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The role of alcohol in the global and regional burden of disease

Introduction

How large a share of all preventable ill health in the world can be explained by excessive drinking? To what extent does the role of alcohol in ill health vary between different parts of the world? How does alcohol compare with other risk factors in an analysis of global and regional ill health? These are some of the questions addressed by an international group of experts in the WHO project *Global Burden of Disease 2000* (GBD 2000). It might, at first glance, seem a rather unlikely challenge they have taken on, yet upon closer inspection we find that the project has in fact gained meaningful insights into many aspects.

The analysis of alcohol as a global and regional risk factor is just one of a number of components in the GBD project where international groups of researchers have applied similar methods to study the role of alcohol and 25 other risk factors in the disease burden in different parts of the world. This has provided a unique opportunity to rank order and compare the health effects of various risk factors, both global and regional.

The dataset that has been collected on drinking habits and the risks involved from all over the world is truly impressive, as is the statistical analysis presented of these data. There is no doubt that the results will have a major impact in the field of alcohol research, not least in the effort to determine the influence of drinking habits on the occurrence of cardiovascular disease and accidents. In addition, the project has made a groundbreaking effort to determine the role of alcohol use in the occurrence of depression. The project's comparative

perspective adds greatly to its interest value; this applies most particularly to its regional comparisons of the impacts of alcohol on ill health and to the comparisons of alcohol with other risk factors. One would certainly hope to see the message reach the world's political decision-makers because it is clear from the results that in many regions there is every reason to give alcohol policy greater weight and priority.

The purpose of this article is to give an overview of the GBD project insofar as it deals with alcohol as a global and regional risk factor; to describe the methods and approaches applied by the project; to summarise its main results; and to briefly discuss the question of how the results could and should be put to use in the political arena.

For the most part I have relied on studies recently published in *European Addiction Research* and *Addiction* (Rehm et al. 2003a-c; Room et al. 2003), as well as a chapter in a WHO title covering many of the risk factors studied in the GBD project (Rehm et al. 2004). As for more general information on the project and on other risk factors, I have consulted articles published in *Lancet* (Ezzati et al. 2002; Ezzati et al. 2003). In addition, many of the project's more detailed analyses have been published in scientific journals; this applies for instance to its studies of alcohol and cardiovascular diseases (Gmel et al. 2003). Furthermore, the results from studies on alcohol and accidents as well as alcohol and depression will soon be coming out.

Methods and approaches

■ The definition and measurement of disease burden

Traditionally, the burden of a particular disease upon a given population is assessed by looking at the number of deaths from a specific diagnosis in relation to the total number of the population. One obvious problem with this approach is that it considers each death equally serious regardless of whether the person was 25 or 85 at death. Another weakness is that this approach disregards the disease burden that usually affects both the individual and society over a certain period of time before the person dies.

One of the measures that is used for these purposes is Disability Adjusted Life Years or DALYs. This includes an assessment of the number of life years lost to deaths occurring before optimal life expectancy, for instance 80 years among men and 82.5 years among women (these figures are for Japan). In other words, the number of lost life years for a female dying at age 40 in this case is 42.5 years.

This measurement of lost life years is then combined with an assessment of the disability implied by the disease concerned. Disability is defined in terms of how far the disease prevents or inhibits "normal" function. Different diseases obviously affect people's well-being in different ways and to different extents and give rise to different degrees of disability. Based on assessments made by experts, a relatively complex procedure has been used to calculate for each type of disease a disability weight which ranges from 0 (no influence) to 1 (death). In order to determine alcohol-related disability, then, it is neces-

sary first of all to have information on the number of people in the population who suffer from an alcohol-related disease or who have been involved in an alcohol-related accident and then apply the relevant disability weights.

WHO experts have calculated DALYs for a number of diseases in a total of 14 WHO regions, and alcohol researchers have then proceeded to estimate the proportion of these that can be attributed to alcohol.

Although DALYs, at a theoretical level, certainly capture the phenomenon of disease burden more accurately than traditional measures of mortality, there still remain some empirical question marks. On the basis of the literature available it is very difficult to assess the quality of the underlying regional data on disease prevalence and on the other hand the quality of the disability weights applied. It is therefore a strength of the WHO study that the burden of disease is explored both from the point of view of alcohol-related mortality and alcohol-related DALYs.

■ The choice of alcohol-related causes of death and diseases

The choice of diseases included in the assessment of alcohol's global disease burden obviously has important implications. The choice is based on the ninth revision of the international classification of causes of death and diseases (ICD-9): working from this basis, WHO experts have identified some 60 diagnoses of diseases and accidents for which there is consistent and sound scientific evidence of a causal link with alcohol. These diagnoses have been divided into three groups according to the impact of alcohol upon risk levels.

The first category consists of 13 diagnoses where alcohol by definition is the decisive risk factor, such as *alcohol* poisoning and *alcoholic* liver disease. The second category comprises chronic illnesses where research has established that long-term heavy alcohol consumption is a contributing cause, albeit to varying degrees. The inclusion of a chronic disease requires not only that a connection has been shown in numerous studies, but also that specific biological mechanisms are implicated. The third category consists of acute consequences, such as different kinds of accidents, suicide and violence. Generally the requirement for inclusion here is that the decisive risk factor is a single bout of heavy consumption and that chronic abuse is not necessarily a leading risk factor.

■ Counting the proportion of alcohol-related cases for different diagnoses

The next step is to try and establish how large a proportion of different kinds of diseases and accidents are attributable to alcohol both globally and in six WHO regions: Africa, Americas, East Mediterranean, Europe, South-East Asia and Western Pacific. These are in turn divided into 14 sub-regions on the basis of infant and adult mortality. Such classifications are obviously always open to criticism, but by and large it would seem they have a reasonably solid and sound foundation.

For the 13 diseases that are by definition alcohol-related, it is obviously superfluous to assess the proportion of alcohol-related cases; all of them are thought to be attributable to alcohol. For other chronic diseases and accidents an Alcohol Attrib-

utable Fraction (AAF) is calculated: this expresses the proportion of cases that are due to alcohol. An AAF of 0.5, for instance, implies that if there were no alcohol consumption at all, half of the current cases of disease/death should be eliminated.

■ Chronic diseases

The AAF for chronic somatic diseases is primarily dependent on the quantity of alcohol consumed. On this basis one would expect that the proportion of liver diseases caused by alcohol is lower in countries where 1 per cent of the population are heavy consumers as compared to countries where 15 per cent are heavy consumers. It follows that the proportion varies not only between different regions, but also between men and women and different age groups. In most chronic diseases, however, drinking patterns are thought to have a lesser impact on risk levels.

In order to calculate the AAF for a certain disease, we need to know how the risk of getting that disease varies at different consumption levels as compared to abstinence. Such assessments of relative risks have been made for most alcohol-related diseases in studies following up the mortality of cohorts after a baseline investigation of their drinking habits. Since it is only rarely that these studies have used alcohol-related morbidity as an outcome, the GBD project has generally relied on mortality-based AAFs even in the case of diseases that are included in the DALY measure.

AAF determinations have been carried out somewhat differently for different diseases. For the majority of chronic diseases, experts have reviewed the latest research estimating the risks of death at different levels of consumption and then calculated the average relative risks in these studies (pooled meta-analyses). The results have then been compiled for non-drinkers and for three different consumption levels separately for women and men (see Table 1).

Table 1. Classification of daily alcohol consumption for men and women

Drinking levels	Men	Women
Non-drinkers	0	0
Consumption level 1	0<40 g*	0–20g
Consumption level 2	40<60g	20–40g
Consumption level 3	60g+	40g+

*One bottle of wine (75cl) is the equivalent of 70 grammes of alcohol
Source: Rehm et al. (2003a)

If the meta-analysis shows that the number of new cases of acute pancreatitis, for instance, is 2 per 10,000 men at consumption level 3 and 0.5 per 10,000 men who do not drink, this means that the relative risk for men at consumption level 3 is fourfold. In other words: men at this level of consumption have a four times greater risk of developing acute pancreatitis than men who do not drink. This kind of information about risks at different levels of consumption is then applied to data on gender and age distributions of alcohol consumption and abstinence in different countries.

So how does one know how many people in each country can be slotted into different consumption levels? This is based on official statistics on total alcohol consumption as well as estimates of unregistered consumption, which are then divided between different groups according to the results of various questionnaire surveys. Using the relative risks calculated for different levels of consumption, researchers can then determine the proportion of

pancreatitis cases that can be attributed to alcohol in different countries. In a country where a relatively large proportion of the male population are at consumption level 3, the AAF for acute pancreatitis will thus be higher than in a country where that proportion is lower.

■ Cardiovascular diseases and depression

There are two types of chronic disease for which different methods of AAF determination have been used, namely cardiovascular diseases and depression. Recent research has revealed a rather complex association between alcohol and cardiovascular diseases in that moderate and regular consumption appears to lower the risk of disease, whereas heavy drinking bouts seem to increase the risk. As most of the cohort studies available provide only limited documentation on the number of heavy drinking bouts, the research group drew the conclusion that cohort studies should not generally be used in determining the proportion of alcohol-related cases, especially in countries such as Russia where drinking patterns are dominated by heavy consumption and drinking to intoxication.

In order to establish the role and impact of different drinking patterns, the WHO group of alcohol researchers conducted a separate analysis of the associations between drinking and mortality from cardiovascular diseases in 74 selected countries, which where divided into four drinking pattern categories from 1 (favourable) to 4 (damaging). The measure includes the extent of bout drinking, the extent to which alcohol is consumed with meals and in restaurants or at pubs. These estimates have been obtained partly through experts from the respective countries and partly through questionnaire studies insofar as these have been available.

Using a method combining multilevel analysis with time series analysis, the researchers discovered that an increase in average consumption in countries with the most favourable drinking patterns led to a reduced mortality, whereas mortality increased in countries with the most damaging drinking habits. No statistically significant association was seen for countries in the second or third drinking pattern categories.

For the majority of countries the measure of associations derived from this aggregate analysis was used to determine the AAF for cardiovascular disease – although the effect shown by the calculation was halved to allow for the possibility that the effect of alcohol depended in part on factors that were not controlled for in the analysis. However, in established market economies (Western Europe, North America and Australia) where most of the cohort studies had been done, and which generally were thought to have favourable drinking patterns, the same methods were used as for other chronic diseases, i.e. calculations based on relative risks derived from follow-up studies. One important difference, though, is that the relative risk for cardiovascular diseases was less than 1 for low consumption, i.e. it was assumed that alcohol has a protective effect.

As for depression, the results suggest that not only does alcohol dependence vary statistically with depression, but it is actually a cause of depression. In contrast to other chronic illnesses, however, there are no set risk levels for depression, and therefore researchers have had to rely on associ-

ations identified in questionnaire studies. It is not quite clear from the published material available exactly how these assessments have been made, but the general principle has been to use questionnaire studies from different countries to work out the association between the number of cases where alcohol dependence has preceded depression and their proportion of the total prevalence of alcohol depression in the population. These analyses have shown that the association is positive, i.e. the larger the proportion of people with an alcohol dependence, the larger the proportion of depressed people with an alcohol dependence that precedes the onset of depression. Using a mathematical formula, this association can then be translated into an AAF. The researchers are keen to stress they have been very conservative in their assessments, halving the figures obtained in order to allow for the possibility that other factors may come into play that they have not been able to control for.

■ Acute harm

AAF determinations for acute harm (accidents, violence) are based on the most recent meta-analyses; their results, in turn, come primarily from case-control studies as well as analyses of police statistics. One exception is alcohol-related violence, where the figures are derived from population-level studies. As drinking patterns play a decisive role in this type of harm, they were also included in the final determinations of regional AAFs. An analysis corresponding to that carried out for cardiovascular diseases confirmed what the researchers had expected: the more harmful the drinking pattern, the stronger the association with the risk of accidents at given levels of change in total alcohol consumption. The effect was significantly stronger for men than for women.

Results

■ Global alcohol-related mortality

The WHO researchers' estimate is that alcohol "caused" 1.8 million deaths in the world in 2000, accounting for 3.2 per cent of all the people who died that year (Table 2). The proportion is around 10 times greater among men (6.2%) than among women (0.6%). Acute alcohol-related deaths through accidents are the single most common cause, accounting for almost half of global alcohol-related mortality; accidents are followed by alcohol-related cancer (20%) and cardiovascular diseases (15%). Other non-contagious diseases, primarily cirrhosis of the liver, account for 13 per cent, while 6 per cent of all "alcohol cases" were attributed to psychiatric disorders such as addiction syndrome, depression and psychoses.

It is worth noting that in their assessment of cardiovascular diseases, the researchers have cleaned the figures to allow for the deaths that they assume have been prevented by favourable drinking habits: the figure they propose is more than 300,000 cases. Alcohol was thus accountable for almost 600,000 cardiovascular deaths, which is more than the figure for accidents.

■ Global alcohol-related disease burden

If the number of person-years lost to death as well as disability caused by alcohol are included in the figures, the contribution of alcohol to the global burden of disease increases from 3.2 to 4 per cent (see Table 3). The increase is particularly noticeable among women, where the proportion is

Table 2. Global mortality burden (thousands of deaths) attributable to alcohol by major disease and accident categories in 2000

Diseases and accidents	Women	Men	Total	Per cent of alcohol-related mortality burden (%)
Foetal damage	1	2	3	0
Cancer	86	269	355	20
Neuropsychiatric disorders (e.g. depression, alcohol dependence)	19	91	111	6
Cardiovascular diseases	-124	392	268	15
Other non-contagious diseases (e.g. cirrhosis of the liver)	49	193	242	13
Unintentional accidents (e.g. traffic accidents, poisonings)	92	484	577	32
Intentional accidents (e.g. suicide, murder)	42	206	248	14
Alcohol-related mortality (all)	166	1,638	1,804	100
All deaths	26,629	29,232	55,861	
% of all death cases	0.6	5.6	3.2	

Source: Rehm et al. (2003b)

more than doubled from 0.6 per cent to 1.3 per cent, while the figure for men shows a more moderate increase from 5.6 per cent to 6.5 per cent. The biggest difference between mortality and morbidity was found for neuropsychiatric diagnoses (e.g. depression and alcohol dependence), which rarely occur as direct causes of death but which often are quite common in the population and which often have a significant adverse effect on quality of life. Neuropsychiatric disorders account for as much as 38 per cent of the alcohol-related burden of diseases as compared with just 6 per cent of alcohol-related deaths, and they generate the same kind of burden of diseases as alcohol-related accidents.

■ Regional differences

There are marked geographical differences in the contribution of alcohol to mortality and the disease burden (see Table 4). The greatest negative impact on both morbidity and mortality can be seen in Europe C (e.g. Russia and the Baltic countries), where almost one in five deaths among men are alcohol-related. Other regions with major problems are Europe B (e.g. Poland), Americas B (e.g. Mexico) and Americas D (e.g. Bolivia). Not surprisingly, the adverse health effects of alcohol are least pronounced in East Mediterranean Muslim countries, where the proportion of female alcohol-related mortality and morbidity is as low as 0.1 per cent.

For women in Europe A, Americas A and Western Pacific A, it was found that alcohol saves more lives than it causes deaths, whereas for men alcohol did not lower mortality in any region. When morbidity is also taken into account, there is no region where alcohol reduces the burden of disease either for men or for women, even when the protective effect of alcohol is taken into consideration. This implies that the adverse effects of alcohol on mortality and morbidity clearly outweigh its beneficial health effects all over the world.

Table 3. Global burden of disease (DALYs in thousands) attributable to alcohol by major disease and accident categories in 2000

Diseases and accidents	Women	Men	Total	Per cent of alcohol-related mortality burden (%)
Foetal damage	55	68	123	0
Cancer	1,021	3,180	4,201	7
Neuropsychiatric disorders (e.g. depression, alcohol dependence)	3,814	18,090	21,904	38
Cardiovascular diseases	-428	4,411	3,983	7
Other non-contagious diseases (e.g. cirrhosis of the liver)	860	3,695	4,555	8
Unintentional accidents (e.g. traffic accidents, poisonings)	2,487	1,4008	1,6495	28
Intentional accidents (e.g. suicide, murder)	1,117	5,945	7,062	12
Total alcohol-related burden of disease (DALYs)	8,926	49,397	58,323	100
All DALYs	693,911	761,562	145,5473	
% of all death cases	1.3	6.5	4.0	

Source: Rehm et al. (2003b)

Table 4. Alcohol-related mortality and disease burden (per cent of total) for men and women in different WHO regions in 2000

	Per cent of total mortality		Per cent of total morbidity	
WHO region[1]	Men	Women	Men	Women
Africa D	2.4	0.7	2.0	0.6
Africa E	4.0	1.0	3.5	0.8
Americas A	2.0	-1.6	11.9	3.2
Americas B	14.2	3.5	17.3	4.1
Americas D	7.6	2.5	8.6	2.2
East Mediterranean B	1.5	0.3	1.3	0.2
East Mediterranean D	0.5	0.1	0.6	0.1
Europe A	3.2	-4.1	11.1	1.6
Europe B	9.7	2.7	10.2	2.5
Europe C	18.0	5.1	21.5	6.5
Southeast Asia B	4.1	0.9	5.3	1.0
Southeast Asia D	2.3	0.4	2.8	0.4
Western Pacific A	3.7	-5.4	8.1	0.6
Western Pacific B	8.5	1.3	9.1	1.8
World	5.6	0.6	6.5	1.3

[1] Letters represent different mortality levels: A= low adult and infant mortality .....E= very high adult and infant mortality.

Source: Babor et al. (2003), Rehm et al. (2003b)

Table 5. Burden of disease attributable to 12 selected leading risk factors by level of development (% of total DALYs)

High mortality[1]	%	Developing countries Low mortality[2]	%	Developed countries[3]	%
Underweight	14.9	Alcohol	6.2	Tobacco	12.2
Unsafe sex	10.2	High blood pressure	5.0	High blood pressure	10.9
Water and sanitary conditions	5.5	Tobacco	4.0	Alcohol	9.2
Indoor smoke from solid fuels	3.6	Underweight	3.1	High cholesterol	7.6
Zinc deficiency	3.2	High BMI	2.7	High BMI	7.4
Iron deficiency	3.1	High cholesterol	2.1	Low fruit and veg intake	3.9
Vitamin A deficiency	3.0	Low fruit and vegetable intake	1.9	Physical inactivity	3.3
High blood pressure	2.5	Indoor smoke from solid fuels	1.9	Drugs	1.8
Tobacco	2.0	Iron deficiency	1.8	Unsafe sex	0.8
High cholesterol	1.9	Water and sanitary conditions	1.8	Iron deficiency	0.7
Alcohol	1.6	Unsafe sex	1.4	Lead poisoning	0.6
Low fruit and vegetable intake	1.3	Lead poisoning	1.4	Sexual abuse of children	0.6

1.= E.g. Bolivia, Egypt, India, Nigeria
2.= E.g. China, Iran, Indonesia, Mexico
3.= E.g. Japan, Russia, USA
Source: WHO (2002)

■ The global burden of disease and its causes in a comparative perspective

Among the 26 risk factors included in the study, alcohol ranked fifth, accounting for four per cent of the global burden of disease (WHO 2002). This is almost as much as the figure for smoking (4.1%) and high blood pressure (4.4%), but less than those for malnourishment (9.5%) and unsafe sex (6.3%). On the other hand, alcohol has a much greater detrimental effect on world health than such factors as high BMI, physical inactivity and high cholesterol levels.

Alcohol's role as a major risk factor in different parts of the world is clearly demonstrated in Table 5, which rank orders 12 selected leading risk factors in three regions with different mortality profiles and patterns of economic development. Alcohol has the most adverse effects on public health in developing countries with low mortality, whereas it is a less significant factor in the poorest parts of the world such as Africa, where total mortality is high. By contrast the burden of disease caused by alcohol is high in industrial countries, including Eastern Europe, where 9.2 per cent of the disease burden is thought to be attributable to alcohol. This means that alcohol is the third most damaging public health factor in these regions – only tobacco and high blood pressure are higher up on the list of leading risk factors.

Discussion

There is, of course, a wide understanding in large parts of the world today that alcohol consumption increases the risk of many health-related problems. On the other hand the thesis regarding the positive

health effects of alcohol has also been gaining significant ground, which may well work against the view of alcohol as a source of ill health. It is therefore important that in its estimates of the burden of disease, the GBD project has also allowed for the positive health effects of low and moderate alcohol consumption. One of the project's greatest merits is that it has managed to establish that in virtually all societies around the world, alcohol continues to cause much more ill health than it contributes to preventing ill health.

The prominent role that alcohol appears to play in the global and regional burden of disease as compared with other risk factors, lends strong support to the view that drinking is a serious social problem indeed. As alcohol represents the third most serious risk factor of ill health in the Western world, that certainly should give cause to some sober debate and deliberation on the EU's currently very passive stance on alcohol policy, for instance. With the ongoing process of EU enlargement, the already extensive burden of disease looks set to expand even further within this region.

In other parts of the world, these results can be taken to shed useful light on an area that hitherto has remained largely unexplored. Hopefully they will also encourage political decision-makers to take steps aimed at reducing the detrimental effects of alcohol. In certain developing countries, especially those with low infant and adult mortality, alcohol emerged as the risk factor with the most damaging effects on public health. It is worth noting in this context that acute harm constitutes such a major disease burden all over the world, and not least in developing countries, that there should be good prospects for a rapid improvement in the current situation. It is of course rather too early to say anything definite about the impacts that the results will have on the political arena, but it is quite clear than this is an issue that deserves to be closely monitored over the next few years.

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