on mortality or morbidity is partly moderated by the way alcohol is consumed by the individual, which in turn is influenced by the cultural context [16]. It should be noted that patterns of drinking have been linked not only to acute health outcomes such as injuries [17, 18], but also to

chronic diseases such as coronary heart disease (CHD) and especially sudden cardiac death [13, 19–23].

The current study tried to quantify both dimensions of alcohol consumption for different regions of the world as a basis for estimating global burden of alcohol-related disease for the year 2000. Alcohol as a global risk factor is thus described, and predictions are made concerning the future level of exposure. Related articles try to quantify the risk relations of alcohol to different categories of morbidity and mortality [24] and to estimate the alcohol-related burden of disease [25]. Finally, policy implications are discussed [26].

## Methods

The next paragraph gives a short overview of methods used. The following points detail the individual steps. Data on overall consumption per country come from: (1) data on total sales, production and trade, and (2) data on unrecorded consumption.

In order to break down overall or per capita consumption by sex and age, we used survey data on: (1) abstention rates by age and sex, and (2) volume of drinking by age and sex.

To compute drinking patterns, data were collected from survey and key informants on: (1) different indicators of heavy drinking; (2) meal-time drinking, and (3) public drinking.

Data were checked for consistency across time and for internal consistency [for details, see 5].

### *Data Sources and Methods for Average Volume of Alcohol Consumption*

Adult per capita data were taken from the Global Status Report on Alcohol [27] and from the WHO Global Alcohol Database created by the Marin Institute for the Prevention of Alcohol and Other Drug Problems, and currently maintained by the Swiss Institute for the Prevention of Alcohol Problems. Most international compilations of alcohol consumption levels have relied on recorded consumption only, which in many countries consists only of industrially produced alcoholic beverages. In the present analysis, systematic efforts were made to include estimates of unrecorded consumption. The unrecorded beverages may be consumed by a home producer, or may be produced in a cottage industry, or may be untaxed commercial production. Unrecorded consumption data were also mainly taken from the Global Status Report on Alcohol [27].

Drinking surveys were also collected from the WHO Global Alcohol Database, but additional surveys were accessed based on individual contacts and by announcing the CRA on a specific list serve. The World Health Organization (WHO) collected key informant data systematically from a mail-out to regional experts early in 2000 and in mid-2001.

The GBD framework requires a disaggregated approach that involves estimating the burden separately by sex, age and regions. Using per capita consumption data derived from production and trade or sales data plus unrecorded consumption as the first estimate of overall alcohol consumption, the following strategy was adopted to generate sex-age-specific prevalence rates for the CRA regions for the year 2000:

**Table 1.** Patterns of drinking included in CRA

Pattern	Link to disease burden
Heavy drinking occasions 1: High usual quantity of alcohol per occasion	Heavy drinking occasions lead to increase in injuries [17,18], even after adjustment for average volume of consumption. Also, heavy drinking occasions have been shown to lead to detrimental cardiovascular outcomes (CVD [5, 14]), again after adjustment for average volume. There are physiological explanations for the relationship of heavy drinking occasions both to injury and to CVD. Usual quantity per occasion, festive drinking and drinking to intoxication are different forms of operationalization of heavy drinking. All have been used in the literature and linked to burden outcomes. <i>Ceteris paribus</i> , the higher the frequency of heavy drinking occasions, the higher the alcohol-related disease burden.
Heavy drinking occasions 2: Festive drinking common – at fiestas or community celebrations	
Heavy drinking occasions 3: Proportion of drinking occasions when drinkers get drunk	
Heavy drinking occasions 4: Proportion of drinkers who drink daily or nearly daily (reverse scored)	The fewer occasions in which a given amount of alcohol is consumed, the more detrimental the consequences [13, 43, 44]. Thus, given a fixed average volume of consumption, the higher the proportion of daily drinking, the lower the expected burden.
Drinking with meals – how common it is to drink with meals (reverse scored)	Drinking with meals has been shown in epidemiological and biological research to be less detrimental than drinking at other times [22, 45, 46]. Thus, <i>ceteris paribus</i> , the higher the proportion of alcohol consumed with meals, the lower the alcohol-related disease burden.
Drinking in public places – how common it is to drink in public places	Drinking in public often requires transportation, and thus has been linked to traffic accidents and injuries. Also, there may be psychological consequences like risky shift. Thus, the higher the proportion of alcohol consumed in public, the higher the alcohol-related disease burden. Again, this holds only when volume and other influencing factors are held constant.

Firstly, for each WHO region (see below for regional subgroupings) the average adult per capita consumption including unrecorded consumption for the population 15 and above was estimated as a population-weighted average of country-specific per capita consumption data. All entries per country after 1998 were taken and averaged to get a stable estimate for 2000. The weights were derived from the average population over age 15 in each country for the years after 1998 on the basis of UN population data. Country-specific per capita data were estimated for 132 countries based on the WHO Global Alcohol Database [5]. This means that for more than 90% of the world population the per capita consumption for this time period was known.

Secondly, country-specific survey data of the ratio of male/female consumption were used to allocate proportionally the overall adult per capita consumption into adult male and adult female per capita consumption.

Thirdly, again based on surveys, the age-specific prevalence of drinking was calculated under the assumptions that the average per capita consumption and the proportions of male and female abstainers were correct. It should be noted that survey information on abstention was available for 69 countries, including almost all of the countries with populations larger than 100 million. Thus, for more than 80% of the world population, survey data were available.

#### *Data Sources and Methods for Patterns of Drinking*

To develop drinking pattern estimates for all the WHO regions used in the CRA, key informant questionnaire studies were undertaken in early 2000 [for the key informant questionnaire, see 28] and repeated in 2001, using a slightly modified questionnaire. In total, answers from 63 countries were obtained, at least one for every WHO region except for the Eastern Mediterranean region (see below for listing of countries by region and subregion).

As described in the following, the responses from the key informant survey on patterns taken together with available survey data provided sufficient data for a first estimate of patterns of drinking for all WHO regions.

The surveys covered main areas of drinking patterns of the culture that might be expected to affect the impact of volume of drinking described in table 1: four different aspects of heavy drinking, drinking with meals and drinking in public places. In most cases, respondents had some access to national or regional survey data, although these data had not always been published in the international literature. In addition, the informants provided a validity rating for their responses (i.e., whether responses were based on surveys or just best guesses). This information was used for decisions about inclusion of data when conflicting information existed.

The key informant ratings were analyzed using optimal scaling analysis [29, chapter 2]. This analysis is similar to factor analysis, but

permits the simultaneous inclusion of ordinal and categorical data. As with factor analysis, this statistical technique allows the analyst to determine the number of underlying dimensions and the relations of items to each dimension. In the case of the patterns of drinking analysis, one dimension was identified and labeled as detrimental impact [28].

The results of the optimal scaling analysis were very similar to a score derived by simply summing the ratings of the key informant survey (Pearson correlation: 0.93). To further simplify the pattern values into robust general categories based on these scale values, the countries were classified into four categories and assigned values from 1 (least risky drinking pattern) to 4 (most risky drinking pattern). In constructing the final pattern values, more individual level survey data from countries were available, and the data from the second key informant survey were included, overriding some of the prior expert opinion data [5]. Also, the proportion of abstainers was no longer included as one of the parameters of pattern weights, because rates of abstention were taken into account separately in the CRA [15]. Appendix 1 gives the final algorithms for calculated pattern scores.

#### Regional Subgroupings

The regional subgroupings below have been defined by WHO (World Health Report [see 30]) on the basis of high, medium or low levels of adult and of infant mortality. All risk factors in the CRA were estimated for these same regions. In terms of alcohol exposure, there is variability within regions, but since both alcohol and mortality are correlated with economic development, overall the regions show some homogeneity also with respect to alcohol. Exceptions are categorizations like Europe B, where Muslim countries with very low and non-Muslim countries with quite high average volume of consumption are grouped together; or Europe A, which combines different patterns of drinking in Mediterranean and Nordic countries. However, it should be noted that differences such as the latter concern only quite small countries with little impact on Europe A as a whole, when estimates for the whole subregions were derived from population-weighted averages.

Africa D	Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Comoros, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Togo
Africa E	Botswana, Burundi, Central African Republic, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe
Americas A	Canada, Cuba, United States of America
Americas B	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela
Americas D	Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru

Eastern Mediterranean B	Bahrain, Cyprus, Iran (Islamic Republic of), Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates
Eastern Mediterranean D	Afghanistan, Djibouti, Egypt, Iraq, Morocco, Pakistan, Somalia, Sudan, Yemen
Europe A	Andorra, Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, United Kingdom
Europe B	Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Poland, Romania, Slovakia, The Former Yugoslav Republic of Macedonia, Tajikistan, Turkmenistan, Turkey, Uzbekistan, Yugoslavia
Europe C	Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine
Southeast Asia B	Indonesia, Sri Lanka, Thailand
Southeast Asia D	Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Maldives, Myanmar, Nepal
Western Pacific A	Australia, Brunei Darussalam, Japan, New Zealand, Singapore
Western Pacific B	Cambodia, China, Cook Islands, Fiji, Kiribati, Lao People's Democratic Republic, Malaysia, Marshall Islands, Micronesia (Federated States of), Mongolia, Nauru, Niue, Palau, Papua New Guinea, Philippines, Republic of Korea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Viet Nam

A stands for very low child and very low adult mortality, B for low child and low adult mortality, C for low child and high adult mortality, D for high child and high adult mortality, and E for very high child and very high adult mortality [30].

## Results

Table 2 gives an overview of the combined results by region for the year 2000. For this year, we have combined data on adult per capita consumption with data on unrecorded consumption and patterns of drinking. The most striking feature is the diversity between regions.

In most regions around the world, spirits dominate as the largest contributor, in terms of pure alcohol, to total alcohol consumption (table 2, second column). Spirits consumption has also grown fastest in the last quarter century, although beer (and particularly European-style lager beer) has also been growing. Global wine production and consumption has decreased, primarily because of substantial decreases in Southern Europe, the leading area of wine production and consumption.

The second column of figures in table 2 shows that the estimated unrecorded consumption constitutes only a

**Table 2.** Characteristics of adult alcohol consumption in different regions of the world 2000 (population-weighted averages)

WHO region (for definition see below)	Beverage type mostly consumed	Total consump- tion <sup>1</sup>	% un- recorded of total <sup>2</sup>	% heavy drinkers <sup>3</sup>	% drinkers among males	% drinkers among females	Consump- tion per drinker <sup>4</sup>	Average drinking pattern <sup>5</sup>
Africa D (e.g. Nigeria, Algeria)	Mainly other fermented beverages	4.9	53	5.3	47	27	13.3	2.5
Africa E (e.g. Ethiopia, South Africa)	Mainly other fermented beverages and beer	7.1	46	10.3	55	30	16.6	3.1
Americas A (Canada, Cuba, USA)	>50% of consumption is beer, about 25% spirits	9.3	11	11.2	73	58	14.3	2.0
Americas B (e.g. Brazil, Mexico)	Beer, followed by spirits	9.0	30	9.1	75	53	14.1	3.1
Americas D (e.g. Bolivia, Peru)	Spirits, followed by beer	5.1	34	2.7	74	60	7.6	3.1
Eastern Mediterranean B (e.g. Iran, Saudi Arabia)	Spirits and beer, but scarce data	1.3	34	1.5	18	4	11.0	2.0
Eastern Mediterranean D (e.g., Afghanistan, Pakistan)	Spirits and beer, but scarce data	0.6	56	0.1	17	1	6.0	2.4
Europe A (e.g. Germany, France, UK)	Wine and beer	12.9	10	15.7	90	81	15.1	1.3
Europe B (e.g. Bulgaria, Poland, Turkey)	Spirits	8.3	41	8.8	72	52	13.4	2.9
Europe C (e.g. Russian Federation, Ukraine)	Spirits	13.9	38	18.6	89	81	16.5	3.6
Southeast Asia B (e.g. Indonesia, Thailand)	Spirits	3.1	27	1.2	35	9	13.7	2.5
Southeast Asia D (e.g. Bangladesh, India)	Spirits	2.0	79	0.9	26	4	12.9	3.0
Western Pacific A (e.g. Australia, Japan)	Beer and spirits	8.5	20	4.2	87	77	10.4	1.2
Western Pacific B (e.g. China, Philippines, Viet Nam)	Spirits	5.0	26	4.1	84	30	8.8	2.2

<sup>1</sup> Estimated total alcohol consumption per resident aged 15 and older in liters of absolute alcohol (recorded and unrecorded).

<sup>2</sup> Percentage of total adult per capita consumption (= column 3) which is estimated to be unrecorded.

<sup>3</sup> Estimated % rate of heavy drinking (males  $\geq 40$  g and females  $\geq 20$  g) among those aged 15+.

<sup>4</sup> Estimated total alcohol consumption (in liters of absolute alcohol) per adult drinker.

<sup>5</sup> Estimated average pattern of drinking (1–4, with 4 being the most detrimental pattern).

small part of the total in Western Europe or North America, but is a much more substantial proportion of all consumption in many parts of the world – about half of all consumption in Africa, and almost four-fifths in India and other countries of Southeast Asia D.

Taking into account both recorded and unrecorded consumption, the highest amount of alcohol per adult resident is consumed in Europe (table 2, first column of figures), especially in Russia and surrounding countries (Europe C) and in the established market economies in Western Europe (Europe A) and North America (America A). The least amount of alcohol per resident is consumed

in the mostly Islamic regions of the Eastern Mediterranean and in the lesser developed region of Southeast Asia (SE Asia D), dominated by India. The range is more than 20-fold between the subregion with the highest estimated consumption level (Europe C) and the subregion with the lowest (Eastern Mediterranean D).

The third column of figures in table 2 shows the estimated rate of average amount of high alcohol consumption in the total population, based on both adult per capita and survey data. Average high alcohol consumption is defined here in terms of the level considered ‘hazardous’ and ‘harmful’ in medical epidemiological meta-analyses

[7]: >40 g/day for males, or about 4 drinks or two-thirds of a bottle of table wine, and >20 g/day for females, or about 2 drinks or one-third of a bottle of table wine. Although the rank order of regions is almost the same as for adult per capita consumption (Spearman's  $\rho$  0.92), there are substantial differences due to the number of abstainers and the distribution of consumption among drinkers.

So far, our analysis has been in terms of the total adult population, that is, including abstainers as well as drinkers in the base. In considering the public health effects of drinking, it is also highly relevant to take into account the proportion of the population who drink at all. In table 2 (fourth and fifth columns of figures), we show estimates of the percentage of the population who are drinkers, defined as having had a drink of alcohol at some time within the last year, for males and females separately. The figures illustrate that in some parts of the world there are very substantial gender differences in the proportion of drinkers. Thus, drinking is estimated to be almost entirely confined to males in the mainly Islamic regions of the Eastern Mediterranean, and drinking by women is nearly as uncommon in Southeast Asia. Almost twice as many men as women drink in the African subregions. In only three subregions – Europe A, Europe C, and Western Pacific A – is the rate of female drinkers within 10 percentage points of the rate of male drinkers.

If one excludes the abstainers from the base, the comparisons among subregions change substantially. The sixth column of figures in table 2 shows the estimated consumption per drinker, excluding the abstainers from the base on which the level of consumption is calculated. The rank order of regions is still somewhat stable (Spearman's  $\rho$ : 0.65), but the range of variation has dropped dramatically – from more than 23-fold to less than 3-fold (2.77). The per-drinker consumption level in 9 of the 14 subregions falls within the relatively narrow range 12.9–16.6 liters per annum, which is all in the range of between 20 and 40 g pure alcohol per day (20 g = 9.2 l/year and 40 g = 18.4 l/year), if all drinkers were to drink the same amount per day. Subregions with lower consumption levels per drinker within this range include the Eastern Mediterranean and Western Pacific regions, and Americas D. Viewed in this perspective, the rate of abstention in the adult population of a subregion plays a major role in determining the total population consumption level.

The last column of table 2 shows the computed average drinking pattern score for the subregion, based on a population-weighted average of the estimated score for each constituent country. The relatively low scores for Europe A and Western Pacific A primarily reflect the relatively

low scores assigned to Japan and to the wine cultures of Southern Europe. Within Europe A are countries with relatively high scores, such as the Nordic countries north of the Baltic, but on a population-weighted basis their scores carry little weight. At the other end of the scale, the figure for Europe C is dominated by Russia and other Slavic countries of the former Soviet Union, where patterns of high consumption in a drinking episode are particularly entrenched. It should be noted that the pattern scores for the developing regions of the world are at best halfway between the Europe A and Europe C scores, with four developing regions – Africa E, Americas B and D, and Southeast Asia D – showing estimated scores of 3 or higher, on a scale from 1 to 4. This higher score implies a greater rate of harm per liter of alcohol consumed as evidenced by multilevel analyses regressing injury and CHD deaths on these patterns and average volume of consumption [5, 32].

## Discussion and Conclusions

### *Methodological Considerations: Data Strengths and Limitations*

Adult per capita data are a key element in estimating alcohol exposure. Per capita data are a useful measure for cross-country comparisons; they are cheap and easy to obtain, and available for the majority of countries. Usually time series are available. Also, these data avoid the underestimation commonly found in survey data. Adult per capita consumption, i.e. consumption by everyone aged 15 and above, is regarded as preferable to per capita consumption due to the varying age structure of populations. Per capita consumption figures based on the total population tend to underestimate consumption in countries where the larger proportion of the population is below age 15, as is the case in many developing countries. For more information and guidance on estimating per capita consumption, see the International Guide for Monitoring Alcohol Consumption and Related Harm [30].

There are three principal sources of data for per capita estimates: national government data, data from international organizations and alcohol industry data. In most cases the best and most reliable source is national government data, which is usually based on sales figures, tax revenue, and/or production data. Generally, sales data are considered the most accurate, provided that sales of alcoholic beverages are separated from sales of any other possible items sold at the location, and that sales data are beverage-specific. One of the drawbacks of production

data is that these are always dependent on accurate export and import data, as otherwise the production figures will yield an under- or an overestimation.

On the international level the most complete and comprehensive dataset is published by FAO (Food and Agriculture Organization of the United Nations). FAOSTAT, the database of the FAO, publishes production and trade data for almost 200 countries for beer, wine and spirits plus a number of other beverage categories (palm wine, maize, millet and sorghum beer, fruit wine, rice wine, rice-fermented beverages, tuba, cider, grape must, vermouth, and wheat-fermented beverages). The estimates are based on official reports of production, usually in metric tons, by national governments, mainly as replies by the Ministries of Agriculture to an annual FAO questionnaire. The statistics on import and export derive mainly from Customs departments. If these sources are not available, other government data such as statistical yearbooks are consulted. The accuracy of the FAO data relies on member nations reporting the data. It is likely that the data underestimates informal, home and illegal production.

The third main source of data comes from the alcohol industry. In this category the most widely used source is World Drink Trends (WDT) published by the Dutch Distillers' Association. The WDT estimates are based on total sales in liters divided by the total mid-year population, and using conversion rates that are not published. WDT also tries to calculate the consumption of both incoming and outgoing tourists. Currently, at least partial data are available for 58 countries. Other alcohol industry sources include the United Kingdom Brewers and Licensed Retailers Association and the Canadian Brewers Association. Some market research companies also offer limited and expensive data.

It is clear that the greatest weakness of both the FAO and WDT figures is the lack of data on unrecorded alcohol consumption. The WHO Global Alcohol Database uses a combination of FAO and WDT data with some recalculations and conversions. The FAO data is converted from metric tons into liters (multiplied by 0.84). The different alcoholic beverages are converted into liters of pure alcohol using estimates of alcoholic strength that sometimes vary between countries. Finally, both sources are converted from per capita estimates into adult per capita using official UN population data. For the countries where the FAO and WDT data overlap, an estimation of the reliability of each source has been carried out and eventually one has been chosen as more reliable than the other. In practice this means that many of the devel-

oped country estimates are based on either WDT or direct government data, while most estimates for the developing countries are based on FAO data.

Plotting the FAO per capita data against the data from WDT shows that with the exception of a few countries, estimates from both sources were comparable and relatively highly correlated (Pearson correlation = 0.74). It does not seem possible to find an overall explanation for the differences in the data for the few countries. Obviously one is that the FAO estimates are based on production data, while WDT is primarily based on sales data. It could perhaps be expected that the higher estimates of FAO partly reflect production of beverages that do not show up in sales data either because of so-called home production, e.g. the production of palm wine or sorghum beer in some African countries, or because WDT does not account for the whole range of beverage categories. Also, FAO estimates were most often higher than those of WDT in wine-producing countries such as Uruguay, Paraguay, South Africa, Portugal, France, Spain, Argentina, and Cyprus. There is some evidence [33, table 4, and pers. commun., e.g. with the Ministry of Health in France] that in those countries not all the wine produced will be officially sold or taxed, as wine growers (vineyards) are allowed to produce wine for what is called their 'own' use. Thus, in those countries the FAO estimates were used.

The main limitation of per capita estimates in general is their status as aggregate statistics, which cannot easily be disaggregated. Thus, surveys play a crucial role in any risk analysis of alcohol. Even though in the current exercise, for more than 80% of the world population there were survey data available, the quality of these data was mixed, and some could not be properly evaluated. With the WHO multi-country survey on health and responsiveness 2000–2001 [34] and the upcoming World Health Surveys [[www.who.int/evidence/whs](http://www.who.int/evidence/whs)], there will be comparable reliable and valid data on dimensions of consumption from many countries for future exercises. These data sets will be especially valuable for emerging economies and for regions, where unrecorded consumption is estimated to make up a larger proportion or the majority of the consumption.

This is the first global assessment of alcohol which is not limited to average volume of drinking. The second dimension assessed, patterns of drinking, should be regarded as a work in progress. While there are clear indications that different patterns of drinking are linked to health consequences, there is not a lot of work on how best to combine these patterns into an index. Instead, alcohol epidemiology is fragmented and each new study tends to



use a different assessment measure despite numerous pleas to at least include a minimal set of standard measures [e.g. 35, 36]. Moreover, global assessment of patterns is still difficult, as the same problem of lack of standardization can also be found in descriptive statistics. On the other hand, the epidemiological literature on CHD and injuries clearly demonstrated that predictions only based on average volume of consumption may lead to substantial errors in estimation [13, 14, 17–20, 23]. As injuries and CHD are potentially the largest contributors to alcohol-related disease burden [26], such errors cannot be tolerated in a global risk assessment.

### *Substantive Conclusions*

Alcohol-related burden is linked to at least two different dimensions of consumption: average volume and patterns of drinking. Thus, in order to avoid burden, both dimensions should be kept in mind. In other words, one may reduce burden by reduction of average volume of alcohol consumption or by shifting patterns of drinking to less harmful patterns. One may also change burden by weakening the link between exposure and disease, e.g. by disaggregating the link between alcohol and traffic accidents by not combining both behaviors.

With the exception of Islamic regions, alcohol is ubiquitous in the modern world. Extrapolating from the historical trends [described in 14], the role of alcohol as a major factor in the burden of disease will even be increasing in the future. Two trends seem most worrying in this respect. Increases in average volume of drinking are predicted for the most populous regions of the world in Southeast Asia, including India and China. In addition, alcohol is linked to categories of disease predicted to increase in their relative impact in the GBD (accidents and injuries, chronic disease [see 1]). Thus, just from extrapolating past trends in average consumption and disease burden, marked increases in alcohol-related burden over the next decades can be predicted.

Secondly, there are some indications that historically more healthful patterns of drinking are deteriorating in young people in Europe [37]. Globalization seems to lead to converging patterns of drinking, and not necessarily to convergence to the most favorable patterns of regular light to moderate drinking predominantly with meals. The deterioration of the favorable pattern in young people in Europe has been linked to aggressive marketing to youth, and the role models and situations publicized surely do not coincide with light to moderate drinking at meals [38]. Rather, drinking is promoted as a lifestyle in association with recreation, fun and partying and other evening activ-

ities. Even though the causal relationship between marketing and patterns of drinking still has to be established, the health ministers of Europe and the WHO have warned about the dangers of marketing especially to young people [<http://www.ias.org.uk/theglobe/2001gapa1/declaration.htm>].

From a larger perspective, the global trend should be reversed and more favorable patterns of drinking should be established. This is easier said than done, as the Southern European way of consumption seems to have been the result of long cultural formations, which are not easily transposed into other cultures [39]. While there are cost-effective policies to influence the overall level of drinking, and rates of some specific alcohol-related problems [40, 41], research does not offer much guidance on successful measures to change drinking patterns in a more favorable direction, other than with politically unpalatable measures such as alcohol rationing.

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## Appendix 1: 'Pattern of Drinking' Variables and Their Relative Weights

### Heavy drinking occasions

(Maximum of 11 points for this component)

#### Daily drinking:

Less than 20% daily drinking for males: 1 point  
Less than 10% daily drinking for females: 1 point

#### Frequency of getting drunk:

Most male drinkers usually get drunk when they are drinking:  
2 points  
Most male drinkers often get drunk: 1 point  
Most female drinkers usually or often get drunk: 1 point

#### Usual quantity per drinking session:

Males: more than 60% typically consume 4 or more drinks per session: 2 points  
Males: between 40 and 60% consume 4 or more drinks per session: 1 point  
Females: more than 50% consume 4 or more drinks per session: 2 points  
Females: between 35 and 50% consume 4 or more drinks per session: 1 point

### Fiesta binge drinking

Males: fiesta drinking commonly occurs: 1 point  
Females: fiesta drinking commonly occurs: 1 point

### Drinking with meals

(Maximum of 4 points for this component)

Males: rarely or never with meals: 2 points  
Males: sometimes with meals: 1 point  
Females: rarely or never with meals: 2 points  
Females: sometimes with meals: 1 point

### Drinking in public places

(Maximum of 2 points for this component)

Males: common and everyday: 1 point  
Females: common and everyday: 1 point

### Scoring (possible range: 0–17 points)

Scoring by summation of individual questions: range 0–17  
10–17 points: assign a pattern value of 4  
7–9 points: assign a pattern value of 3  
4–6 points: assign a pattern value of 2  
0–3 points: assign a pattern value of 1

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