Chapter **47**

Alcohol

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This chapter provides an overview of epidemiology of alcohol use and health consequences as well as introducing cost-effectiveness interventions to reduce alcohol-related harm.

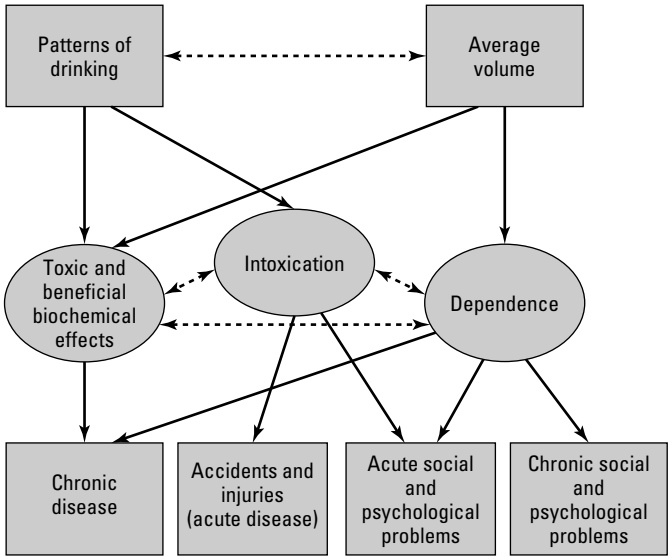
EPIDEMIOLOGY OF ALCOHOL USE AND ALCOHOL-RELATED DISEASE CONDITIONS

Alcoholic beverages and the problems they engender have been familiar fixtures in human societies since the beginning of recorded history. Because alcohol is causally related to more than 60 International Classification of Diseases codes (Rehm, Room, Graham, and others 2003), disease outcomes are among the most important alcohol-related problems. Depending on the pattern of consumption, alcohol is also protective against diseases, most important among them, coronary heart disease (Rehm, Sempos, and Trevisan 2003). However, the net effect is negative, and 4 percent of the global burden of disease is attributable to alcohol, or about as much death and disability globally as is attributable to tobacco and hypertension (Ezzati and others 2002; WHO 2002). Alcohol thus constitutes a serious public health problem (Room, Babor, and Rehm 2005). Evidence-based preventive measures are available at both the individual and the population levels, with alcohol taxes, restrictions on alcohol availability, and drinking-and-driving countermeasures among the most effective policy options (Babor and others 2003). This chapter reviews the cost-effectiveness of different interventions in developing regions of the world.

Dimensions of Alcohol Related to Disease

The relationship between alcohol consumption and health and social outcomes is complex and multidimensional (Rehm and others 2004). As figure 47.1 shows, alcohol consumption is linked to acute and long-term health and social consequences through three intermediate mechanisms—toxic and beneficial biochemical effects, intoxication, and dependence (Babor and others 2003; Rehm, Room, Graham, and others 2003)—as follows:

- *Toxic and beneficial biochemical effects.* These effects of alcohol consumption may influence chronic disease in either beneficial or harmful ways. Accepted beneficial effects include the influence of moderate drinking on coronary heart disease through reduction of plaque deposits in arteries, protection against blood clot formation, and promotion of blood clot dissolution (Zakhari 1997). Examples of harmful effects include increased risk for high blood pressure and for liver damage (Rehm, Room, Graham, and others 2003) and direct toxic effects on acinar cells triggering pancreatic damage (Apte, Wilson, and Korsten 1997) or hormonal disturbances (Emanuele and Emanuele 1997). These are just examples, because alcohol exposure is associated with a multitude of toxic effects on different organs.
- *Intoxication.* Alcohol intoxication is a powerful mediator for acute health outcomes, such as accidental or intentional injuries or deaths, although intoxication can also be implicated in chronic health and social problems and in certain forms of heart disease. The subjective feeling of intoxication is mainly caused by the effects of alcohol on the central nervous system, and these effects are felt and can be measured even at light to moderate consumption levels (Eckardt and others 1998).
- *Dependence.* Alcohol dependence is a clinical disorder in its own right, but it is also a powerful mechanism sustaining alcohol consumption and mediating its impact on both



Source: Adapted from Babor and others 2003.

Figure 47.1 Model of Alcohol Consumption, Intermediate Outcomes, and Long-Term Consequences

chronic and acute physiological and social consequences of alcohol (Drummond 1990). In the quantitative analyses reported in this chapter, alcohol dependence—and alcohol-use disorders (AUDs) in general—will be considered only as a health outcome related to high-risk alcohol use.

This chapter, including the section on the cost-effectiveness of interventions, focuses primarily on health consequences, although later it briefly discusses the social consequences of high-risk drinking and recommended interventions. The epidemiological calculations are taken from Ezzati and others' (2002) comparative risk analysis (CRA) and the World Health Organization (WHO) assessment of the global burden of disease (WHO 2002). (For further information, see Mathers and others 2003; Rehm, Rehn, and others 2003; Rehm, Room, Graham, and others 2003; Rehm, Room, Monteiro and others 2003; Rehm and others 2004). The CRA defines alcohol exposure using two measures: the average volume of alcohol consumption and patterns of drinking (figure 47.1). It then relates these exposure measures to disease outcomes.

The average volume of consumption has been the conventional measure of exposure in alcohol epidemiology (Bruun and others 1975) and has been linked to many disease categories following the seminal work of English and others (1995; see also Rehm, Room, Graham, and others 2003). Patterns of drinking have been linked mainly to two categories of disease outcome: acute effects of alcohol (such as accidental and intentional injuries) and cardiovascular outcomes (mainly coronary heart disease). The CRA defines patterns of drinking primarily in terms of high-risk drinking occasions and also in terms of drinking in public settings and the proportion of drinking that occurs outside of meals (for further details, see Rehm and others 2004).

Epidemiology of High-Risk Alcohol Use

The intervention analyses presented in this chapter focus on average high-risk drinking, although patterns of drinking were also incorporated into the disease burden calculations. High-risk drinking is defined in sex-specific terms as drinking 20 grams per day or more of pure alcohol on average for females and 40 grams per day or more of pure alcohol on average for males (a bottle of table wine contains about 70 grams of pure alcohol). This definition of high-risk drinking is fairly standard in alcohol epidemiology and was first introduced by English and others (1995) on the basis of Australian guidelines. Originally, English and others (1995) used two categories: *hazardous drinking* (defined as drinking between 20 and 40 grams per day of pure alcohol on average for females and between 40 and 60 grams per day of pure alcohol for males) and *harmful drinking* (defined as drinking 40 grams per day or more of pure alcohol on average for females and 60 grams per day or more of pure alcohol on average for males). These categories have been used in almost every comprehensive meta-analysis on alcohol and disease since 1995 (see Rehm, Room, Graham, and others 2003 for an overview). However, critics asserted that the terms *hazardous drinking* and *harmful drinking* were not neutral; thus, the CRA uses drinking categories II and III, referring to the term *high-risk drinking* when both categories are considered together. High-risk drinking thresholds differ by sex because the risk for chronic disease is related to lower volumes of drinking for women than for men; thus, the thresholds for high-risk drinking were set to reflect an approximately similar risk of chronic disease.

Table 47.1 shows the distribution of high-risk drinking by age and by World Bank region. The table excludes the Middle East and North Africa because prevalence rates of high-risk drinking are considerably lower than 1 percent and this situation is unlikely to change in the near future.

Calculating the burden of high-risk alcohol use that is avertable by means of effective interventions requires additional epidemiological data—in particular, rates of incidence to and remission from high-risk alcohol use and the relative fatality of high-risk alcohol users compared with non-high-risk alcohol users. We derived remission rates from studies of natural recovery from alcohol problems, which found an average of 10.9 years to remission (Sobell, Ellingstad, and Sobell 2000), with an adjustment of plus 20 percent for older age groups and minus 20 percent for younger age groups. We set the relative risk of mortality for high-risk alcohol users age 15 to 44 at 2.5 and the relative risk for older age groups at 1.3 for men and 1.4 for women (Gmel, Gutjahr, and Rehm 2003; Rehm, Gutjahr, and Gmel

Table 47.1 Prevalence of High-Risk Drinking by Gender, Age Group, and Region, 2000
(percentage of the population)

Region	Gender	Age group (years)				
		15–29	30–44	45–59	60–69	70+
Europe and Central Asia	Male	20.8	18.7	21.4	15.2	8.1
	Female	11.2	10.4	11.5	7.9	5.7
Latin America and the Caribbean	Male	9.7	11.1	10.6	7.9	3.4
	Female	6.8	7.5	6.5	5.8	3.1
Sub-Saharan Africa	Male	10.4	14.3	12.9	11.3	8.4
	Female	3.1	4.7	5.1	3.2	2.2
East Asia and the Pacific	Male	6.2	7.5	7.1	6.5	5.0
	Female	0.3	0.2	0.1	0.1	0.0
South Asia	Male	0.8	2.5	0.3	0.1	0.0
	Female	1.2	0.4	0.4	0.0	0.0
High-income countries	Male	18.0	17.9	16.2	10.9	7.6
	Female	10.9	8.7	9.8	6.8	5.4

Source: Authors' calculations based on Rehm, Rehn, and others 2003 and Rehm and others 2004.
Note: The criteria for high-risk drinking were set sex specific (for details see text).

2001). Using WHO disease-modeling software, we derived an internally consistent epidemiological profile of current high-risk alcohol use in each region, including specifications of incidence and the relative risk of mortality, with currently observed rates of prevalence, remission, and risk of mortality as inputs. A final input parameter is the disability level for high-risk alcohol use, which we estimated at 0.154 (where zero equals no disability); this is a weighted average based on the severity breakdown of high-risk drinkers from the CRA (80 percent category II, or hazardous; 20 percent category III, or harmful). The preference values for these health states of 0.11 and 0.33, respectively, are derived from Stouthard, Essink-Bot, and Bonsel (2000).

Relationship between High-Risk Drinking and AUDs

Assessing the relationship between high-risk drinking and AUDs is not a straightforward exercise. Even though high-risk drinking over a long period entails the risk of AUDs, that all people with AUDs are also high-risk drinkers does not automatically follow. First, neither the definition of alcohol dependence nor WHO's (1993) definition of harmful use includes actual consumption levels. An individual is considered dependent if at least three of the following criteria apply:

- strong desire or compulsion to take the substance
- impaired control and physiological withdrawal if the substance is reduced or ceased
- tolerance to the effects of the substance
- preoccupation with use of the substance
- persistent use despite clear evidence of harmful consequences.

By contrast, harmful alcohol use is defined as a pattern of use that is causing damage to physical or mental health. Thus, whereas many of these criteria are associated with high-risk alcohol use, no strict classificatory rule indicates that people with AUDs are a subcategory of high-risk drinkers.

Second, the prevalence of AUDs is often derived from surveys, where the operationalization usually requires that three symptoms be present in a lifetime and at least one of these criteria be present within the past 12 months (see, for example, Demyttenaere and others 2004, table 2). Thus individuals may be categorized as alcohol dependent even if they are currently abstaining from alcohol.

Third, qualitative studies across a wide range of cultures have found that the criteria used for diagnosing AUDs often have different meanings and implications in different cultural settings (Room and others 1996; Schmidt and Room 1999). For instance, in the United States over the past decade, the level of reported AUDs increased despite decreases in high-risk drinking (Grant and others 2004). This fact has been explained in terms of changes in drinking norms and social attitudes during a period when the United States has become a "drier" culture. Thus, the measurement of AUDs is quite complex and culturally dependent. Moreover, AUDs are only one outcome of alcohol consumption and, in many parts of the world, not the most important one. As a result, we decided to focus on high-risk alcohol consumption rather than AUDs.

Relationship between Alcohol Use and Disease Categories

The exact procedures for quantifying the risk of disease attributable to alcohol are described in detail elsewhere (Rehm, Room, Graham, and others 2003; Rehm and others 2004). For most chronic disease categories, investigators have derived alcohol-attributable fractions of disease by combining

prevalence and relative risk estimates based on meta-analyses (Corrao and others 2000; English and others 1995; Gutjahr, Gmel, and Rehm 2001; Ridolfo and Stevenson 2001; Single and others 1996, 1999). For depression, we drew alcohol-attributable fractions from mental health surveys, looking at the rates of comorbidity and the order of onset of depression and alcohol disorders. For coronary heart disease, we modeled the interaction of average volumes and patterns of drinking based on multilevel analyses that include temporal information as covariates (Gmel, Rehm, and Frick 2003; Rehm and others 2004). For the final estimates, we based alcohol-attributable fractions on these multilevel results for all countries, except for developed countries with relatively favorable drinking patterns (Australia, Japan, and countries in North America and Western Europe), which are not discussed here because the focus is on developing countries. For injuries, we took a similar multilevel approach to quantify the interaction of the average volume of consumption and patterns of drinking in determining alcohol-attributable fractions (Rehm and others 2004).

Thus the analysis includes the following major disease categories:

- chronic disease
  - cancer (mouth and oropharyngeal, esophageal, liver, female breast)
  - neuropsychiatric diseases (AUDs, unipolar major depression, epilepsy)
  - diabetes
  - cardiovascular diseases (hypertensive diseases, coronary heart disease, stroke)
  - gastrointestinal diseases (cirrhosis of the liver)
  - conditions arising during the perinatal period (low birthweight)
- injury
  - unintentional injury (motor vehicle accidents, drowning, falls, poisonings, other unintentional injuries)
  - intentional injury (self-inflicted injuries, homicide, other intentional injuries).

We did not include other disease categories that are clearly alcohol-related, such as fetal alcohol syndrome, because the current analysis was based on the CRA and was, thus, limited to the global burden-of-disease categories.

Social Determinants of Exposure and Risk

Alcohol-specific risks to health are in part determined and modified by social determinants. For example, Harrison and Gardiner (1999) find that for men age 25 to 69 in England and Wales in 1988–94, those in the lowest socioeconomic status category, unskilled labor, had a 15-fold greater risk for alcohol-related mortality than professionals in the highest category had. These differences cannot be explained by the overall volume of drinking, which actually tended to be greater for those in higher socioeconomic groups. Rather, the differences can be explained by the fact that more of the drinking of those in lower socioeconomic status categories is in high-risk patterns; that is, depending on the use values for drinking in the culture, poor drinkers may see little point in wasting resources on drinking that is not to intoxication. Poorer drinkers are also likely to be less protected physically and socially from possible harm arising from drinking, such as injuries and chronic and infectious diseases. Mäkelä (1999) finds that multiple dimensions of socioeconomic status are required to capture all the adverse interactions of socioeconomic status with alcohol-related mortality.

A critical macroeconomic question is how a country's level of economic development is related to alcohol-related risks to health. The impact of alcohol on disease and mortality may be more potent in countries with greater poverty and nutritional deficiencies (Isichei, Ikwuagu, and Egbuta 1993; Room and others 2002, 119–30). However, most of the risk relationships between alcohol and disease have been derived from studies in established market economies, and the extent of systematic research is currently insufficient to allow quantification of this phenomenon. As a result, the estimated disease burden cited here may be considered as a lower-bound estimate of the actual alcohol-attributable disease burden in developing countries.

BURDEN OF DISEASE RELATED TO HIGH-RISK ALCOHOL USE

In the following sections, the procedures to estimate alcohol-related burden of disease are described, as well as the limitations of the used approach.

Determining the Alcohol-Related Burden of Disease

Table 47.2 breaks down alcohol-attributable disability-adjusted life years (DALYs) by disease category and World Bank region using a constant 3 percent per year discount rate, but with no age weighting. Results differ from those of the CRA (Ezzati and others 2002; Rehm and others 2004; WHO 2002) because of the use of non-age-weighted DALYs.[1]

Determining the Burden of Disease Related to High-Risk Alcohol Consumption

In determining the burden of disease related to high-risk alcohol consumption, we first divided the burden of disease between chronic and acute disease. For chronic disease, we assume that almost the entire disease burden reported in the CRA is associated with high-risk alcohol use. Indeed, the overall disease burden in the CRA is an underestimate, because drinking up to 20 grams per day of pure alcohol by females and

Table 47.2 Alcohol-Attributable DALYs by Disease Category and World Bank Region, 2001
(thousands of DALYs)

Disease category	Europe and Central Asia	Latin America and the Caribbean	Sub-Saharan Africa	Middle East and North Africa	East Asia and the Pacific	South Asia	High-income countries	World
Chronic disease								
Maternal and perinatal conditions	12	7	39	1	2	29	6	105
Cancer	526	296	635	25	2,820	189	1,103	5,594
Neuropsychiatric	2,159	3,315	1,035	89	4,726	1,444	4,752	17,600
Vascular	2,639	926	556	40	1,751	1,199	−2,488	5,209
Other noncommunicable diseases	1,175	739	504	27	997	306	1,153	5,126
Subtotal chronic disease	6,511	5,283	2,769	182	10,296	3,167	4,526	33,634
Injury								
Unintentional	4,127	1,984	2,308	135	3,613	2,222	1,753	15,619
Intentional	1,822	1,872	1,074	9	927	567	571	6,755
Subtotal injury	5,949	3,856	3,382	144	4,540	2,789	2,324	22,374
Total DALYs attributable to alcohol	12,460	9,139	6,151	326	14,836	5,956	6,850	56,008
Total DALYs from all diseases	116,502	104,287	344,754	65,570	346,225	408,655	149,161	1,535,871
Proportion of DALYs attributable to alcohol (percent)	10.7	8.8	1.8	0.5	4.3	1.5	4.6	3.6

Source: Authors' calculations based on Rehm and others 2004 and WHO 2002.
Note: Negative DALYs can occur because certain patterns of alcohol have cardio-protective effects.

up to 40 grams per day of pure alcohol by males is globally associated with a net beneficial effect in relation to chronic disease. However, this effect occurs mainly in countries with moderate drinking patterns (Rehm, Sempos, and Trevisan 2003), which tend to be high-income countries (Rehm, Rehn, and others 2003). Although high-risk but regular drinking patterns may also have some beneficial effects, such effects are not important in countries with binge drinking patterns. (For the association between alcohol and coronary heart disease, see McKee and Britton 1998; Puddey and others 1999; Rehm, Sempos, and Trevisan 2003; for consequences on modeling the regional burden of disease, see Rehm and others 2004.)

For injuries, which are considered to be acute outcomes, we started by separating out the proportion of injury not caused by high-risk drinking, which we accomplished by assuming that injuries are linearly related to per capita consumption (Rehm and others 2004).[2] This assumption is probably conservative, because high-risk drinkers in countries with binge drinking patterns are likely to have more frequent and intensive drinking occasions, and the risk of injury usually rises logarithmically with the amount of drinking on a specific occasion (see, for example, National Highway Traffic Safety Administration 1992). Following this initial calculation, we could calculate the proportion of per capita consumption related to high-risk drinking in each region, thereby determining the proportion of injury caused by high-risk drinking (table 47.3). Together with our calculation of the chronic disease burden attributable to high-risk alcohol use, this percentage enabled us to estimate the overall disease burden attributable to high-risk alcohol use: whereas 3.6 percent of the global burden was attributable to alcohol drinking generally, 2.8 percent was attributable to high-risk drinking.

Limitations of the CRA Approach

The CRA's estimates of the global and regional alcohol-related burden of disease are based on a number of assumptions, of which the following are the most crucial:

- The estimates of per capita consumption and unrecorded consumption for different countries do not contain substantial measurement error.
- The distribution of consumption as derived from surveys is similar to actual distribution in the population.
- The relationships between alcohol and chronic disease derived from meta-analyses of cohort and case-control studies are stable among countries and regions.

Table 47.3 DALYs Attributable to High-Risk Average Alcohol Consumption by Disease Category and Region, 2001
(thousands of DALYs)

Disease category	Europe and Central Asia	Latin America and the Caribbean	Sub-Saharan Africa	East Asia and the Pacific	South Asia	High-income countries	World
Total chronic disease	6,510	5,283	2,770	10,296	3,167	4,526	33,634
Total injury	3,149	1,500	1,693	1,532	514	1,092	9,207
Total DALYs attributable to high-risk alcohol consumption	9,659	6,783	4,463	11,828	3,681	5,618	42,841
Total DALYs from all diseases	116,502	104,287	344,754	346,225	408,655	149,161	1,535,871
Proportion of DALYs attributable to high-risk alcohol consumption	8.3	6.5	1.3	3.4	0.9	3.8	2.8

Source: Authors' calculations based on Rehm and others 2004 and WHO 2002.

Some evidence indicates that per capita consumption can be reliably estimated, and information on this indicator is available for the vast majority of countries (Rehm, Rehn, and others 2003). With respect to survey information, reliability and worldwide coverage are lower. However, because the overall volume of consumption and, thus, the average volume per capita are based on production and sales estimates, the measure of the volume of drinking overall can be considered reliable. These factors leave the stability of relationships between alcohol and chronic disease as the most crucial part of our estimates. Some indications suggest that relative risks may not be the same in developing countries as in developed countries (for example, for tobacco and lung cancers, see Liu and others 1998). Thus, the CRA's estimates may be biased, most likely toward an overestimation of the impact of alcohol.

One additional problem pertains to the usual epidemiological approach as applied to alcohol. Most information about alcohol and chronic disease is derived from cohorts. Because cohorts are frequently not representative of the population as a whole, specific patterns of consumption such as binge drinking are often not represented, and thus their influence cannot be analyzed (Rehm, Gmel, and others 2003). Unfortunately, the patterns most often missing are those that are the most detrimental with respect to health; thus, the impact of alcohol on chronic diseases that are influenced by patterns of drinking other than average volumes is underestimated.

INTERVENTIONS FOR REDUCING HIGH-RISK DRINKING

The next two sections estimate the burden of disease attributable to high-risk alcohol consumption that is currently being averted or could be averted by a range of personal and nonpersonal intervention strategies and calculate the expected costs and cost-effectiveness of such interventions. Methods and analyses draw on Chisholm and others (2004), adjusted as necessary to conform to the analytical standards of this volume, including the specification of all costs in U.S. dollars rather than international dollars.

Population Model

We determined intervention effectiveness using a state transition population model (Lauer and others 2003), which traces the development of a regional population taking into account births, deaths, and the specified risk factor—in this case, high-risk alcohol use. In addition to population size and structure, the population model uses a number of epidemiological parameters (incidence and prevalence, remission, and cause-specific and residual rates of mortality) and assigns age- and gender-specific health state valuations to both the disease in question and to the nondiseased population. The output of the model is an estimate of the total healthy life years experienced by the population over a lifetime period (100 years).

We ran the model for a number of possible scenarios, including no intervention at all (natural history), current intervention coverage, and scaled-up coverage of current and possible new interventions. For the intervention scenarios, we used an implementation period of 10 years for an intervention program (after which epidemiological rates return to their natural history levels), from which we derived the number of additional DALYs averted each year compared with the case for no intervention at all. We discounted DALYs at 3 percent but did not age weight them.

Effectiveness

A number of interventions have been evaluated and shown to be effective in reducing alcohol use, yet their level of

implementation remains low in all but a handful of countries and their potential effect on population-level health has rarely been assessed. By contrast, some interventions without clearly established effects continue to be widely used, including, for example, mass media public information campaigns and school-based education aimed at reducing alcohol consumption. Recent reviews of measures to reduce alcohol misuse have assessed the quality of the evidence for four types of interventions specifically aimed at reducing high-risk alcohol use (Babor and others 2003; Ludbrook and others 2002):

- policy and legislative interventions, including taxation of alcohol sales, laws on drunk driving, restrictions on retail outlets, and controls on advertising
- measures to better enforce these interventions, such as random breath testing of drivers
- mass media and other awareness campaigns
- brief interventions with individual high-risk drinkers.

On the basis of these reviews, we included the following strategies and intervention effects in our analysis: drinking-and-driving legislation and random breath testing, taxation of alcoholic beverages, reduced hours of sale in retail outlets, and advertising bans (included as population-based interventions) and so-called brief interventions (included as interventions aimed at personal behavior). We considered including one other intervention strategy—mass media or school-based awareness campaigns—but omitted it in the final analysis on the grounds that evidence for its effectiveness was weak, both in terms of methodological quality and in terms of its effect on consumption (as opposed to transfer of information or knowledge alone) (Babor and others 2003; Edwards and others 1994; Foxcroft and others 2003; Foxcroft, Lister-Sharp, and Lowe 1997; Ludbrook and others 2002).

Drunk-Driving Legislation and Random Breath Testing. Drunk-driving laws and reinforcement policies, such as random breath testing of drivers, influence fatal and nonfatal traffic injuries among both high-risk alcohol users and other members of the population, such as passengers and pedestrians. We assessed two independent effects on alcohol-related traffic injuries, but note that evidence for these effects comes from the developed countries, where road infrastructures and driving patterns may differ significantly from those in the developing world. The first intervention was drunk-driving laws, estimated to reduce traffic fatalities by 7 percent if widely implemented across a region. The second was enforcement by random breath testing, estimated to reduce fatalities by 6 to 10 percent in regions partially implementing such a strategy and by 18 percent with wide implementation. The effect on nonfatal injuries was estimated to be a reduction of 15 percent (Peek-Asa 1999; Shults and others 2001). In each region, we applied these estimated effects to the proportion of total deaths and of years lived with a disability attributed to alcohol-related traffic accidents (table 47.4).

Taxation on Alcoholic Beverages. Excise taxation on alcoholic beverages primarily affects the incidence of drinking through reduced consumption. Effects are measured in terms of price elasticity, which relates the change in consumption to the size of the price increase (table 47.5). We derived price elasticities, adjusted downward by one-third to reflect possible reduced price responsiveness among high-risk drinkers, with reference to preferred type of alcoholic beverage (beer, wine, or spirits) by region, built up from country-level data (WHO 2003b). This downward adjustment of price elasticities for high-risk drinkers is a conservative approach; most of the literature found similar effects on high-risk and dependent drinkers as on social users (Babor and others 2003; see also Farrell, Manning, and Finch 2003).

Price elasticities ranged from −0.3 for the most preferred beverage category to −1.5 for the least preferred (Babor and others 2003; Levy and Ornstein 1983). For a beer-drinking region where wine is the second-most preferred beverage type, for example, elasticities were set as follows: beer −0.3, wine −1.0, distilled spirits −1.5. We performed sensitivity analysis around these elasticities. We evaluated three rates of excise tax on alcoholic beverages: the current rate of tax, a 25 percent increase over the current rate, and a 50 percent increase over the current rate. We adjusted estimated reductions in the incidence of high-risk alcohol use by the observed or expected level of unrecorded consumption resulting from illicit production and smuggling (for instance, an estimated 35 percent of alcohol consumption in Eastern Europe and Central Asia is unrecorded, a proportion that was modeled to increase by 10 to 15 percent with the tax increases). In regions with rates of unrecorded consumption already greater than 50 percent (South Asia and Sub-Saharan Africa), tax increases can actually have a regressive impact on incidence if accompanied by a rise in the already high level of unrecorded (and therefore untaxed) consumption.

Reduced Hours of Sale in Retail Outlets. Access to and availability of alcohol can be dramatically reduced by prohibition or rationing, but implementing and sustaining such strategies without adverse effects, such as black markets and poisonings from home-produced alcohol, present considerable challenges. A more modest strategy is to reduce the hours of sale of retail outlets selling alcoholic beverages (for example, no sales for off-premise consumption for a 24-hour period at the weekend), which in Scandinavia has reduced consumption and alcohol-related harm (Leppänen 1979; Nordlund 1984; Norström and Skog 2003). On the basis of these studies, we modeled a modest reduction of 1.5 to 3.0 percent in the incidence of high-risk drinking and 1.5 to 4.0 percent in alcohol-related traffic

Table 47.4 Effectiveness of Drinking-and-Driving Legislation and Its Enforcement
(per 100,000 population)

World Bank region	WHO subregion	Sex	Attributable fractions (per 100,000 deaths): Deaths attributed to traffic accidents[a]	Attributable fractions (per 100,000 deaths): Deaths attributed to alcohol-related traffic accidents[a]	Effectiveness of drinking-and-driving laws and random breath testing: Reduced deaths (per 100,000)	Effectiveness of drinking-and-driving laws and random breath testing: Reduced years lost due to disability (per 100,000)
Europe and Central Asia	Europe B	Male	1,473	657	141	77
		Female	542	74	16	6
	Europe C	Male	2,197	1,396	299	193
		Female	799	223	48	30
Latin America and the Caribbean	Americas B	Male	4,358	2,053	439	148
		Female	1,514	220	47	12
	Americas D	Male	2,599	861	184	64
		Female	1,093	101	22	6
Sub-Saharan Africa	Africa D	Male	2,159	417	89	43
		Female	1,079	90	19	9
	Africa E	Male	2,075	803	172	107
		Female	1,027	123	26	17
East Asia and the Pacific	Southeast Asia B	Male	7,809	1,993	427	164
		Female	2,343	127	27	8
	Western Pacific B	Male	3,629	723	155	66
		Female	1,790	157	34	12
South Asia	Southeast Asia D	Male	3,689	591	126	45
		Female	1,451	53	11	3

Source: Deaths attributed to traffic accidents: WHO 2003a; deaths attributed to alcohol-related traffic accidents: Rehm and others 2004.
B = low child mortality, low adult mortality; C = low child mortality, high adult mortality; D = high child mortality, high adult mortality; E = high child mortality, very high adult mortality.
a. Percentages for all age groups combined shown here.

fatalities, depending on the regional pattern of drinking, with the largest effects in regions with the highest levels of high-risk drinking occasions.

Advertising Bans. Public health specialists are becoming increasingly interested in the effect of a comprehensive ban on alcohol advertising, including advertising on television and through radio and billboards. However, available evidence from econometric studies suggests a modest effect on consumption at best, even for a comprehensive ban, arguably because of the continuing presence of other alcohol marketing strategies, such as product placement or event sponsorship (Grube and Agostinelli 2000; Saffer 2000; Saffer and Dave 2002). Here we consider the potential effects of a comprehensive advertising ban (television, radio, and billboards) by modeling a 2 to 4 percent reduction in the incidence of high-risk alcohol use, depending on regional drinking patterns.

Brief Interventions. We modeled brief interventions (such as physician advice provided in primary health care settings), which involve a small number of education sessions and psychosocial counseling, to influence the prevalence of high-risk drinking by increasing remission and reducing disability. Efficacy reviews of brief interventions reveal an estimated 13 to 34 percent net reduction in consumption among high-risk drinkers (Higgins-Biddle and Babor 1996; Moyer and others 2002; Whitlock and others 2004), which, if applied to the total population at risk, would reduce the overall prevalence of high-risk drinking by 35 to 50 percent, equivalent to a 14 to 18 percent improvement in the rate of recovery over no treatment at all. After taking into account adherence (70 percent) and potential treatment coverage in the population (50 percent of high-risk drinkers), however, we estimated remission rates to be between 4.9 and 6.4 percent higher than natural history rates.

Table 47.5 Effect of Taxation on the Incidence of High-Risk Alcohol Use

World Bank region	WHO subregion[a]	Prevalence by preferred beverage (percent): Most preferred	Prevalence by preferred beverage (percent): Next preferred	Prevalence by preferred beverage (percent): Least preferred	Rate of taxation by preferred beverage (percent): Most preferred	Rate of taxation by preferred beverage (percent): Next preferred	Rate of taxation by preferred beverage (percent): Least preferred		Price increases (percent)[b]: Elasticity −0.3, most preferred	Price increases (percent)[b]: Elasticity −1.0, next preferred	Price increases (percent)[b]: Elasticity −1.5, least preferred	Nonrecorded or untaxed consumption (percent)	Effect (percent)[c]: Baseline	Effect (percent)[c]: Lower[d]	Effect (percent)[c]: Upper[e]
Europe and Central Asia	Europe B	0.45 (spirits)	0.30 (beer)	0.25 (wine)	0.29	0.13	0.12	(current rate)	−0.04	−0.08	−0.11	0.34 (current rate)	−0.05	−0.03	−0.06
					0.36	0.16	0.15	(25 percent increase)	−0.05	−0.09	−0.13	0.37 (10 percent increase)	−0.05	−0.04	−0.07
					0.44	0.20	0.18	(50 percent increase)	−0.06	−0.11	−0.15	0.39 (15 percent increase)	−0.06	−0.04	−0.08
	Europe C	0.68 (spirits)	0.21 (beer)	0.11 (wine)	0.65	0.13	0.25	(current rate)	−0.08	−0.08	−0.20	0.36 (current rate)	−0.06	−0.04	−0.08
					0.81	0.16	0.31	(25 percent increase)	−0.09	−0.09	−0.24	0.40 (10 percent increase)	−0.06	−0.05	−0.09
					0.98	0.20	0.38	(50 percent increase)	−0.10	−0.11	−0.27	0.42 (15 percent increase)	−0.07	−0.05	−0.09
Latin America and the Caribbean	Americas B	0.53 (beer)	0.30 (spirits)	0.17 (wine)	0.16	0.49	0.22	(current rate)	−0.03	−0.22	−0.18	0.29 (current rate)	−0.08	−0.06	−0.10
					0.20	0.61	0.28	(25 percent increase)	−0.03	−0.25	−0.22	0.32 (10 percent increase)	−0.09	−0.06	−0.12
					0.24	0.74	0.33	(50 percent increase)	−0.04	−0.28	−0.25	0.34 (15 percent increase)	−0.10	−0.07	−0.13
	Americas D	0.58 (spirits)	0.39 (beer)	0.03 (wine)	0.26	0.21	0.25	(current rate)	−0.04	−0.12	−0.20	0.22 (current rate)	−0.06	−0.04	−0.08
					0.33	0.26	0.31	(25 percent increase)	−0.05	−0.14	−0.24	0.24 (10 percent increase)	−0.07	−0.05	−0.09
					0.39	0.32	0.38	(50 percent increase)	−0.06	−0.16	−0.27	0.25 (15 percent increase)	−0.08	−0.05	−0.10
Sub-Saharan Africa	Africa D	0.79 (beer)	0.16 (spirits)	0.05 (wine)	0.36	0.41	0.35	(current rate)	−0.05	−0.19	−0.26	0.77 (current rate)	−0.02	−0.01	−0.03
					0.45	0.51	0.44	(25 percent increase)	−0.06	−0.23	−0.30	0.85 (10 percent increase)	−0.01	−0.01	−0.02
					0.54	0.62	0.53	(50 percent increase)	−0.07	−0.25	−0.34	0.89 (15 percent increase)	−0.01	−0.01	−0.02
	Africa E	0.49 (beer)	0.30 (spirits)	0.21 (wine)	0.28	0.50	0.38	(current rate)	−0.04	−0.22	−0.28	0.47 (current rate)	−0.08	−0.06	−0.10
					0.35	0.63	0.48	(25 percent increase)	−0.05	−0.26	−0.32	0.52 (10 percent increase)	−0.08	−0.06	−0.11
					0.42	0.75	0.57	(50 percent increase)	−0.06	−0.29	−0.36	0.55 (15 percent increase)	−0.09	−0.06	−0.11
East Asia and the Pacific	Southeast Asia B	0.88 (spirits)	0.12 (beer)	0.00 (wine)	0.30	0.40	0.00	(current rate)	−0.05	−0.19	0.00	0.36 (current rate)	−0.04	−0.03	−0.05
					0.38	0.50	0.00	(25 percent increase)	−0.05	−0.22	0.00	0.39 (10 percent increase)	−0.05	−0.03	−0.06
					0.45	0.60	0.00	(50 percent increase)	−0.06	−0.25	0.00	0.41 (15 percent increase)	−0.05	−0.03	−0.07
	Western Pacific B	0.88 (spirits)	0.11 (beer)	0.01 (wine)	0.17	0.09	0.11	(current rate)	−0.03	−0.06	−0.10	0.27 (current rate)	−0.02	−0.02	−0.03
					0.21	0.11	0.14	(25 percent increase)	−0.04	−0.07	−0.12	0.32 (10 percent increase)	−0.03	−0.02	−0.04
					0.26	0.14	0.17	(50 percent increase)	−0.04	−0.08	−0.14	0.31 (15 percent increase)	−0.03	−0.02	−0.04
South Asia	Southeast Asia D	0.89 (spirits)	0.11 (beer)	0.00 (wine)	0.40	0.25	0.00	(current rate)	−0.06	−0.13	0.00	0.79 (current rate)	−0.01	−0.01	−0.02
					0.50	0.31	0.00	(25 percent increase)	−0.07	−0.16	0.00	0.87 (10 percent increase)	−0.01	−0.01	−0.01
					0.60	0.38	0.00	(50 percent increase)	−0.08	−0.18	0.00	0.91 (15 percent increase)	−0.01	−0.01	−0.01

Source: WHO 2003b.

a. B = low child mortality, low adult mortality; C = low child mortality, high adult mortality; D = high child mortality, high adult mortality; E = high child mortality, very high adult mortality.

b. Price rise caused by tax = [percentage of tax/(1 + percentage of tax)] × elasticity × 2/3 (high-risk drinkers less responsive).

c. Effect = sum of (prevalence × price increase) for each beverage × (1 − percentage of unrecorded consumption).

d. Lower-range elasticities = −0.2, −0.7, −1.2.

e. Upper-range elasticities = −0.4, −1.3, −2.0.

Costs

Costs covered in the analysis include program-level costs associated with running the intervention (such as administration, training, and media costs) and patient-level costs (such as costs of primary care visits). Program-level costs include resource inputs used in the production of an intervention at a level above that of the patient or providing facility, such as central planning, policy, and administration functions, as well as resources devoted to preventive programs, such as the enforcement of drunk-driving legislation by police officers (Johns and others 2003). We derived estimated quantities of resources required to implement each intervention for 10 years at the national, provincial, and district levels with reference to the region's prevailing characteristics—for example, the stability and efficiency of tax systems, the volume of traffic (for breath testing), and the strength of antidrinking sentiment as indicated by existing alcohol controls (advertising bans, restricted sales). In this analysis, patient-level resource inputs used in the provision of a given health care intervention (for example, hospital inpatient days, outpatient visits, medications, and laboratory tests) are relevant only to brief interventions. We estimated an average of four primary care visits per year for the intervention itself, plus an additional 0.33 outpatient visits (20 percent × 1.67 visits) and 0.25 inpatient days (5 percent × 5 days) (see, for example, Fleming and others 2000). We applied these patient-level resource inputs to the 50 percent of prevalent high-risk alcohol users in receipt of brief advice in year 1 and (because we model an enduring effect for 10 years) year 6 and to the 50 percent of incident cases in years 2 to 5 and 7 to 10. Note that, throughout, the costing does not include possible offsetting revenues for the government, for instance, from drunk-driving convictions and, in particular, from the revenues likely to result from increased alcohol taxes.

Unit costs and prices of program- and patient-level resource inputs include the salaries of central administrators; the capital costs of vehicles, offices, and furniture; and the cost per outpatient visit (see chapter 7 for an overview of the costing methodology, plus prices by World Bank region). All costs are expressed in U.S. dollars for 2001 and are discounted at an annual rate of 3 percent.

COST-EFFECTIVENESS OF INTERVENTIONS

In the following section, we provide results relating to the population-level health effects, costs, and cost-effectiveness of the evidence-based interventions previously reviewed.

Population-Level Effects

Except for random breath testing, two-thirds of the total population-level health gain from these interventions was among males (the proportion for random breath testing rises to 80 to 90 percent because of the higher proportion of deaths and injuries attributed to traffic accidents among men). A clear difference is also apparent between regions with relatively high rates of high-risk alcohol use (that is, prevalence in the total population greater than 5 percent) and regions with generally low levels of high-risk drinking (that is, less than 2 percent).

As shown in table 47.6, in the three regions with a higher prevalence of high-risk alcohol use—Europe and Central Asia, Latin America and the Caribbean, and Sub-Saharan Africa—the most effective interventions were taxation and brief physician advice to individual high-risk drinkers, with each averting more than 500 DALYs per million population per year. The remaining control strategies—random breath testing, reduced access to alcoholic beverage retail outlets, and a comprehensive advertising ban—mainly produced effects in the range of 200 to 400 DALYs averted per million population per year. In the two regions with lower rates of high-risk drinking (particularly among the female population), by contrast, the burden that is avertable through taxation is very much reduced (10 to 100 DALYs averted per million population per year). In South Asia, the most effective intervention is enforcement of drinking-and-driving laws by means of random breath testing, because of the higher rate of traffic-related injuries than elsewhere as well as the low levels of high-risk drinking.

Population-Level Costs

Table 47.7 summarizes the costs and cost-effectiveness of each intervention and of two combination strategies by region. The most costly interventions to implement in all regions were random breath testing and brief physician advice in primary care. The higher costs of brief advice stem from a combination of patient-level costs in the provision of the intervention itself (an average annual cost of US$7 to US$20 per treated case), plus program costs associated with administration and training primary care providers (15 to 40 percent of total costs). Random breath testing is also a relatively resource-intensive intervention to implement because of the need for regular sobriety checkpoints administered by law enforcement officers. Other interventions, including taxation, had a per capita cost in the range US$0.02 to US$0.13, depending in part on the efficiency of the tax collection system and the degree of antidrinking sentiment.

Population-Level Cost-Effectiveness

Compared with doing nothing, taxation is the most cost-effective population-level strategy in Europe and Central Asia, Latin America and the Caribbean, and Sub-Saharan Africa, the three regions with a relatively high prevalence of high-risk drinking (table 47.7). At the current rate of tax, for example, each DALY averted costs US$104 to US$225, equivalent to 4,435 to 9,633 DALYs averted per US$1 million expenditure.

Table 47.6 Population-Level Effects of Interventions to Reduce High-Risk Alcohol Use by World Bank Region

	Coverage[a] (percent)	Europe and Central Asia	Latin America and the Caribbean	Sub-Saharan Africa	East Asia and the Pacific	South Asia
Burden of disease (DALYs/million population)		20,241	12,894	6,685	6,263	2,652
Total effect (DALYs averted/ million population/year)						
Excise tax on alcoholic beverages (current situation)	*0.95*	685	586	697	83	13
Excise tax on alcoholic beverages (25 percent increase)	*0.95*	756	654	724	96	10
Excise tax on alcoholic beverages (50 percent increase)	*0.95*	828	719	764	109	8
Reduced access to alcoholic beverage retail outlets	*0.95*	441	287	386	203	32
Comprehensive advertising ban on alcohol	*0.95*	395	243	406	226	20
Random breath testing of motor vehicle drivers	*0.80*	284	307	197	181	125
Brief advice to heavy drinkers by a primary care physician	*0.50*	1,328	713	539	362	80
Combination: highest tax + brief advice		2,048	1,360	1,237	447	83
Combination: highest tax + advertising ban + random breath testing + brief advice		2,551	1,784	1,715	790	210
Reduction in current burden (percent)						
Excise tax on alcoholic beverages (current situation)	*0.95*	0.03	0.05	0.10	0.01	0.01
Excise tax on alcoholic beverages (25 percent increase)	*0.95*	0.04	0.05	0.11	0.02	0.00
Excise tax on alcoholic beverages (50 percent increase)	*0.95*	0.04	0.06	0.11	0.02	0.00
Reduced access to alcoholic beverage retail outlets	*0.95*	0.02	0.02	0.06	0.03	0.01
Comprehensive advertising ban on alcohol	*0.95*	0.02	0.02	0.06	0.04	0.01
Random breath testing of motor vehicle drivers	*0.80*	0.01	0.02	0.03	0.03	0.05
Brief advice to heavy drinkers by a primary care physician	*0.50*	0.07	0.06	0.08	0.06	0.03
Combination: highest tax + brief advice		0.10	0.11	0.19	0.07	0.03
Combination: highest tax + advertising ban + random breath testing + brief advice		0.13	0.14	0.26	0.13	0.08

Source: Chisholm and others 2004.
a. Refers to the modeled percentage of all high-risk drinkers exposed to the intervention.

Advertising bans had a cost per unit of effect similar to that of reduced access to sales outlets, US$134 to US$380, equivalent to 2,631 to 7,442 averted DALYs per US$1 million dollars expenditure, whereas random breath testing had the highest estimated cost per DALY averted: US$973 to US$1,856 per DALY, approximately 500 to 1,000 DALYs averted per US$1 million dollars expenditure. Brief physician advice provided in primary care settings had an average cost-effectiveness in the range of US$204 to US$502 per DALY averted, or close to 2,000 to 5,000 averted DALYs for every US$1 million expenditure.

Table 47.7 Costs and Cost-Effectiveness of Interventions to Reduce High-Risk Alcohol Use by World Bank Region

	Coverage[a] (percent)	Europe and Central Asia	Latin America and the Caribbean	Sub-Saharan Africa	East Asia and the Pacific	South Asia
Total cost (US$ million/year/million population)						
Excise tax on alcoholic beverages (current situation)	*0.95*	0.10	0.13	0.07	0.04	0.04
Excise tax on alcoholic beverages (25 percent increase)	*0.95*	0.10	0.13	0.07	0.04	0.04
Excise tax on alcoholic beverages (50 percent increase)	*0.95*	0.10	0.13	0.07	0.04	0.04
Reduced access to alcoholic beverage retail outlets	*0.95*	0.10	0.10	0.06	0.03	0.03
Comprehensive advertising ban on alcohol	*0.95*	0.07	0.09	0.05	0.03	0.02
Random breath testing of motor vehicle drivers	*0.80*	0.53	0.47	0.19	0.18	0.07
Brief advice to heavy drinkers by a primary care physician	*0.50*	0.36	0.36	0.11	0.08	0.04
Combination: highest tax + brief advice		0.44	0.48	0.18	0.12	0.07
Combination: highest tax + advertising ban + random breath testing + brief advice		0.97	0.97	0.39	0.30	0.15
Cost-effectiveness relative to no intervention (US$/DALY averted)						
Excise tax on alcoholic beverages (current situation)	*0.95*	141	225	104	516	2,671
Excise tax on alcoholic beverages (25 percent increase)	*0.95*	127	202	100	447	3,654
Excise tax on alcoholic beverages (50 percent increase)	*0.95*	116	184	95	394	4,641
Reduced access to alcoholic beverage retail outlets	*0.95*	216	340	152	146	827
Comprehensive advertising ban on alcohol	*0.95*	185	380	134	123	1,123
Random breath testing of motor vehicle drivers	*0.80*	1,856	1,542	973	984	531
Brief advice to heavy drinkers by a primary care physician	*0.50*	270	502	204	224	462
Combination: highest tax + brief advice		216	350	143	269	845
Combination: highest tax + advertising ban + random breath testing + brief advice		381	546	229	383	707
DALYs averted/US$ million expenditure						
Excise tax on alcoholic beverages (current situation)	*0.95*	7,107	4,435	9,633	1,937	374
Excise tax on alcoholic beverages (25 percent increase)	*0.95*	7,847	4,953	10,007	2,239	274
Excise tax on alcoholic beverages (50 percent increase)	*0.95*	8,590	5,442	10,553	2,536	215
Reduced access to alcoholic beverage retail outlets	*0.95*	4,638	2,940	6,580	6,856	1,209
Comprehensive advertising ban on alcohol	*0.95*	5,417	2,631	7,442	8,139	891
Random breath testing of motor vehicle drivers	*0.80*	539	648	1,027	1,016	1,882
Brief advice to heavy drinkers by a primary care physician	*0.50*	3,705	1,992	4,891	4,460	2,163
Combination: highest tax + brief advice		4,627	2,859	7,016	3,718	1,184
Combination: highest tax + advertising ban + random breath testing + brief advice		2,621	1,833	4,364	2,612	1,415

Source: Chisholm and others 2004.
a. Refers to the modeled percentage of all high-risk drinkers exposed to the intervention.

Starting from the current situation in these regions, the most efficient strategies for reducing high-risk alcohol use would be tax increases (additional gains are obtained at virtually no extra cost because the costs of tax administration and enforcement remain relatively constant whatever the rate of tax), followed by the introduction or escalation of comprehensive advertising bans on alcohol products, reduced access to retail outlets, and the provision of brief interventions such as physician advice in primary care. Even a multifaceted strategy made up of an increase in taxation plus full implementation of the other interventions considered here has a favorable ratio of costs to health benefits.

In East Asia and the Pacific and South Asia, the two regions with lower rates of high-risk alcohol use, a comparison of intervention costs and effects to a no-intervention scenario reveals that current practice—namely, excise taxes on alcoholic

beverages—is not the most efficient response to the existing burden of alcohol use. The reduced efficiency of taxation in these lower-prevalence regions is related both to the distribution of the fixed costs of administering and enforcing alcohol tax legislation across a smaller target population of drinkers and to underlying drinking patterns: more than 85 percent of all alcohol consumption falls into a single preferred drink category, spirits, which therefore diminishes the scope for reducing the consumption of less preferred but more elastic categories of alcoholic beverages. In South Asia, targeted strategies such as brief physician advice and random breath testing have the lowest cost per DALY averted (around US$500), while taxation policies are the most expensive at more than US$2,500 per DALY averted. In East Asia and the Pacific, the most cost-effective interventions are brief physician advice, a comprehensive ban on advertising, and reduced access to retail outlets (below US$250 per DALY averted).

Implications and Limitations of Sectoral Cost-Effectiveness Analyses

This cost-effectiveness analysis offers a new approach to generating economic evidence that can inform public health policy on alcohol in a wide range of cultural and epidemiological settings (Chisholm and others 2004). Resulting estimates of cost-effectiveness can inform policy makers not only by determining the efficiency of existing resource allocation and practices, but also by identifying priorities for future alcohol control strategies. Furthermore, use of a common methodology enables comparison with cost per DALY estimates for other risk factors or disease entities, which may constitute an important argument when considering priorities for the allocation of scarce health care resources. However, the application of a broad sectoral approach using entire regions as the unit of analysis clearly limits the approach's use in specific country contexts, where demographic or epidemiological characteristics, as well as treatment costs and coverage, may not coincide with estimates for the region as a whole. In addition, extrapolation of the extent of intervention effects from relatively information-rich countries to other sociocultural settings lessens the precision of derived estimates of population-level health gains.

Although an ongoing analytical step is to calibrate results at the country level, the primary purpose and utility of the sectoral approach is to identify interventions that are clearly cost-effective as opposed to those that clearly do not seem to offer good value for money. In this respect, the primary conclusion to be drawn from the analysis is that in regions with high or moderate rates of high-risk alcohol use, a number of intervention strategies can have a notable effect on population health, including both individual-based interventions, such as brief physician advice at the primary care level, as well as population-wide measures, such as taxation of alcoholic beverages. Of these, taxation has the most sizable and least resource-intensive effect on reducing the avertable burden of high-risk alcohol use. In regions where high-risk alcohol use represents less of a public health burden, targeted approaches such as brief physician advice as well as other intervention strategies that restrict the supply or promotion of alcoholic beverages appear to be the most cost-effective mechanisms, although greater empirical support for the efficacy of these interventions in these localities is clearly needed before considering their widespread implementation.

Even though sectoral cost-effectiveness analysis pursues a societal perspective, considerable challenges remain in relation to the appropriate measurement of certain societal costs and effects that fall outside the boundaries of the health system. Therefore, this analysis has not been able to successfully capture potential reductions in workforce and household productivity losses among high-risk drinkers, nor does it incorporate the economic costs associated with alcohol-related crime, violence, and harm reduction. It also does not value the time spent by patients and informal caregivers in seeking or providing care and support. Including these modest additional costs and substantial incremental effects is likely to improve the cost-effectiveness ratios of all interventions, but to a variable and currently unknown extent.

ECONOMIC BENEFITS OF INTERVENTIONS

By design, estimates of the burden of alcohol do not include most social harm and harm to people other than the drinker; however, the burden of social problems from drinking can be at least as significant as the health burden. The burden attributable to alcohol in the CRA estimates is actually a substantial underestimate of the full harm alcohol imposes on human welfare. The estimates reported earlier reflect primarily the chronic disease and injury effects of drinking. Because the CRA focused on disease and disability, the estimates were not designed to take account of the social harm and problems that are particular to alcohol and that result for the drinker and for others as a consequence of a person's drinking (Klingemann and Gmel 2001). These problems are quite prevalent in many populations (Room and others 2003) and are also affected by the interventions listed earlier.

Some information on the relative burden of alcohol for social services versus health services is available for a handful of societies. In an estimate of the staffing and service costs attributable to alcohol in different service systems in Scotland for fiscal year 2001/02, for instance, health services accounted for only 21 percent of the estimated costs, whereas social services accounted for 19 percent, and criminal justice and fire services accounted for 60 percent (Catalyst Health Consultants 2001, 3).

If those estimates are used as a rough gauge of the burden to society, the illness and disability burden of alcohol may thus constitute half or less of the total burden when social problems are also taken into consideration.

Thus, policies that affect the levels of alcohol-related health and social harm not only are a matter of intervening to save people from the detrimental effects of their own behavior, but also potentially have a broader effect on the health and well-being of families and of associates of drinkers. This issue is especially relevant for women: even though men predominate among high-risk drinkers worldwide (Rehm and others 2004; Room and others 2002), women bear much of the burden of harm from others' drinking, not only in such forms as domestic violence, but also in such forms as diversion of family resources from greater needs.

IMPLEMENTATION OF CONTROL STRATEGIES: LESSONS OF EXPERIENCE

The following paragraphs provide a few concrete examples of interventions or policy changes that illustrate the actual implementation and effects of control strategies in developing societies (the examples are taken from Room and others 2002).

Tax Rate Reduction and the Resulting Disease Burden in Mauritius

Mauritius, an island nation in the Indian Ocean, has a population of about 1 million. These people are of Indian, African, European, and Chinese origin. By religious affiliation, 53 percent are Hindu, 29 percent are Christian, and 17 percent are Muslim. Tourism is the third-ranked industry in terms of hard currency earnings. In June 1994, the government drastically lowered customs duties on imported alcoholic beverages to 80 percent from rates that had ranged from 200 percent for wine to 600 percent for whisky and other spirits (Abdool 1998). The government made the change under pressure from the hotel industry, which claimed that tourists were not purchasing enough alcohol because of its high prices (Lee 2001). Other reasons given for the change were to reduce unofficial imports from abroad and to make better, more refined alcoholic beverages available to the local population. Despite little evidence to support the view, there were claims in the public discussion that better-quality alcohol would result in fewer health problems.

The effects of the change were felt mainly by Mauritians rather than tourists, as follows:

- Arrests for driving with blood alcohol over the legal limit made primarily in connection with traffic crashes increased by 23 percent between 1993 and 1997.
- Admissions of alcoholism cases to the island's psychiatric hospital shot up in 1994. The 1995 rate was more than twice the 1993 rate, and the rate rose again slightly in 1996 and 1997. Medical specialists in Mauritius agree that patients with alcohol problems account for an increasing portion of admissions in general medical wards and now represent between 40 and 50 percent of bed occupancy (Abdool 1998).
- Age-adjusted death rates per 100,000 population for chronic liver disease and cirrhosis rose from 32.8 for males and 4.0 for females in 1993 to 42.7 for males and 5.3 for females in 1996 (WHO 1999, 2000).

Even though available statistics are limited, the reduction in alcohol import taxes clearly had a substantial negative effect on the health of Mauritians. Thus, the government's 1997 call for control measures for alcohol—specifically, new permits for licensed premises, increased excise duties on alcohol, and limitations on bars' opening hours—was not surprising. Alcohol taxes were increased somewhat in the 1999/2000 budget (U.S. Department of State 1999). However, an analysis by World Bank staff that did not take health effects into account called for further reductions in maximum tariff rates, identifying Mauritius as having an antitrade bias on the basis of the structure of its alcohol and tobacco taxes (Hinkle and Herrou-Aragon 2001).

Wallace and Bird (2003) suggest the following general principles for setting and collecting alcohol taxes in the context of developing societies from the perspective of revenue generation rather than public health (see also Tax Policy Chief Directorate 2002):

- Countries around the world need revenues they can raise relatively efficiently, but this need is probably more critical in the case of developing nations. That said, alcohol taxes are probably a good bet for future revenues.
- Excise taxes on alcohol should be set by alcohol content, rather than as a percentage of the price.
- Tax rates should be logically defined so that alcoholic beverages with similar alcohol content are treated similarly, with stronger alcohol beverages taxed more heavily.
- Analyses of revenue-maximizing rates should be conducted to determine a range of tax rates that is likely to maximize government revenues.
- Tax systems should be designed to be as simple as possible to allow for the maximum efficiency of tax administration.

Reduced Access through Locational Prohibition in Brazil

The second example involves the institution of a new control on alcohol availability in an environment where it is likely to be combined with driving. Although we have modeled the effects of another, better studied availability control (namely, closing on a weekend day), a wide variety of possible

measures is available to control the time and place of alcohol purchase or drinking (Babor and others 2003; Room and others 2002). Even though in this case the particular control was extremely limited in scope, it appears to have had measurable effects.

Traffic deaths are an important source of mortality in Brazil, amounting to 3.6 percent of overall mortality. The few available studies suggest that alcohol plays a significant role in traffic casualties. For instance, one study in São Paulo found positive blood alcohol levels in 72 percent of pedestrian deaths and 32 percent of driver and passenger deaths of persons age 13 and older (Carlini-Cotrim and Chasin 2000).

In 1985, motivated by concern about alcohol and impaired driving and about the lax enforcement of drinking and driving laws, a conservative party politician from the state of São Paulo introduced legislation to prohibit alcohol sales in commercial facilities that had access to state highways. Even though the bill passed in the legislature, its implementation was delayed by the state's alcohol producers and commercial and industrial federations, which claimed that the law would be a barrier to improved facilities for travelers, would encourage people to carry bottles in their cars, and would restrict individual freedoms. Discussion in the press was also generally unsympathetic. In August 1988, however, a new state governor from the same party implemented the law. At that time, the press was slightly more supportive. Since then, the law has been on the books, although site visits to restaurants and snack bars along a state highway in 1997 suggested a low level of compliance. In 1995, another legislator from the same party proposed repealing the law on the grounds that no studies proved that it lowered traffic accidents. The repeal passed the legislature without significant public debate, but the state governor vetoed it. Undaunted, the same legislator then proposed a law to criminalize buying as well as selling alcohol along state highways. That law passed but has not yet been implemented.

A study by Carlini-Cotrim, Pinsky, and Serrano Barbosa (1998) assesses the effects of the intervention. Finding data for a controlled study comparing traffic casualties on state highways with casualties on federal highways, which were unaffected by the law, proved impossible. The best data available were on crashes and crashes resulting in injuries per 10,000 vehicles traveling on three short highway systems administered by a private agency. Linear regressions on those data for 1983–93 showed that the law had made a significant difference in the number of accidents resulting in injuries on all three roads and a significant difference in all accidents on two of the roads. A separate analysis on estimated accidents and accidents with injuries per 10,000 vehicles in two geographic areas of the state did not show significant effects of the law. Overall, the analyses do provide some support for the law having a beneficial effect on the rate of traffic casualties.

Drunk-Driving Enforcement in South Africa

No published studies are available of the implementation of random breath testing in a developing country. However, some data are available on a campaign to increase drunk-driving enforcement in South Africa, a strategy that has often shown some effects, although weaker and less lasting than those of random breath testing.

The minister of finance launched a short-term campaign, ARRIVE ALIVE, for the period October 1997 to January 1998, in response to the high rate of traffic fatalities and injuries. The campaign's main aim was to mobilize all available traffic policing, control, and education resources to reduce traffic accidents on South African roads by at least 5 percent, especially in the Western Cape, Gauteng, and KwaZulu Natal provinces, because 75 percent of all accidents occurred in those provinces. The ARRIVE ALIVE campaign targeted, in turn, what were considered the three critical factors having the greatest impact on injuries: failing to wear seat belts, drinking and driving, and speeding. Unofficially, the campaign came to be called "belts, booze, and bats out of hell."

As many of the parties interested in road safety as possible were involved, with funding drawn from a variety of government and business sources. The campaign included a number of components particularly relevant to alcohol use. New equipment purchased by the provinces included alcohol screening devices, alcohol evidentiary units, and so-called booze buses (vehicles containing all the technology needed to check breath and blood alcohol levels). Sentences were increased to underline the point that traffic violations are serious offenses, with a three-month suspension of a driver's license and an increased maximum fine for a first conviction for drunk driving and with license suspension for one to five years for second offenders. Traffic supervisors underwent intensive training courses before the start of the campaign.

Because the aim of the campaign included educating road users, advertisements covering aspects of the campaign were run on the radio, on television, and in movie theaters throughout the country. Supplements were published in national and provincial newspapers. Private companies, such as a supermarket chain and an automobile manufacturer, also promoted the campaign. A national transportation center, established to collect and collate data from local and provincial authorities, operated for 12 hours every day throughout the campaign. Traffic authorities staffed an additional 80 roadside communications points, and at selected points on certain routes, road signs were erected and updated to display the percentage of speed limit and drinking-and-driving violations and the rate of seat belt use in that area.

A total of 776 enforcement points were set up on 195 strategic routes in the selected provinces. Posters, pamphlets, key rings, and license decals were produced for distribution and

display at roadblocks in the three provinces. Between October 1, 1997, and January 17, 1998, 6,674 notices of prosecution were issued for alcohol-related traffic offenses, 83 percent of which were issued in the intervention provinces.

Comparison studies showed a decrease in the drinking rate of drivers in the three provinces, whereas the other six provinces, as a group, showed an increase. KwaZulu Natal had the lowest drinking rate of all drivers throughout the campaign (3 to 7 percent), and the Western Cape had the most dramatic decrease (from 12.0 to 9.3 percent in October). Except for in Gauteng, the drinking rates for pedestrians decreased from more than 15 percent to less than 7 percent. Overall, during the months targeted, drinking-and-driving rates decreased by 2 to 4 percent, as measured by breath testing. The total number of crashes decreased by 8 percent, and fatalities dropped by 9 percent. The ratio of benefits to costs for the intervention was estimated as 4 to 1, based on an investment in the campaign of R50 million, or about US$4.4 million at 2002 rates (ARRIVE ALIVE Campaign 2000).

Despite the potential inconvenience of roadblocks and other enforcement activities, the public generally perceived the campaign positively. The liquor retail and hospitality industries complained about decreased sales, and tow truck operators complained about reduced business.

Even though driver behavior improved during the focus months, violations often increased after the focus was changed, for example, from drunk driving to seat belt use. This finding emphasizes the need for sustained enforcement as opposed to ad hoc campaigns. (This example was summarized from ARRIVE ALIVE Campaign 2000 and Cerff and Plüddemann 1998.)

Implementation of Brief Interventions in Several Developing Countries

In the first phase of the WHO Collaborative Project on Identification and Management of Alcohol Related Problems (Saunders and Aasland 1987), a screening measure suitable for use in both developing and developed countries—the alcohol-use disorders identification test—was developed to identify people at risk for alcohol problems among those attending primary health care services. In the second phase, a multicenter clinical trial of brief intervention procedures designed to reduce the health risks associated with hazardous alcohol use was carried out in primary health care settings in Australia, Bulgaria, Costa Rica, Kenya, Mexico, Norway, the Soviet Union, the United Kingdom, the United States, and Zimbabwe (Babor and others 1994).

The project's aims were to study the influence of simple advice and brief counseling, to examine the moderating role of reduced consumption on the prevention of alcohol-related problems, and to evaluate the cross-national generalizability of brief intervention techniques. The project's hypothesis was that the amount of change in alcohol consumption over a nine-month period would be proportional to the intensity of the intervention provided by a trained primary health care professional. The results showed a significant effect of interventions on both consumption and intensity of drinking among males, but the intensity of the intervention was not related to the amount of change in drinking behavior; 5 minutes of simple advice turned out to be as effective as 20 minutes of brief counseling (Babor and Grant 1992). The female sample was too small for the results to attain significance, and the intervention did not significantly affect men's frequency of dependence symptoms, problems related to alcohol, or concern expressed by others (WHO Brief Intervention Study Group 1996).

The findings suggest that in a population of high-risk drinkers, behavior change is more a function of motivational factors and social influence than of the moderation skills and social learning techniques that behavioral self-control training packages typically use. Changes in drinking were not attributable solely to the small number of patients who achieved an abstinence goal, nor to the small number who gave up daily or almost daily drinking. Rather, changes seem to have been distributed across a broad spectrum of the drinkers who reduced their consumption by small, but clinically meaningful, amounts.

RESEARCH AND DEVELOPMENT AGENDA

Research and development needs in the area of alcohol consumption are large and multidimensional. The work reported in this chapter represents best estimates from the available data, some of which were developed to fill the needs of the analysis; however, we cite few figures for the developing world for which we can say that the underlying data are so good that they could not usefully be improved. Nevertheless, more and better data are available on alcohol than on many other health topics.

The health and social burdens of alcohol are clearly extremely large in most developing societies. Thus, the most urgent focus should be on development and evaluation projects to study the outcomes of various policy and program interventions. The projects must necessarily be attuned to what is politically feasible in a particular time and place. They are likely to include natural experiment studies, where the research tracks the effects of changes that governments undertake, whether those changes are expected to increase or to decrease the extent of alcohol problems. Where possible, the projects should include experimental and quasi-experimental studies, whereby the effects of a change at intervention sites are studied in comparison to outcomes at control sites, with random

assignment where possible. Costing data should be included to permit cost-effectiveness analysis.

Also important are process studies—that is, research on how policy makers decide on policy changes, how they implement them, and what the reactions and sequelae are. For example, deciding to introduce a new alcohol tax may be the easiest part of an initiative, but actually implementing it in a developing society with a great deal of unrecorded alcohol in the informal market and with poorly guarded borders may be much more difficult. Currently, no international mechanism or nexus exists for developing and disseminating practical knowledge about implementing effective alcohol control strategies between developing countries.

At this time, nearly all studies of alcohol interventions come from a limited range of developed countries. Extending knowledge and experience in and between developing societies is urgently needed.

A secondary need, but one that is also important, is to extend the epidemiological database in developing societies on levels and patterns of drinking and on the health and social consequences of drinking. To this end, better estimation of unrecorded alcohol consumption is needed. Which dimensions of drinking patterns matter for what kinds of outcomes needs to be studied in the context of different kinds of developing societies. Studies of the effects that the interaction of drinking levels and patterns with poverty and social exclusion have on the extent of alcohol-related problems are also necessary. Because most of our knowledge about the health effects of drinking concerns mortality, studies of alcohol's role in various kinds of morbidity should be emphasized. Another area where data are lacking is the social harm arising from drinking, for which we cannot presently make the kinds of estimates that are possible to make for harm to health. Developing and reaching consensus on ways to measure the social harm caused by drinking is a substantial agenda for both the developed and the developing world.

Developing the epidemiological database can provide clues to etiology to be pursued further by biomedical and social researchers and, thus, offers hope for the development of new treatments or preventive interventions. It can provide information on the distribution of drinking patterns and problems in subpopulations that can be used to guide targeting and prevention and treatment priorities. However, from a short-term policy perspective, the most important function of developing the epidemiological database in a particular country may be providing a base for creating political will for action. For example, the development of devices to measure blood and breath alcohol and the collection of data on drinking and driving that they made possible were prerequisites for developing the political will and support for implementing drinking-and-driving countermeasures in industrial countries.

CONCLUSION

The burden of disease attributable to alcohol in the developing world is considerable, and the social harm not accounted for in this analysis increases the costs. However, known interventions can reduce the burden by up to 25 percent, depending on the region of the world. Compared with other interventions in the health care field, these interventions are quite cost-effective, but given the nature of many of the interventions, caution is needed. In particular, the following recommendations can be given:

- Interventions and research about their effectiveness are based mostly on experiences from established market economies; thus, the levels of effectiveness estimated in our analysis should be treated as broad indications. Depending on actual methods of implementation, individual interventions could be more or less effective.
- Interventions should ideally be modeled on the basis of the specific environment (that is, countries or provinces) and on the harm distribution in the respective environment, including social harm.
- General principles, such as restricting access to alcohol, should be attuned to local cultures and traditions when interventions are formulated.
- Population measures must take into account the complex interplay of public opinion and balance the interests of different groups and stakeholders with conflicting values. One of these stakeholders is, of course, the alcohol industry.

If policy makers keep these principles in mind, reducing the alcohol-related health burden could be one of the most cost-effective targets of population-level health programs in developing countries. This target is even more attractive because the measures discussed will also reduce the alcohol-related social burden, thereby further contributing to development.

NOTES

1. The global burden of disease attributable to alcohol is 4.0 percent using age-weighted DALYs and 3.6 percent using non-age-weighted DALYs. This difference can be explained by the many alcohol-attributable outcomes occurring during adolescence and young adulthood, when age weights are higher.

2. The CRA defined *per capita consumption* as average consumption of pure alcohol per person 15 years old or older.

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