GLOBAL BURDEN OF DISEASE AND INJURY AND ECONOMIC COST ATTRIBUTABLE TO ALCOHOL USE AND ALCOHOL USE DISORDERS

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ABSTRACT

BACKGROUND

Alcohol consumption has been identified as an important risk factor for chronic disease and injury.

METHODS

Alcohol exposure and prevalence of alcohol use disorders were estimated based on reviews of the literature. After identifying other major disease categories causally linked to alcohol, attributable fractions were estimated for each such category by sex, age and WHO region, as well as for selected large countries. These attributable fractions were applied to the 2004 Global Burden of Disease estimates for burden of mortality and disease; the latter measured in disability adjusted life years (DALYs). In addition, social costs of alcohol in selected countries were compared also based on a systematic review.

FINDINGS

Overall, there is wide variation around the global consumption average of 6.2 litres of pure alcohol adult per capita per year. The majority of adults abstain. The net impact of alcohol consumption on health is detrimental, with an estimated 3.8% of all global deaths and 4.6% of global DALYs were attributable to alcohol. Alcohol-attributable burden of disease and injury is higher in men and affects relatively young cohorts (especially related to injury). Overall, burden is closely related to average volume of alcohol consumption is stronger on the poor and marginalized.

INTERPRETATION

Alcohol consumption globally is one of the major avoidable risk factors, and steps for reducing alcohol-attributable burden and costs should be initiated.

KEY WORDS:

Alcohol, heavy drinking occasions, risk factor, burden of disease, mortality, chronic disease, injury, poverty, global health

INTRODUCTION

Alcohol has been a part of human culture since the beginning of recorded history (1). Almost all societies that consume alcohol show related health and social problems. The industrialization of production and globalization of marketing and promotion of alcohol have increased both the amount of global consumption and the harms associated with it.

These developments have led to several resolutions by the World Health Assembly and WHO Regional Committees, outlining the public-health problems caused by alcohol (2), as well as possible strategies to reduce the harmful use of alcohol (3). The latter resolution calls for the development of a global strategy, and will be discussed in companion papers (REF for companion papers when available).

This paper gives an overview of alcohol as a risk factor for the global burden of disease and injury, with a special emphasis on so-called alcohol use disorders (AUD), i.e., alcohol dependence (AD) and harmful use of alcohol as outlined in the International Statistical Classification of Disease 10th Revision (ICD-10) (4). AUD, especially for men, have been shown to be among the most disabling disease categories for the global burden of disease (5). However, this is not the only alcohol-linked disease category, as more than 30 ICD-10 three or four digit codes include alcohol in their name or definition (4) indicating that alcohol consumption is a necessary cause. Furthermore, there are over 200 ICD-10 three digit disease codes, in which alcohol is part of a component cause (6). We present global, regional, and selected country overviews for both types of consequences from alcohol consumption.

No overall assessment of the health effects of alcohol would be complete without discussing the beneficial effects of certain drinking patterns. Regular drinking at low levels has been identified as contributing to a lower incidence of a number of disease conditions, most notably ischaemic cardiovascular outcomes and diabetes (7;8). Although these beneficial effects are far outweighed by the detrimental effects of alcohol on disease and injury (9), they will also be estimated in this paper, together with the net burden resulting from alcohol consumption.

Finally, we will also give estimates on the economic costs of alcohol consumption in selected societies. This will enable us to examine the full societal impact of alcohol, as economic studies are not restricted to health but usually include criminal outcomes and other social detriments (10).

METHODS

INDICATORS OF ALCOHOL CONSUMPTION

The exposure data on recorded and unrecorded adult per capita alcohol consumption for 2003, the most recent year of available comprehensive data, were taken from the WHO Global Status Report on Alcohol 2004 (11) and the WHO Global Information System on Alcohol and Health (http://www.who.int/globalatlas/default.asp), which provides regular updates on these data. Recorded alcohol consumption per capita was based on government records (taxation), and industry publications on the production and sales of alcohol, as well as data from the Food and Agriculture Organization (FAO). By definition, unrecorded alcohol consumption is not reflected in these records. Thus, different methods were used to estimate unrecorded consumption, mainly expert opinion and general population surveys (12). The principal sources of unrecorded alcohol include home production, alcohol intended for industrial, technical and medical uses, and illegal industrial production or illegal import.

Prevalence of abstention and average volume of drinking categories were taken from large representative surveys in the respective countries in the 2000s, and survey-derived volume of drinking was adjusted for total adult per capita consumption (for a description of methodology see (12)).

Two different dimensions of alcohol consumption have been shown to impact health: average volume of alcohol consumption and patterns of drinking, especially heavy drinking occasions (8;9). As in the Comparative Risk Assessment (CRA) of the Global Burden Disease (GBD) 2000 Study (9), patterns of drinking were used in addition to average volume in the modeling of impact on injury and ischaemic heart disease.

INDICATORS OF MORTALITY AND BURDEN OF DISEASE

We use both event-based (mortality) and time-based (disability adjusted life years) measures of population health. Disability-adjusted life years (DALYs) combine years of life lost (YLL) due to premature death and years of life lived with disabilities (YLD) into a single indicator that assesses the total lost years of full health from different causes (13;14). A comprehensive revision of estimates for mortality and DALYs for 136 disease and injury causes for the year 2004 (most recent year available) was provided by WHO as part of the ongoing GBD project (15). Of particular relevance for the estimation of mortality and burden of disease attributable to alcohol use were the revision of cancer incidence and mortality data, of diabetes incidence and prevalence, of AUD incidence and prevalence using procedures as described below, and of the disability part of cardiovascular diseases (15). Methods and data for estimating mortality and DALYs in the GBD project are described elsewhere (16;17). Population estimates for 2004 were based on the latest revisions by the United Nations Population Division (18).

ALCOHOL USE DISORDERS (AUD)

Previous global estimates for AUD were based on a range of assessment instruments with varying quality including screening instruments such as the CAGE or the Alcohol Use Disorders Identification Test (19), which by design overestimate the prevalence (20). A new review was carried out for the GBD 2004 update using only studies conducted after 1990, which used ICD-10, DSM-IIIR or DSM-IV criteria for alcohol dependence and one of the following diagnostic instruments: the Composite International Diagnostic Interview, the Schedules for Clinical Assessment in Neuropsychiatry or the Alcohol Use Disorder and Associated Disabilities Interview Schedule-Alcohol/Drug-Revised (21).

Population estimates of the point prevalence of AD in the age range 18–64 years were obtained from 37 studies (21). Estimated regional prevalence for AD by age and sex were then adjusted to account for the additional prevalence of harmful use of alcohol, and to correct for comorbidity. Incidence rates and

average durations for AUD were estimated from prevalence, relative risk of mortality and remission rates using DISMOD II (22). An instantaneous average remission rates of 0.175 was assumed for ages 15 years and over; the relative risk of mortality averaged 1.8 for men and 3.8 for women (23).

The original GBD 1990 disability weight of 0.18 for AD was applied to both AD and harmful use in the GBD 2000–2002. Recent analyses of disability associated with harmful use of alcohol from the Australian Burden of Disease Study (24) and of health state valuations collected in the WHO Multi-country Survey Study (MCSS) (25) suggested that the actual average disability weights for AUD were lower, and weights were adjusted downwards to to 0.122–0.137 (depending on age and sex).

Applying these weights, the overall YLD for AUD for 2004 are 22.0 million compared to 19.1 million, if GBD 2000 assumptions and estimates were maintained for the 2004 population. The revised prevalence estimates have resulted in increases in the estimated burden for China, India and countries of the former Soviet Union, and decreases for high-income countries, Latin America and Africa.

IDENTIFICATION OF DISEASE CATEGORIES CAUSALLY LINKED TO ALCOHOL

As indicated above, several disease and injury conditions are caused by alcohol by definition (e.g., AUD, alcoholic liver disease, alcohol induced pancreatitis). These disease conditions are 100% alcohol-attributable, meaning that without the existence of alcohol, these conditions would not exist. In addition, there are disease and injury conditions where alcohol is a contributory cause; i.e. part of some component causes constellations (6). For many of the latter disease conditions such as certain types of cancer, only a relatively small portion is attributable to alcohol.

In identifying disease categories where alcohol is a contributory cause, the standard epidemiological criteria were applied. The establishment of causality required sufficient evidence of: (1) a consistent association (positive or negative) between alcohol consumption and the disease or injury; (2) chance, confounding variables, and other bias being ruled out as factors for association with reasonable

confidence (26); and (3) evidence of a plausible mediating process (27). These evaluations were made using the standard criteria for establishing causality in epidemiology, in which the most weight was placed on the following (9): temporality; consistency across studies; established experimental biological evidence of mediating processes or at least physiological plausibility (biological mechanisms); strength of the association (effect size).

In terms of wider codes from the GBD study (17) the following categories were related to alcohol: conditions arising during the perinatal period: low birth weight (ICD-10: P05-P07), mouth and oropharynx cancers (C00-C14), esophageal cancer (C15); colon and rectal cancers (C18-C21); liver cancer (C22); breast cancer (C50); other neoplasms (D00-D48); diabetes mellitus (E10-E14); AUD (F10); unipolar depressive disorders (F32-F33); epilepsy (G40-G41); hypertensive heart disease (I10-I14); ischaemic heart disease (I20-I25); haemorrhagic stroke (I60-I62); ischaemic stroke (I63); cirrhosis of the liver (K74); road traffic accidents (many V codes; for details see (9)); poisonings (X40-X49); falls (W00-W19); drownings (W65-W74); other unintentional injuries (rest of V codes plus some W, X, Y codes; for details see (9)) self-inflicted injuries (X60-X84, Y870); violence (X85-Y09, Y871); other intentional injuries (Y35). The identified alcohol-attributable disease and injury conditions are the same as in the CRA 2000 with one exception: colorectal cancer has been added, based on the 2007 evaluation of the International Agency for Research on Cancer on the carcinogenicity of alcohol beverages (28).

It should be noted, that for alcohol, the usual epidemiological model has to be widened, as in some instances, drinking may harm the health of non-drinkers (i.e. the impact of maternal drinking on the health of the newborn; drunk driving on bystanders).

ESTABLISHING RISK RELATIONS

For most chronic disease categories, the quantification of the risk of disease attributable to alcohol was estimated by combining the prevalence of exposure and the relative risk estimates based on meta-analytic studies with the following formula to derive alcohol-attributable fractions (AAFs) (29;30):

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

Where
i: exposure category with baseline exposure or no exposure i=0
RR(i): relative risk at exposure level i compared to no consumption
P(i): prevalence of the i^{th} category of exposure

The derived AAFs were taken from the CRA for 2002 (31) for chronic disease categories. For injury, AAFs were taken from CRA 2000 study (9). These AAFs take patterns of consumption into account for ischaemic heart disease and all injury conditions.

AAFs represent the proportion of each outcome (i.e., number of deaths or burden of disease and injury in DALYs), which is attributable to alcohol. This is based on a counterfactual scenario of no alcohol consumption (32). The counterfactual scenario is, of course, the same for both beneficial and detrimental effects of alcohol.

LEVEL OF AGGREGATION

Exposure data was collected on country level and then aggregated onto the regional level. All analyses on mortality and morbidity were based on the year 2004, conducted separately by sex, age and regions. The following age groups used were: 0-4 years, 5-14 years, 15-29 years, 30-44 years, 45-59 years, 60-69 years, and 70+ years. Fourteen WHO regions, the same as in the CRA 2000, were used as bases for calculations (9). These regions were established based on levels of child and adult mortality (33). Whenever larger regions are shown, calculations were done at the sub-regional level and then aggregated. Furthermore, country-specific analyses were conducted.

POOLED ANALYSES OF SOCIAL COSTS OF ALCOHOL CONSUMPTION STUDIES FROM LITERATURE REVIEW

In order to estimate the economic costs due to alcohol in selected societies, a literature search of existing alcohol-attributable social cost studies was performed for the period of January 1992 to September 2007, in multiple electronic bibliographical databases, including: Ovid MEDLINE, PubMed, EMBASE, Web of Science, PsychINFO, Google Scholar and the Cochrane Database of Systematic Reviews. In addition, manual reviews of the content pages of the major epidemiological journals were

conducted and citations from all relevant articles were retrieved. The contents of 247 abstracts and 45 full-text manuscripts were reviewed to determine whether they contained data on cost drivers associated with alcohol consumption. Of these, 29 studies were identified from 17 different countries and the EU (list available from the authors).

Predictably, a large variation in the methods used for the estimation of the social cost of alcohol was observed from the review. For example, studies from Australia (34;35) and Sweden (36) presented the "net cost" which took into account the possible positive effects, e.g. reduction of the risks of cardiovascular illnesses generated from low to moderate regular alcohol consumption without heavy drinking occasions, while most of the studies adopted the "gross cost estimation" in which only the costs associated with the negative effects of alcohol consumption were counted. In addition, although a majority of studies used the discount rate of 6%, we found that the rates actually ranged between 3 and 10% (36;37). The discount rate used to quantify the present value of the future cost is vital because the opportunity costs lost from premature mortality attributed to alcohol always constitutes a significant portion of the overall costs.

Because the methodology varied considerably across studies, it is difficult to draw sensible conclusions or comparisons from all identified studies. Thus, the authors only included studies that were methodologically most comparable; i.e. estimating the gross cost and using the same discount rate of 6% (except the Korean study where a discount rate of 5% was applied (38). Only the most recent and comprehensive study per country, detailing cost categories, was included for the analysis to avoid overlapping in our database. As a result, four studies from high-income countries, France, the U.S.A., Scotland, and Canada, were included. In terms of middle-income countries, only two comparable alcohol-attributable social cost studies from Korea and Thailand were identified and included in the analysis.

The data were tabulated according to potential direct and indirect cost components including: (1) health care costs, (2) law enforcement costs, (3) other direct social costs e.g. property damage and loss, direct

administrative costs, and social work services, and (4) indirect costs. Costs for different countries were converted to a single currency unit, an international dollar (I$) using the Purchasing Power Parity (PPP) index used by the International Monetary Fund (39). All costs were also reported in the present value by inflating the original cost to the equivalent cost in the year 2007 using country-specific inflators (39). Lastly, the population weighted averages of all cost components, total costs and costs as a percentage of Gross Domestic Product (GDP) on PPP in the study year converted to the present value were calculated to facilitate comparison. These weightings determine the relative importance of each quantity on the population average.

RESULTS

EXPOSURE TO ALCOHOL

Overall, there is wide variation around the global consumption average of 6.2 litres of pure alcohol adult per capita per year (Figure 1). The countries with highest overall consumption are in Eastern Europe around the Russian Federation, but other areas of Europe also have high overall consumption (WHO Europe region 11.9 litres adult per capita). The Americas are the region with the next highest overall consumption (WHO Americas region 8.7 litres adult per capita). Except for a few countries, some of them in Africa, alcohol consumption is lower in other parts of the world. To set the African countries with highest consumption into context, one should take into consideration, that unrecorded consumption constitutes a large part of the overall consumption, and the figures for unrecorded consumption in African countries are fraught with the highest uncertainty (see also discussion of unrecorded consumption below). The WHO Eastern Mediterranean region is lowest with 0.7 litres adult per capita consumption of alcohol. On a country level, alcohol consumption is linked to wealth in terms of gross domestic product (GDP) per capita measured in international dollars, i.e., purchasing power parity adjusted dollars. Up to about $10,000, the higher the gross domestic product, the higher the adult per capita consumption. Above this threshold, the relationship flattens considerably. There is also a strong inverse relationship

between per capita GDP and the abstention up to a threshold of $7,000, but above this threshold, there is no relation between wealth and abstention (40). Thus, the relationship between wealth and adult per capita consumption seems to be mainly based on the level of abstention.

- Insert Figure 1 about here -

In all world regions, men consume more alcohol than women, although the exact ratio varies, with women consuming a relatively larger proportion in higher income countries. In interpreting these numbers one should keep in mind that the majority of the adult population around the world actually abstains from drinking alcohol (45% of men and 66% of women), most of them for their lifetime.

MORTALITY

In 2004, 3.8% of all global deaths were attributable to alcohol, 6.3% for men and 1.1% for women. The gender difference in mortality reflects the difference in drinking, with respect to both overall volume and heavy drinking occasions. Alcohol attributable mortality proportions are net numbers that have taken into consideration the beneficial effects of alcohol. Most of the deaths caused by alcohol were in the following broad categories: injury, cancer, cardiovascular disease and liver cirrhosis. The deaths prevented were almost entirely in the cardiovascular category. Overall, the proportion of alcohol-attributable deaths increased since 2000, mainly due to increases among women.

- Insert Table 1 about here –

The net impact of alcohol was relatively larger in younger age groups, again for both sexes. Whereas 3.8% of deaths in all age groups were attributable to alcohol, 5.3% of deaths under the age of 60 were attributable to this risk factor (7.9% in men; 1.9% in women). This effect was mainly due to injuries caused by alcohol, with the majority of beneficial effects concentrated in older age groups.

Again reflecting the differences in drinking, the proportion of alcohol-attributable net deaths varied widely between regions (see Figure 2). As expected, the European region had the highest proportion, with

more than 1 in every 10 deaths among European men attributed to alcohol. Within Europe, the highest proportion is for the countries of the Former Soviet Union (for details on Russia see below).

- Insert Figure 2 about here –

The rates of alcohol-attributable mortality per 10,000 population below age 70 varied between 1.1 in the Eastern Mediterranean region (EMR) and 15.0 in the European region (EUR) for men; and between 0.2 (EMR) and 3.5 (EUR) for women, with global averages of 7.4 for men and 1.4 for women (other rates per 10,000 population in the following regions: African: men: 9.5; women: 2.1; American: men: 8.8; women: 1.6; South-east Asian (SEAR): men: 5.0; women: 0.5; Western Pacific: men: 6.2; women: 1.1). Relative to the volume of alcohol consumed per capita, the rates of alcohol-attributable mortality were higher in the developing world especially in South-East Asia with India as the most populous country.

Alcohol-attributable mortality rates vary between 4-fold (for EUR) and almost 10-fold (SEAR) between gender; globally, alcohol-attributable mortality rates for men are about 5.2 times the rates of women. The exact relation depends on the differential of the volume consumed by gender, but also on the pattern of drinking.

BURDEN OF DISEASE

In 2004, 4.6% of the global burden of disease and injury was attributable to alcohol, 7.6% for men and 1.4% for women (see Table 2). In contrast to deaths, the impact of neuropsychiatric disorders became more pronounced. 36.4% of all DALYs caused by alcohol were found in this category, compared to 5.4% of the deaths caused. This effect is mainly due to AUD, which cause disability but much less mortality than the non-psychiatric chronic diseases (see detailed Figure 4 below).

- Insert Table 2 about here –

As expected, there was considerable regional variability along the same lines as for alcohol-attributable deaths.

- Insert Figure 3 about here –

ALCOHOL USE DISORDERS: INCIDENCE AND PREVALENCE

Not surprisingly, AUD, followed the same pattern as alcohol-attributable harm in general: Again, men showed markedly more disorders than women, and the regional patterns were similar (see Figure 4). Relative to the average volume of alcohol consumed per capita, there was higher prevalence of AUD in South East Asia (with India as the most populous country), the Americas and the Western Pacific Region (most populous country: China). This pattern can be explained in part by the higher abstention rates in these regions, resulting in higher average volume consumed per drinker, and thus in higher risk for AUD (see also point of country profiles below). The point can be exemplified by the current Indian situation of high albeit declining abstention rates with the vast majority of women still being lifetime abstainers, but a pattern frequent and heavy drinking of spirits among drinkers, often to the point of intoxication, resulting in over proportional rates of AUD (41;42)

- Insert Figure 4 about here –

COUNTRY PROFILES

Table 3 shows alcohol-attributable burden in the most populous countries. Again, there were the expected gender and regional variations. However, there are also marked differences in the relative proportion of different disease categories. With respect to detrimental effects of alcohol, injury had a proportionally high impact in Brazilian, Nigerian, Russian and South African men, and in Chinese and Indian women. AUD were most important in Chinese, German, Thai and US men, and in Brazilian and US women. In Japan, cancer was the most important alcohol-attributable burden of disease category for both gender.

- Insert Table 3 about here –

ECONOMIC COSTS ATTRIBUTABLE TO ALCOHOL

Table 4 presents the economic costs attributable to alcohol for selected high- and middle-income countries. The results demonstrate that the economic costs of alcohol were substantial in both groups. Alcohol-attributable cost per capita in high-income countries ranged from 358 I$ in Scotland to 837 I$ in the U.S.A.; in middle-income countries, Korea (524 I$) had more than 4 times greater alcohol-attributable

cost per capita than Thailand (122 I$). All countries were found to spend more than 1% of their GDP PPP with the highest in the USA (2.7%) among the selected high-income countries and in Korea (3.3%) among the selected middle-income countries.

- Insert Table 4 about here –

The indirect costs due to productivity losses were the predominant cost category of all alcohol-attributable social costs among all countries in both groups, ranging from 49% of the total cost in Canada to 95% in Thailand. In terms of direct costs in high-income countries, the “other direct costs” category was the leading category for France and Korea, while the direct health care costs were the highest contributor to direct costs in Canada and the U.S.A. Among middle-income countries, direct health care costs were the largest contributor among direct costs for Thailand. Direct law enforcement costs were the lowest contributor among direct costs categories for France, the USA. and Thailand.

In terms of a weighted average for high income countries, the greatest contributor to total alcohol-attributable costs was the cost of productivity loss, which accounted for 72.1% of the overall cost, followed by direct health care costs (12.8%), other direct costs (11.6%) and direct law enforcement costs (3.5%) of the overall cost. The hierarchy of costs was similar for middle-income countries except that the weighted average for other direct costs were the second largest share (15.5%), followed by health care costs (5.6%).

DISCUSSION

Before discussing the implications of the results, we would like to point out the limitations of the approach taken. First, while we were able to collect data from the majority of countries with respect to exposure of alcohol, the quality of data on unrecorded consumption in many countries was questionable. As more

than 25% of the global consumption is estimated to be unrecorded (31;43), this creates some uncertainty around the harm estimates, as these data are mainly based on expert opinion due to the very nature of unrecorded consumption, which is often illegal. Second, for lack of survey data on patterns of drinking these had to be estimated from nearby countries or expert opinion. Third, the risk relations between alcohol and chronic disease outcomes were taken from meta-analytic studies. This assumes transferability of relative risks between countries. While this assumption is customary for most comparative risk assessments (44), and certainly plausible in light of identical biological pathways, there may be interactions between alcohol and other risk factors such a poverty, malnutrition or hopelessness, which introduce error (45-48). It should be noted, however, that the risk relations as derived from the meta-analyses are predominantly based on middle-class cohorts from the developed world, and thus the introduced bias would be an underestimation of the real risk. Finally, the study did not include any alcohol-attributable infectious disease. By 1785 Benjamin Rush (49) had already described pneumonia and tuberculosis as disease outcomes resulting from heavy consumption of alcohol, and modern research has confirmed a consistent relationship with biological and social pathways (50-52). These disease conditions will be included in the next iteration of the CRA of the GBD Study.

With respect to social costs, although many scholars frequently express them in reference to a renowned macroeconomic indicator i.e. GDP, this approach poses a significant methodological challenge. This is because of the fact that some components often included in the social costs e.g. health expenditure, research and prevention, and administration costs are parts of GDP, and so cannot be appropriately interpreted as its deficit. As a result, recent WHO guidelines for identifying the economic consequences of disease and injury recommend excluding these costs before a comparison to GDP (53). We compare each cost component in a disaggregate form as well as the overall cost in relation to GDP so that readers can contrast these findings to previous literature that used the conventional approach as well as readjust their viewpoint if they prefer to assess only some cost components.

Overall, our analysis shows again, that alcohol consumption is a major risk factor for burden of disease. The average volume of alcohol consumption and patterns of drinking, especially heavy drinking occasions, contribute to this disease burden. Alcohol is linked to many disease categories, but AUD, cancer, cardiovascular disease, liver cirrhosis, and injury are the most important disease categories causally impacted by alcohol. The net effect of alcohol on cardiovascular disease in older people may be beneficial in regions, where alcohol is consumed lightly to moderately in a regular fashion without heavy drinking occasions. In other regions, where this is not the case, no protective effect on ischaemic heart disease is expected, and the overall effect of alcohol on cardiovascular disease will be detrimental because of it harmful impact on hemorrhagic stroke and hypertensive disorders. Even in regions, where the net impact on cardiovascular disease is beneficial, the overall impact of alcohol on the burden of disease is detrimental. Globally, the impact of alcohol on burden of disease as described above has been shown to be about the same size as the impact of smoking in the year 2000, but it is less concentrated on the developed world (9;44). Our analyses show, that the alcohol-attributable burden has not declined since then, but probably increased. This is not surprising on the one hand, as the global consumption is increasing, especially in the most populous countries of India and China (11); http://www.who.int/globalatlas/default.asp). Secondly, the relative impact of the disease categories related to alcohol has been increasing over the past decades (17). Finally, the patterns of drinking have not improved over the past years (54).

The irony of the situation is that we face a large and increasing alcohol-attributable burden in a situation, where we know more than ever about which strategies can effectively control alcohol related harms (54;55). The next papers of this series will therefore be devoted to ways of decreasing this burden.

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Table 1: Alcohol-attributable deaths in 1,000* by sex and cause of death in 2004

Disease category	*M*	*W*	*Total*	*%$ M*	*%$ W*
Maternal and perinatal conditions (low birth weight)	2	1	3	0.1%	0.3%
Cancer	377	111	487	18.5%	25.0%
Diabetes mellitus	0	0	0	0.0%	0.1%
Neuropsychiatric disorders	109	25	135	5.4%	5.7%
Cardiovascular diseases	466	80	545	22.8%	18.0%
Cirrhosis of the liver	297	76	373	14.6%	17.1%
Unintentional injuries	556	110	666	27.3%	24.8%
Intentional injuries	232	40	272	11.4%	9.0%
Total 'detrimental effects' attributable to alcohol	**2039**	**443**	**2482**	**100.0%**	**100.0%**
Diabetes mellitus	-8	-4	-12	8.3%	3.2%
Cardiovascular diseases	-88	-128	-215	91.7%	96.8%
Total 'beneficial effects' attributable to alcohol	**-96**	**-132**	**-227**	**100.0%**	**100.0%**
All alcohol-attributable net deaths	**1944**	**311**	**2255**		
All deaths	31063	27674	58738		
Percentage of all net deaths attributable to alcohol	**6.3%**	**1.1%**	**3.8%**		
For comparison: CRA 2000	5.6%	0.6%	3.2%		

M – men; W - women

* numbers are rounded to the nearest thousand. Zero (0) indicates fewer than 500 alcohol-attributable deaths in the disease category

$ % refer to all deaths either caused or prevented by alcohol

Table 2: Alcohol-attributable burden of disease in 1,000* DALYs by sex and cause in 2004

Disease category	*M*	*W*	*Total*	*%$ M*	*%$ W*
Maternal and perinatal conditions (low birth weight)	64	55	119	0.1%	0.5%
Cancer	4732	1536	6268	7.6%	13.5%
Diabetes mellitus	0	28	28	0.0%	0.3%
Neuropsychiatric disorders	23265	3417	26682	37.6%	30.1%
Cardiovascular diseases	5985	939	6924	9.7%	8.3%
Cirrhosis of the liver	5502	1443	6945	8.9%	12.7%
Unintentional injuries	15694	2910	18604	25.4%	25.6%
Intentional injuries	6639	1021	7660	10.7%	9.0%
Total 'detrimental effects' attributable to alcohol	**61881**	**11349**	**73231**	**100.0%**	**100.0%**
Diabetes mellitus	-238	-101	-340	22.2%	8.1%
Cardiovascular diseases	-837	-1145	-1981	77.8%	91.9%
Total 'beneficial effects' attributable to alcohol	**-1075**	**-1246**	**-2321**	**100.0%**	**100.0%**
All alcohol-attributable net DALYs	**60806**	**10104**	**70910**		
All DALYs	799536	730631	1530168		
Percentage of all net DALYs attributable to alcohol	7.6%	1.4%	4.6%		
For comparison: CRA 2000	6.5%	1.3%	4.0%		

M – men; W - women

* numbers are rounded to the nearest thousand. Zero (0) indicates fewer than 500 alcohol-attributable DALYs in the disease category

$ % refer to all DALYs either caused or prevented by alcohol

Table 3: Alcohol-attributable burden of disease in 1,000* DALYs by sex and cause in ten selected countries in 2004

Disease Category	*Brazil*		*China*		*Germany*		*India*		*Japan*		*Nigeria*		*Russia*		*South Africa*		*Thailand*		*USA*	
	M	*W*	*M*	*W*	*M*	*W*	*M*	*W*	*M*	*W*	*M*	*W*	*M*	*W*	*M*	*W*	*M*	*W*	*M*	*W*
Cancer	93	51	2,180	403	83	63	325	19	164	60	85	57	143	109	34	13	100	22	168	122
Neuropsychiatric disorders	1,091	237	6,752	271	365	88	2,947	310	42	25	255	58	1,664	332	150	43	420	48	1,410	527
Cardiovascular diseases	290	52	1,148	54	35	16	993	6	43	2	95	80	841	253	47	18	39	7	122	31
Cirrhosis of the liver	281	37	913	93	141	57	826	46	83	26	61	23	507	299	22	5	88	27	225	107
Unintentional and intentional injuries	1,632	118	2,414	710	113	30	2,244	401	154	47	390	125	3,579	529	554	65	175	28	676	173
All other DALYs caused by alcohol	4	5	0	1	0	0	8	9	0	0	4	9	1	4	1	2	0	1	1	1
Total 'detrimental effects' attributable to alcohol	3,392	499	13,406	1,532	738	254	7,343	791	487	160	891	353	6,734	1,526	809	147	822	133	2,601	962
Total 'beneficial effects' attributable to alcohol	0	0	0	0	-144	-271	0	0	-94	-99	0	0	0	0	0	0	0	0	-270	-180
All alcohol-attributable net DALYs	3,392	499	13,406	1,532	594	-17	7,343	791	393	61	891	353	6,734	1,526	809	147	822	133	2,331	782
Percentage of all DALYs attributable to alcohol	17.7%	3.4%	12.9%	1.8%	12.8%	-0.4%	4.9%	0.5%	6.7%	1.3%	2.4%	0.8%	28.1%	10.7%	7.8%	1.4%	12.1%	2.5%	12.1%	4.5%

M – men; W - women
* Numbers are rounded to the nearest thousand. Zero (0) indicates fewer than 500 alcohol-attributable DALYs in the disease category

Table 4: Overview of economic costs attributable to alcohol in selected high-income and middle-income countries (in 2007 million I$)

Indicators	*France*[1]	*U.S.A.*[2]	*Scotland*[3]	*Canada*[4]	*Weighted average*	*Korea*[5]	*Thailand*[6]	*Weighted average*
Study year	1997	1998	2001/2	2002	n/a	2000	2006	n/a
Population in study year (Million)	58.6	280.6	5.1	31.9	n/a	47.5	64.6	n/a
GDP(PPP) in study year*	1,301,087	8,587,884	133,179	929,912	6,689,552	760,549	604,575	670,666
1. Direct health care cost	3,592	29,855	162	3,045	23,090	1,516	344	841
2. Direct laws	72	8,049	454	2,830	6,262	-	15	9
3. Other direct cost	7,619	26,244	145	966	20,848	5,459	49	2,341
4. Indirect cost	11,223	170,707	1,052	6,564	129,659	17,938	7,496	11,921
Total economic costs of alcohol	22,506	234,854	1,813	13,406	179,859	24,914	7,903	15,111
Cost per capita (2007 USD PPP)	384	837	358	420	725	524	122	293
Health care costs as % of total cost	16.0	12.7	8.9	22.7	12.8	6.1	4.3	5.6
law enforcement as % total cost	0.3	3.4	25.0	21.1	3.5	-	0.2	0.1
Other direct cost as % total cost	33.9	11.2	8.0	7.2	11.6	21.9	0.6	15.5
Indirect cost as % total cost	49.9	72.7	58.0	49.0	72.1	72.0	94.8	78.9
Total cost as % GDP (PPP)	1.7	2.7	1.4	1.4	2.5	3.3	1.3	2.1
health care costs as %GDP (PPP)	0.3	0.4	0.1	0.3	0.3	0.2	0.1	0.1
Law enforcement as % GDP (PPP)	0.0	0.1	0.3	0.3	0.1	0.0	0.0	0.0
Other direct cost as % GDP (PPP)	0.6	0.3	0.1	0.1	0.3	0.7	0.0	0.3
Indirect cost as % GDP (PPP)	0.9	2.0	0. 8	0.7	1.7	2.4	1.2	1.7

n/a - not applicable; - indicates unavailability of data; *adjusted to 2007 million USD

[1](56); [2](57); [3](58); [4](59;60); [5](61); [6](38).

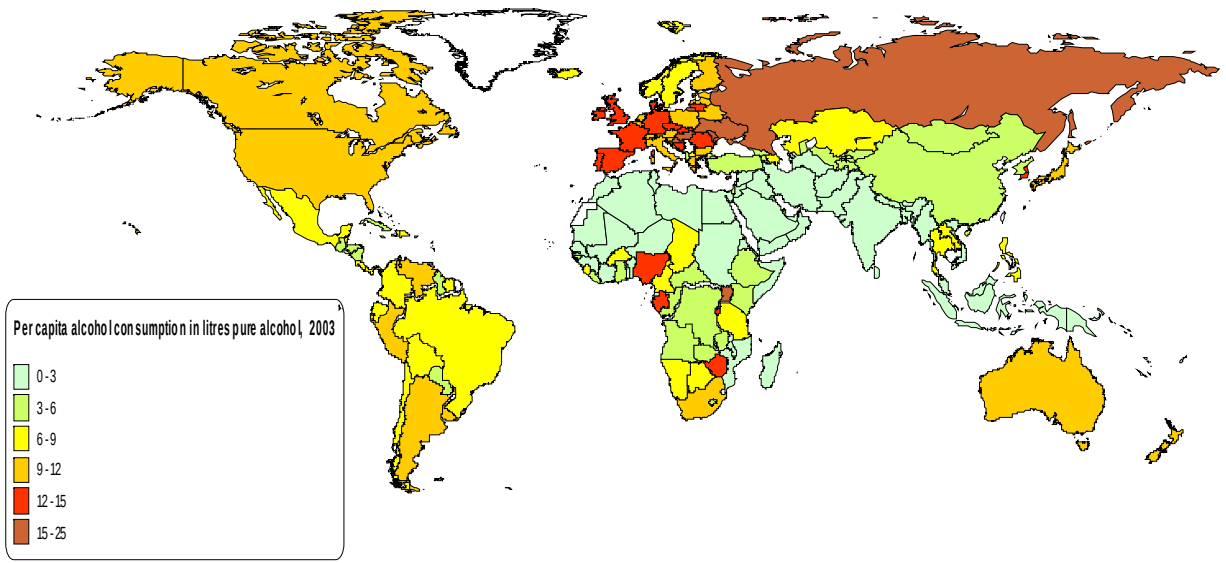
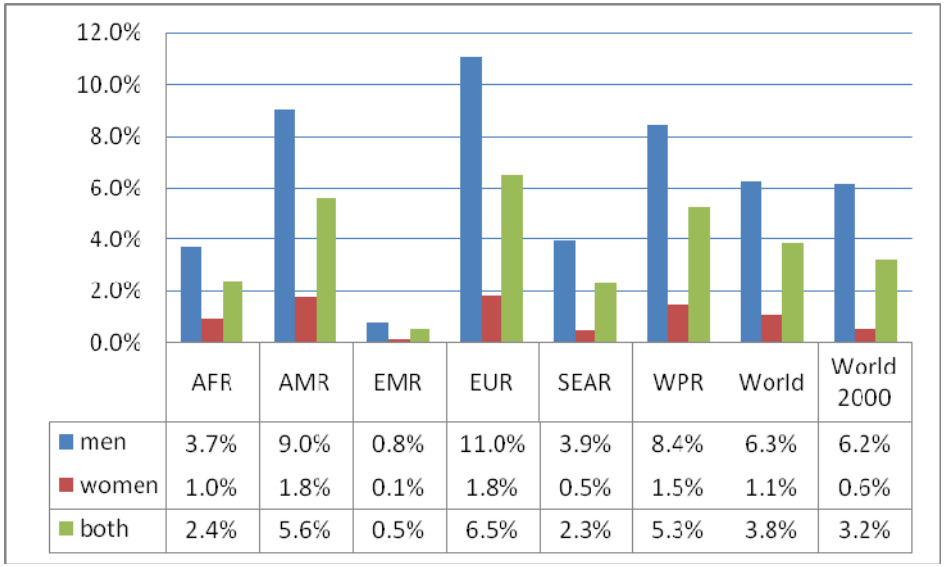


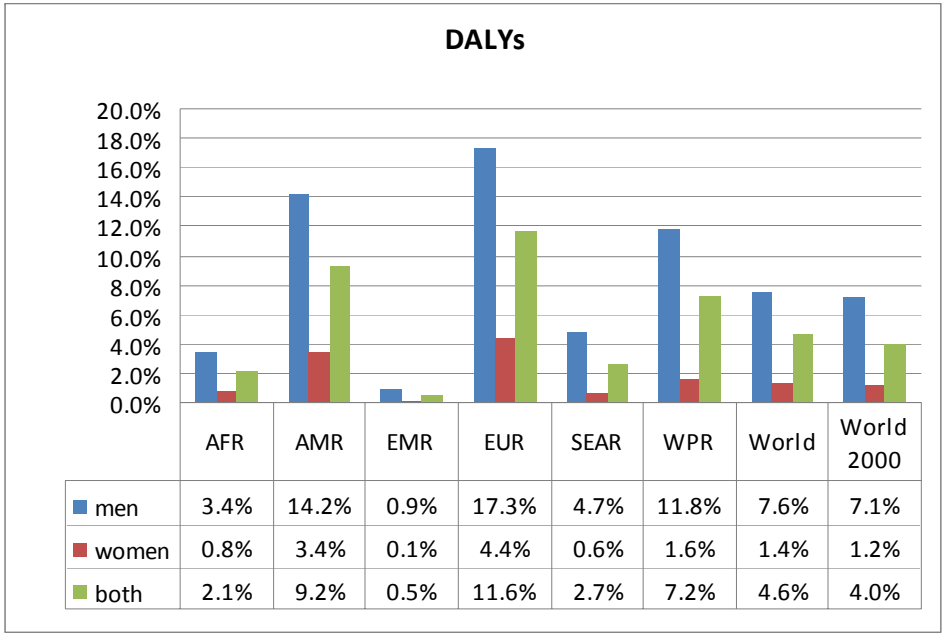
Figure 1: Global exposure to alcohol – recorded and unrecorded adult per capita consumption



	AFR	AMR	EMR	EUR	SEAR	WPR	World	World 2000
men	3.7%	9.0%	0.8%	11.0%	3.9%	8.4%	6.3%	6.2%
women	1.0%	1.8%	0.1%	1.8%	0.5%	1.5%	1.1%	0.6%
both	2.4%	5.6%	0.5%	6.5%	2.3%	5.3%	3.8%	3.2%

WHO regions:
AFR: African region; AMR: American region; EMR: Eastern-Mediterranean region; EUR: European region; SEAR: South-east Asian region; WPR: Western Pacific region

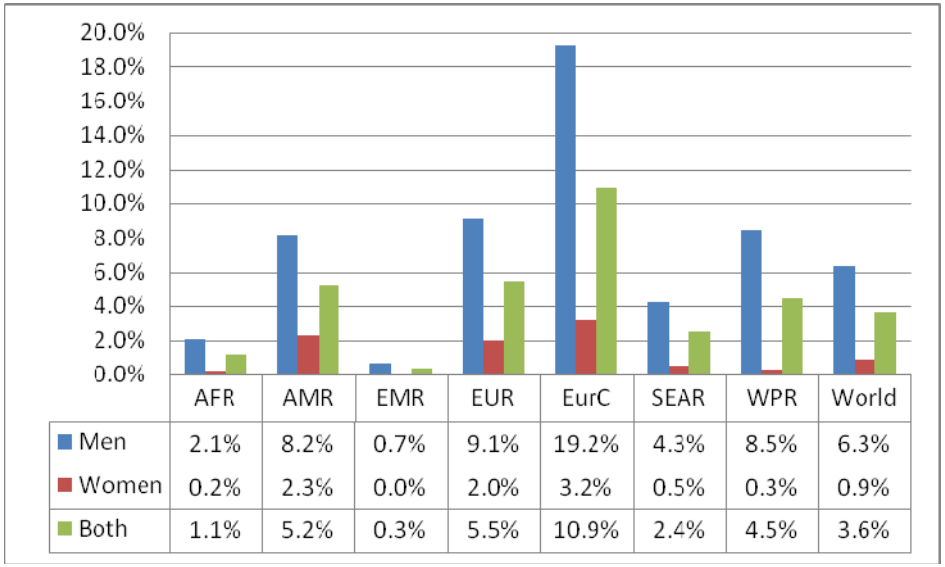
Figure 2: Alcohol-attributable deaths as portion of all deaths in % by sex and WHO region in 2004



	AFR	AMR	EMR	EUR	SEAR	WPR	World	World 2000
men	3.4%	14.2%	0.9%	17.3%	4.7%	11.8%	7.6%	7.1%
women	0.8%	3.4%	0.1%	4.4%	0.6%	1.6%	1.4%	1.2%
both	2.1%	9.2%	0.5%	11.6%	2.7%	7.2%	4.6%	4.0%

WHO regions:
AFR: African region; AMR: American region; EMR: Eastern-Mediterranean region; EUR: European region; SEAR: South-east Asian region; WPR: Western Pacific region

Figure 3: Alcohol-attributable burden of disease in DALYs as portion of all DALYs in % by sex and WHO region in 2004



	AFR	AMR	EMR	EUR	EurC	SEAR	WPR	World
Men	2.1%	8.2%	0.7%	9.1%	19.2%	4.3%	8.5%	6.3%
Women	0.2%	2.3%	0.0%	2.0%	3.2%	0.5%	0.3%	0.9%
Both	1.1%	5.2%	0.3%	5.5%	10.9%	2.4%	4.5%	3.6%

WHO regions:
AFR: African region; AMR: American region; EMR: Eastern-Mediterranean region; EUR: European region; EurC: Easter European Region with proportionally higher adult mortality than other European parts (most populous country: Russia); SEAR: South-east Asian region; WPR: Western Pacific region

Figure 4: One year prevalence of AUD in % (in age groups 15-64) by sex and WHO region in 2004