Alcohol Use In Minnesota: Extent and Cost

A report on alcohol consumption, health consequences, and the economic cost of alcohol-related problems in Minnesota

Minnesota Department of Health

October 1995

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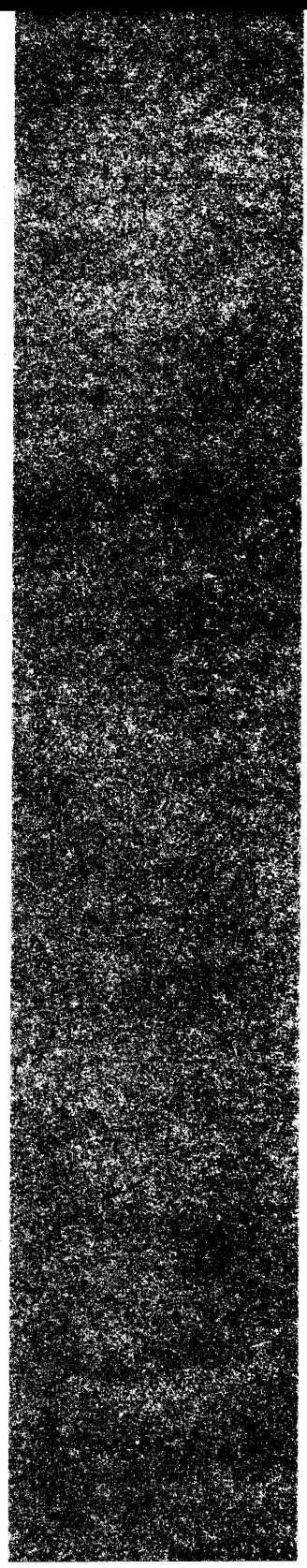

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Executive Summary

Alcohol is the most widely used drug in Minnesota and is centrally related to a number of persistent threats to public health, including: unintentional injuries such as burns, falls, drownings, and motor vehicle crashes; violent acts such as homicide, suicide, and personal assault; chronic diseases such as cancer, digestive disease, and cardiovascular disease; unintended pregnancies and sexually transmitted diseases; and alcohol-related birth defects. The purpose of this report is to examine patterns of alcohol use in Minnesota, describe the scope and epidemiology of alcohol-related problems, and estimate the statewide economic cost associated with alcohol use.

In 1991, approximately 1,581 deaths in Minnesota were alcohol-related. These deaths translate to over 34,000 years of potential life lost. Forty-five percent of alcohol-related deaths were from chronic medical conditions. Four in ten alcohol-related deaths (41%) were due to injury or acts of violence. Overall, young people accounted for a disproportionate share of alcohol-related deaths. Whereas children, adolescents and young adults accounted for only 5% of deaths from all causes, these Minnesotans (younger than 34) accounted for 17% of all alcohol-related fatalities.

In 1991, the economic cost of alcohol use in Minnesota totaled $1.74 billion, or nearly $400 for every resident of the state. This figure includes: (1) direct health care costs; (2) indirect mortality costs; (3) indirect morbidity costs; (4) fetal alcohol syndrome costs; and (5) non-health sector costs. The potential cost of alcohol use is further magnified when considering emotional and social costs to individuals, families, and communities.

Alcohol-Related Disease Impact (ARDI) software was used to generate estimates of alcohol-related mortality and subsequent cost. The software program incorporates Minnesota-specific population and mortality data, Minnesota economic cost data, and national cost data proportionately applied to Minnesota. To supplement the ARDI estimates, additional state data not used in the software package are incorporated into the report. The figures reported here are best estimates based on the most advanced and widely accepted definitions and methods used in alcohol epidemiology and cost-of-illness research.

Report findings illustrate that alcohol affects the economy; the use and distribution of public health, health care, public safety, criminal justice, and social service resources; and the health of individuals, families, and communities. This report is written for program planners and policy makers in Minnesota to advance alcohol-related disease prevention and health promotion efforts statewide.

Chapter 1

Summary points

- The purposes of this chapter are to (1) identify environmental factors related to alcohol use, (2) review federal guidelines regarding abstinence and moderate use, (3) illustrate the potential for population-based approaches to prevention, (4) explain terminology used in this report, (5) review and outline patterns of use in Minnesota.

- Alcohol is the most widely used drug in Minnesota, and is centrally related to a number of persistent threats to public health.

- Prevention efforts are challenged by the complex relationship between social norms, public policy, and patterns of alcohol use.

- Community health promotion is a comprehensive, systematic process that seeks to influence community norms and policies, thereby affecting long-term health behavior change. Social action is central to community health promotion.

- Although some studies have suggested that moderate alcohol use may reduce risk for some forms of cardiovascular disease, few public health researchers and practitioners have translated these findings into population-wide advocacy of alcohol use.

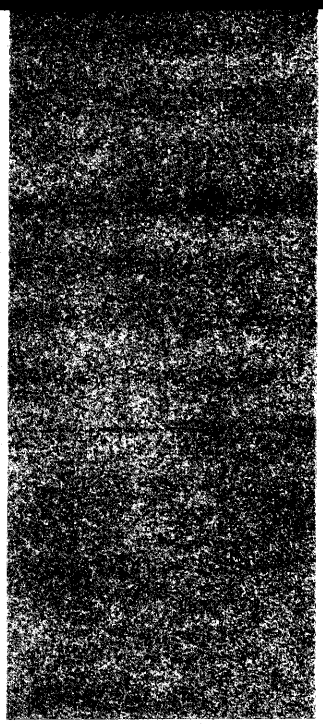
- Individual risk for alcohol-related problems increases markedly at higher levels of use. Yet alcohol-related problems are not limited to the relatively small group of heavy drinkers in any community. The majority of those who experience alcohol-related problems are not addicted to alcohol.

- Per capita alcohol use in Minnesota consistently exceeds use nationwide. In 1991, the average drinker in Minnesota consumed approximately 83 glasses of wine, 288 shots of liquor, and 453 beers—the equivalent of more than 2 drinks per day. To achieve the national public health goal for 2000, per capita use in Minnesota will have to decline by 16% during the 1990s.

- Approximately one-third of high school seniors in Minnesota drink to intoxication at least monthly, or have five or more drinks on a typical occasion.

Chapter 1

Alcohol Use in Minnesota



Why a report on alcohol use in Minnesota?

Along with tobacco, diet, and activity patterns, alcohol is among the most prominent contributors to mortality in the United States (McGinnis & Foege, 1993). In Minnesota, premature alcohol-related deaths in 1991 *alone* led to more than 34,000 years of potential life lost, and the total economic costs of alcohol use amounted to more than $1.7 billion. The potential cost of alcohol use is magnified still further when considering emotional and social costs to individuals, families, and communities.

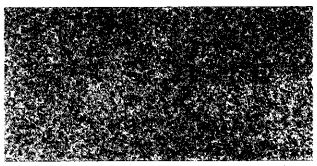
Alcohol is the most widely used drug[1] in Minnesota, and is centrally related to a number of persistent threats to public health, including traumatic injury, violence, chronic disease (cancer, digestive disease), sexually transmitted disease, and unintended pregnancy (USDHHS, 1993b).

Minnesota public health goals specifically address alcohol use patterns and problems (MDH, 1995a). To achieve these public health goals and objectives, community-based health promotion is an important public health strategy.

Community health promotion is a comprehensive, systematic process that seeks to influence community norms and policies, thereby affecting long-term health behavior change. Social action is central to community health promotion (MDH, 1995).

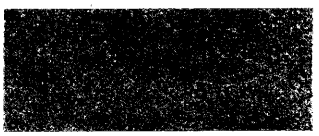
The activities that government public health agencies undertake to fulfill their responsibilities are often referred to as the core public health functions of assessment, policy development and planning, and assurance. Through each of these core public health functions, the public health system plays an important role in the prevention of alcohol-related problems (MDH, 1995b).

More specifically, *chemical heath promotion* is a community-wide process of achieving chemical[2] health goals by bringing together all factions of a community to encourage, develop and maintain conditions and personal attributes that promote chemical health and that reduce negative consequences from the use of alcohol and other chemicals.



This report aims to advance efforts in Minnesota to create and sustain community environments that promote and reinforce healthy choices.

This report aims to advance chemical health promotion in Minnesota by (1) assessing the context and scope of alcohol use in Minnesota, as well as the extent of alcohol-related economic costs, (2) informing policy development and program planning, and (3) promoting community-based activities designed to create and sustain environments that support and reinforce healthy choices around alcohol use.



The purposes of this chapter are to (1) identify environmental factors related to alcohol use, (2) review federal guidelines regarding abstinence and moderate consumption, (3) illustrate the potential for population-based approaches to prevention, (4) explain terminology used in this report, and (5) review and outline patterns of alcohol use in Minnesota.[3]

The environmental context of alcohol use

Daily personal decisions, ranging from food choices and exercise habits to safety-belt use and alcohol consumption, relate directly to individual health and fitness. Research in public health and the behavioral sciences suggests that health decisions are shaped in part by the social environment—the norms, values, and patterns of behavior prevailing in families and communities (Glanz, Lewis & Rimer, 1990; Green & Kreuter, 1991). Patterns of alcohol consumption are influenced by the social environment in many ways:

- Perceived social disapproval is an important element in reducing rates of drinking and driving (Cleary, Shapiro, & Williams, 1992).
- Children raised by a parent or parents who abuse alcohol are more likely to abuse alcohol as adolescents (Kumpfer, 1989). Adolescent drinkers are far more likely than their non-drinking peers to be involved in many other high risk behaviors such as early sexual activity, physical violence, attempted suicide, and illicit drug use (Fe Caces, Stinson & Harford, 1991; Leigh & Morrison, 1991; Minnesota Department of Education [MDE], 1992a; Silverman, 1989).
- Women in Minnesota are more likely to report drinking alcohol during pregnancy if they (a) know several people who drank during their own pregnancies, or (b) have friends and family who are largely unconcerned about drinking during pregnancy (Mueller, 1994).

Nonetheless, the social environment is only one influential element in the broader economic and political environment. Countless school, workplace, and public policies encourage or discourage healthy behaviors, either directly or indirectly. Smoke-free environments discourage smoking, drug testing discourages chemical use, and availability of safe parks and trails encourages outdoor recreation.

Empirical public health research has shown a relationship between the rate of alcohol-related problems and certain alcohol control policies (Edwards et al., 1994). Ashley and Rankin (1988), Moskowitz (1989), and Toomey et al. (1994) review studies which consistently link price increases with reduced rates of alcohol use and some alcohol-related problems (e.g., liver cirrhosis mortality, motor vehicle crashes, and violence), particularly among young people. The nationwide increase in the minimum legal drinking age from 18 to 21 years substantially reduced rates of alcohol use and motor vehicle mortality among young adults (United States Department of Health and Human Services [USDHHS], 1993a; Wagenaar, 1993).

Prevention efforts are challenged by the complex relationship between social norms, public policy, and patterns of alcohol use. Community-based health promotion is an important and promising strategy for meeting this challenge (MDH, 1991b).

Alcohol use guidelines and definitions

In Minnesota, as in the rest of the United States, alcohol is both a popular beverage,[4] and the most frequently consumed drug. The federal government has attempted to influence drinking behavior by passing alcohol control legislation and publishing guidelines for alcohol consumption.[5] The United States Dietary Guidelines identify five groups of people who should not drink any alcohol, even in moderation:

- women who are pregnant or trying to conceive,
- people who plan to drive or engage in other activities that require attention or skill,
- people taking prescription or over-the-counter medication,
- recovering alcoholics, and
- people under age 21

(United States Department of Agriculture [USDA] & USDHHS, 1990). In addition, abstinence is suggested for people with certain medical conditions, such as a peptic ulcer (USDHHS, 1992).

Consumed moderately,[6] alcohol may provide some individual protection from cardiovascular disease (Bofetta & Garfinkel, 1990; De Labry, Glynn, Levenson, Hermos, LoCastro, & Vokonas, 1992; Stampfer, Colditz, Willet, Speizer, & Hennelkens, 1988).

Based on this research, some have suggested that alcohol use may be part of a beneficial lifestyle for some people (Friedman & Klatsky, 1993). However, few public health researchers and practitioners have translated these research findings into population-wide advocacy of alcohol use (Blackburn, Wagenaar & Jacobs, 1991; Lands & Zakhari, 1990; Pearson & Terry, 1994; Shaper, 1993; Stampfer, Rimm & Walsh, 1993). Public health professionals are reluctant to promote alcohol use for a number of reasons, including:

- The modest cardioprotective benefit of 1 or 2 drinks per day is not large enough to recommend that non-drinkers begin drinking alcohol, or that lighter drinkers increase their consumption (Bradley et al., 1993).
- The cardioprotective effect of alcohol use can only be interpreted within the context of *all* risk factors for cardiovascular disease (Stampfer et al., 1993).[7]
- The cardioprotective benefit of alcohol use on a population level is offset by increases in other causes of death (Criqui & Ringel, 1994).
- The same level of alcohol use associated with decreased risk for some forms of cardiovascular disease is also associated with increased risk for motor vehicle crashes, traumatic injury, and birth defects (USDHHS, 1992).
- The extent of alcohol dependency and suggested genetic predisposition to alcoholism preclude encouraging alcohol use to promote public health (Criqui & Ringel, 1994).

Promoting chemical health: The promise of population-based strategies

Individual risk for alcohol-related problems increases markedly at higher levels of alcohol use (Williams, Dufour, DeBakey et al., 1993).[8] Yet alcohol-related problems are not limited to the relatively small group of heavy drinkers in any community. To the contrary, the majority of those who experience alcohol-related problems are not addicted to alcohol (USDHHS, 1993b, Kreitman, 1986, Moore & Gerstein, 1981).

The majority of those who experience alcohol-related problems are light or moderate drinkers who as individuals are at far less risk than heavy drinkers, but who collectively form a much greater proportion of the population.

The National Research Council, Institute of Medicine (1981) convened an expert panel to estimate the proportion of alcohol-related problems that lies beyond the relatively small fraction of drinkers who are alcoholic, or alcohol-dependent. The panel concluded:

> While chronic drinkers with high consumption both cause and suffer far more than their numerical share of the adverse consequences of drinking, their share of alcohol problems is still only a fraction—typically less than half—of the total. Alcohol problems occur throughout the drinking population. They occur at lower rates but at much greater numbers as one moves from the heaviest drinkers to more moderate drinkers (p. 45).

Public health theory and practice[9] suggest that a modest shift in drinking norms across the general population of drinkers would contribute to substantial declines in rates of alcohol-related problems (Edwards et al., 1994; Kreitman, 1986; MDH, 1995a; Moore & Gerstein, 1981). As a consequence, research at the National Institute on Alcohol Abuse and Alcoholism (NIAAA) is focused increasingly on strategies aimed at the entire population of drinkers (Gordis, 1995).

By design, population-based strategies reach people before they are symptomatic, at a time when changing behaviors can prevent problems. Community-based chemical health promotion seeks to mobilize all factions of a community to encourage, develop, and maintain social and environmental conditions and personal attributes that reduce or eliminate negative consequences from the use of alcohol and other chemicals. Community-based strategies targeting the general population complement interventions targeting "high risk" groups, because clear and consistent norms and policies support "high risk" individuals to initiate and maintain behavioral changes (Bradley et al, 1993; MDH, 1995b).

Comprehensive efforts to prevent alcohol problems and promote chemical health will balance population-based strategies with high-risk strategies. In this way, population-based primary prevention strategies (e.g., to restrict alcohol use in public parks, or to more consistently enforce minimum age of sale laws), will reinforce secondary and tertiary prevention efforts designed to identify and provide counseling and treatment services to those at highest risk of alcohol-related problems.

For these reasons, the authors have chosen to employ the term "use" of alcohol in this report. The term "use" implicitly acknowledges that negative consequences (a) may occur in conjunction with many different levels and patterns of alcohol consumption, and (b) are strongly influenced by the social and physical environment, as well as expectations of the drinker (e.g., drinking to get drunk, in the proximity of firearms, on a boat, during work hours, etc.). In contrast, the term "abuse" is typically linked to extreme patterns of consumption (chronic heavy drinking) and/or the past experience of an alcohol-related problem (Williams et al., 1987). This terminology is consistent with growing consensus within the medical community that drinking habits, not just problems, are an important component of primary prevention (Bradley et al, 1993).

Despite the deliberate adoption of the term "use" in this report, readers will periodically encounter the term "abuse" when references are made to other studies. We have retained the language of other authors to be consistent with terminology and definitions adopted in the work cited.

Economic cost of chemical use

Dorothy Rice, a nationally recognized leader in cost-of-illness research, estimates that the cost of alcohol and illicit drug use in 1990 amounted to $165.5 billion.[10] More than half of these costs (60%) stem from alcohol use (Figures 1.1 & 1.2).

Rice's estimate includes the expenses of medical care and chemical dependency treatment, productivity losses caused by premature death and inability to perform usual activities, and costs related to crime, destruction of property, and other losses.

Population-based strategies to strengthen norms and prevent alcohol problems:

- Delay the onset of alcohol use.
- Decrease the frequency of binge, or acute, drinking (drinking five or more drinks on one occasion).
- Sensitize people to the signals of alcohol dependency so that treatment or other services occur as early as possible.
- Encourage and support abstinence as a personal life choice in certain situations, such as before and during pregnancy; while operating machinery, cars and boats; while taking some medications; and when depressed or angry.
- Enforce and develop public policies that support chemical health such as prohibiting alcohol use in public parks, appropriate placement of billboards, checking IDs in bars and including non-alcoholic beverages in happy hours.

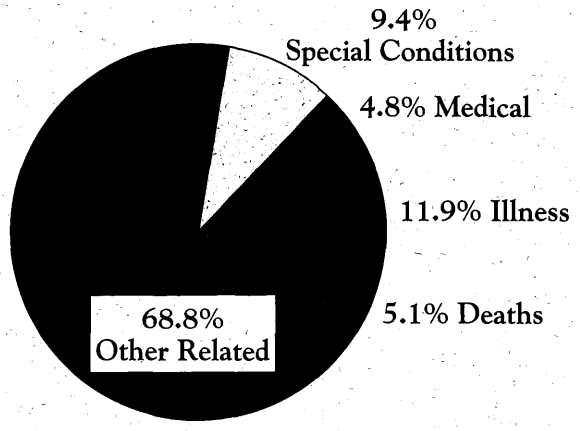
There is no single threshold between safe and unsafe alcohol consumption (Bradley et al., 1993).

The methodology underlying this national estimate is the basis for the estimate of the cost of alcohol use to Minnesota in 1991 ($1.74 billion; see chapter 3).

The authors have chosen to employ the term "use" of alcohol in this report. The term "use" implicitly acknowledges that negative consequences (a) may occur in conjunction with many different levels and patterns of alcohol consumption, and (b) are strongly influenced by the social and physical environment, as well as expectations of the drinker.

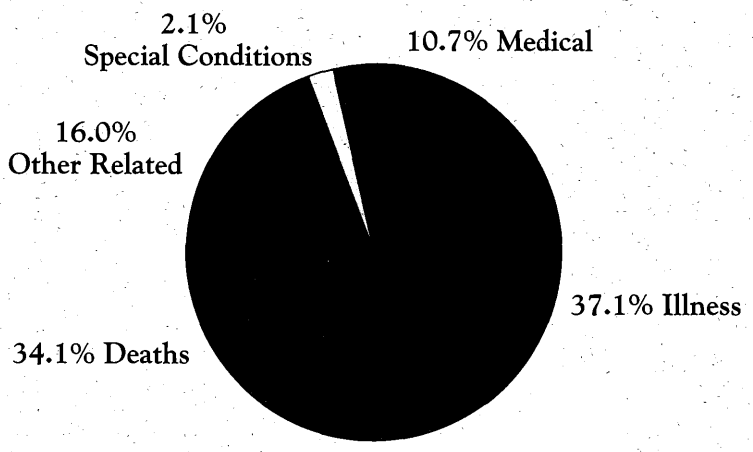
Although specific cost estimates vary across studies because of differences in underlying assumptions and definitions, all show substantial economic costs. This is an enormous burden that affects all of society—people who use chemicals, and those who do not.

Figure 1.1 – Economic cost of illicit drug use, US, 1990



Total Cost $66.9 billion

Figure 1.2 – Economic cost of alcohol use, US, 1990



Total Cost $98.6 billion

Notes:
Medical: Direct expenditures. *Illness:* Present value of lost productivity due to illness or injury. *Deaths:* Present value of future lost productivity due to premature death. *Other Related Costs:* Direct—crime, motor vehicle crashes, etc. Indirect—victims of crime, incarceration, etc. *Special Conditions:* AIDS attributable to drug abuse. Fetal Alcohol Syndrome.

Source: Data for 1990 from Dorothy P. Rice. Institute for Health and Aging, University of California at San Francisco, CA 94143-0612. Cited in Institute for Health Policy (1993).

Each substance impacts users and society differently. The major burden of alcohol relates to productivity losses associated with illness and death, whereas the primary cost of illicit drug use relates to crime.

Rice reports that the core costs of chemical use in the US (costs of medical expenses, illness, and death) fall disproportionately on young people (18-44 year olds). This finding is consistent with the Minnesota-specific findings for alcohol use reported in chapters 2 and 3. The core costs for most other health conditions tend to be concentrated in older age groups.

Adapted from *Substance abuse: The nation's number one health problem, Key indicators for policy*. See Institute for Health Policy (1993).

Alcohol Use in Minnesota

Alcohol use compared to use of other drugs

In a statewide random household survey of adults (Minnesota Department of Human Services [DHS], 1989), many more Minnesotans reported lifetime[11] and current[12] use of alcohol than cigarettes or other drugs.[13] Approximately 6 in 10 Minnesotans drank alcohol in the month preceding the interview; whereas 25% smoked cigarettes, 3% used marijuana or hashish, and less than 1% used cocaine during the same period. Similar patterns of use were found in a comparable nationwide household survey (USDHHS, 1991a).

Alcohol is not only the most widely used drug in the general adult population, but is also the most frequently cited primary substance problem of persons entering chemical dependency treatment in Minnesota.[14] In 1992, alcohol was identified by 76% of clients as the primary substance problem. In contrast, far fewer clients identified cocaine (4%), crack (4%), marijuana (7%), or heroin (1%) as the primary substance problem. This pattern is true for youth and adult clients, as well as metro[15] and greater Minnesota clients (DHS, 1993; Figures 1.3-1.6).

Figure 1.3 – Distribution of primary drug problem cited by persons younger than 21 entering chemical dependency treatment in Minnesota during 1992

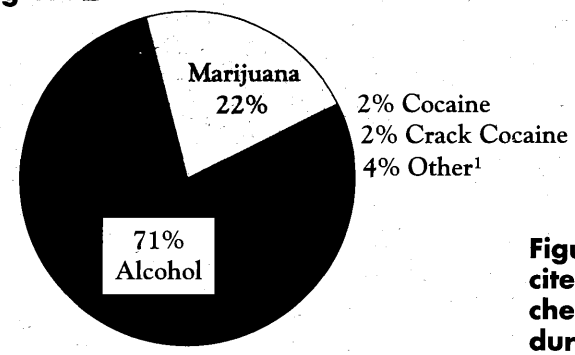


Figure 1.4 – Distribution of primary drug problem cited by persons 21 years or older entering chemical dependency treatment in Minnesota during 1992

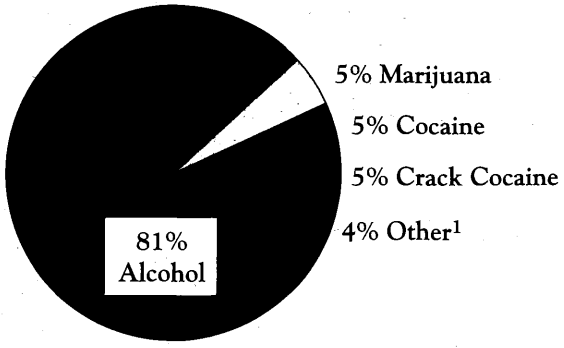


Figure 1.5 – Distribution of primary drug problem cited by persons entering chemical dependency treatment in the 7-county metro area during 1992

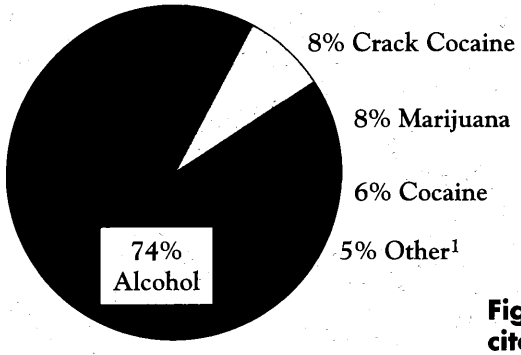
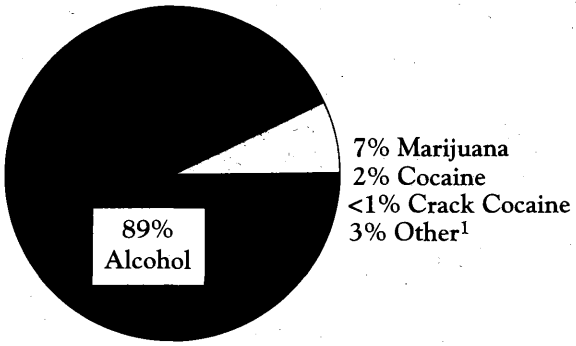


Figure 1.6 – Distribution of primary drug problem cited by persons entering chemical dependency treatment in greater Minnesota during 1992

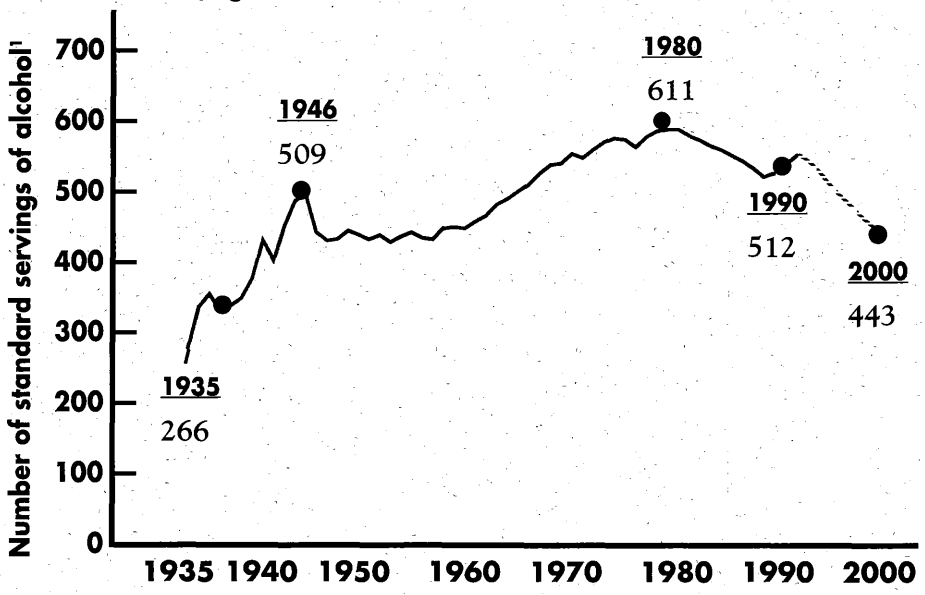


[1] Includes, for example, heroin, other opiates, hallucinogens, amphetamines, barbiturates, and inhalants.

Note: Figures may not total 100% due to rounding.

Source: Minnesota Department of Human Services, 1993.

Figure 1.7 – Estimated annual per capita consumption of alcoholic beverages, US, 1935-1990[2]



[1] A standard serving or "drink" refers to 12 oz. of beer, 5 oz. of wine, or 1.5 oz. of 80-proof distilled spirits.

[2] These data do not measure consumption of alcohol directly, but reflect "apparent consumption." As reported here, apparent per capita consumption is calculated by dividing total purchased alcohol by the total population aged 14 years or older. The term "apparent" is used because these estimates artificially attribute consumption to all persons in the population, regardless of their actual consumption. The proportion of purchased alcohol which is actually consumed is unknown.

Source: NIAAA Surveillance Report #27, Williams, Clem, and Dufour, 1993.

Table 1.1 – Alcohol consumption patterns in Minnesota, 1986-1990

YEAR	PERCENTAGE ABSTAINERS[1]	NUMBER OF STANDARD DRINKS[2] PER CAPITA	PER DRINKER[3]
1991	37%	525	824
1990	37%	569	901
1989	38%	540	874
1988	35%	554	847
1987	33%	569	846
1986	31%	566	821

[1] People are considered "abstainers" if they do not report consuming alcohol in the 30 days immediately prior to a telephone interview. Note that this estimate excludes persons under 18, and may include people who are infrequent drinkers, or heavy drinkers who had not consumed alcohol in the preceding month.

[2] A standard drink refers to 12 oz. of beer, 5 oz. of wine, or 1.5 oz. of 80-proof distilled spirits.

[3] The "drinking population" is generalized from the proportion of randomly selected adult Minnesotans who reported drinking alcohol in the month preceding a telephone interview as part of the MDH Behavioral Risk Factor Surveillance System.

Source: NIAAA Surveillance Report #27, Williams, Clem, and Dufour, 1993.

Estimates of per capita alcohol use

A comprehensive understanding of patterns of alcohol use is essential to sound planning in public health, education, and human services. Alcohol use can be estimated from (1) annual sales and shipping of alcoholic beverages, and (2) population surveys.

For each state, the National Institute on Alcohol Abuse and Alcoholism (NIAAA) collects alcoholic beverage sales and shipments data.[16] The NIAAA reports that per capita alcohol use gradually increased throughout the 1960s and 1970s, peaking in 1981. However, 1991 per capita consumption decreased 16% nationwide[17] (Williams, Clem & Du Four, 1993; Figure 1.7). Apparent consumption in Minnesota for 1980-1991 mirrors the national downward trend.

Declines in alcohol use during the 1980s may reflect the effects of prevention efforts, changes in demographics (e.g., the decreasing proportion of the population aged 15 – 34) or other as yet unknown underlying factors. By the year 2000, public health officials hope to reduce alcohol use to an average of no more than 443 standard servings per person per year (USDHHS, 1991b). To achieve this national goal, per capita use must decline by an additional 13% during the 1990s.

Per capita use in Minnesota consistently exceeds per capita use nationwide. In 1991, per capita alcohol use in Minnesota was approximately 525 standard servings, compared to 512 standard servings nationwide. Per capita alcohol use will have to decline an additional 16% in Minnesota during the 1990s to reach the federal goal.

The proportion of Minnesotans that abstain[18] from alcohol increased 6% from 1986 to 1991. Average annual consumption within the drinking population[19] fluctuated over the same period, but appears comparable to the level of 1986 (Williams et al., 1993; Table 1.1). In 1991, the average drinker in Minnesota consumed approximately 83 glasses of wine, 288 shots of liquor, and 453 beers.[20]

In 1991, the average drinker in Minnesota consumed approximately 83 glasses of wine, 288 shots of liquor, and 453 beers—The equivalent of more than 2 drinks per day.

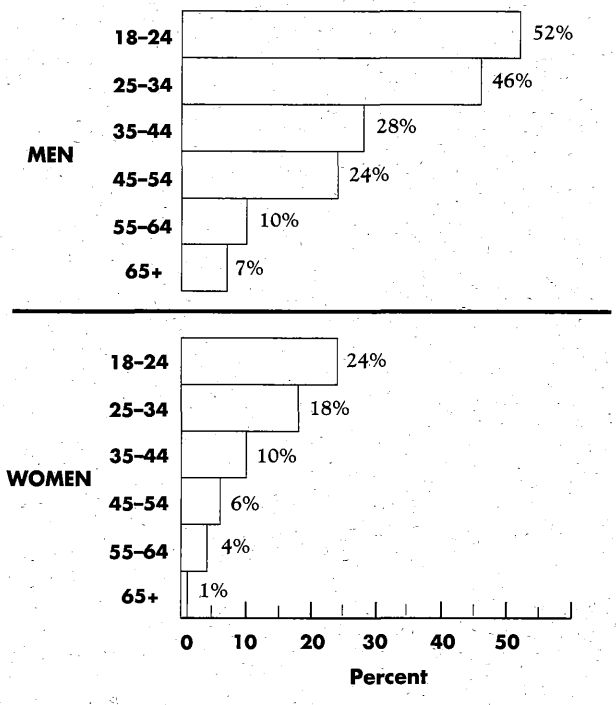
Estimates of binge and heavy drinking

The most common way to estimate group-specific drinking patterns is through population surveys (USDHHS, 1990), such as the Behavioral Risk Factor Surveillance System (BRFSS).[21] This national surveillance system estimates alcohol consumption in terms of self-reported abstinence, binge drinking, and heavy drinking. This section will report findings of the Minnesota BRFSS, and will compare state-specific figures to figures of other participating BRFSS states.

Persons who report consuming 5 or more standard servings of alcohol on at least one occasion in the past month are defined as *binge*, or *acute drinkers*. Those who report consuming an average of 60 or more alcoholic beverages in a month (i.e., an average of 2 or more drinks per day) are defined as *heavy*, or *chronic drinkers*.[22] Binge drinking and heavy drinking have been identified as behaviors which place individuals at greater risk for alcohol-related disease or injury (USDHHS, 1993b).

Binge drinking in Minnesota is more common among younger persons (18-34) and among men (Figure 1.8).

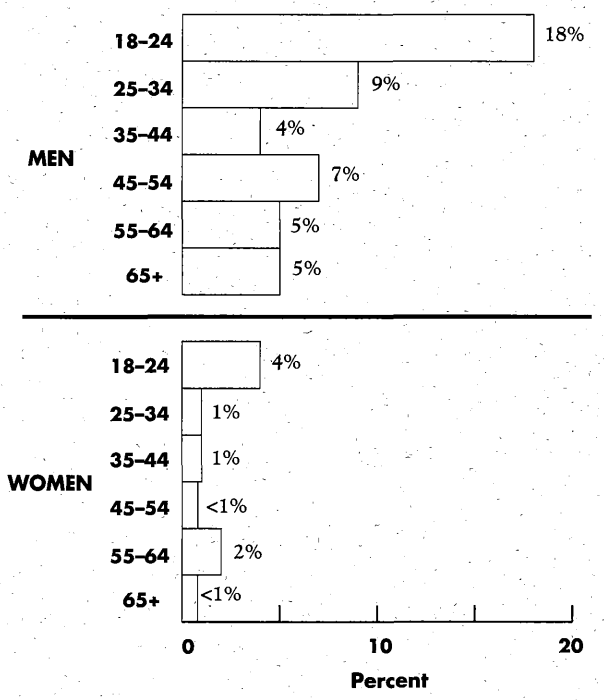
Figure 1.8 – Percent of Minnesota adults who report binge drinking[1], by age and gender, 1992



[1] Consuming 5 or more alcoholic beverages on at least one occasion in the past month; also termed acute drinking.

Source: Minnesota Department of Health, 1994.

Figure 1.9 – Percent of Minnesota adults who report heavy drinking[1], by age and gender, 1992



[1] Consuming on average 60 or more alcoholic beverages in a month; also termed chronic drinking.

Source: Minnesota Department of Health, 1994.

Among Minnesota adults age 18 and older, men are three times more likely than women to report binge drinking. In 1992, the majority of 18-24 year old men (52%) reported binge drinking.

Heavy drinking is also much more common among men than women. Though nearly 8% of men surveyed in Minnesota during 1992 reported heavy drinking, fewer than 2% of women reported a similar level of consumption. Young adult men and women are far more likely to report heavy alcohol consumption. Approximately 1 in 6 young men aged 18 – 24 report consuming an average of 60 or more drinks per month (MDH, 1994; Figure 1.9).

Overall, 37% of Minnesota adults surveyed in 1992 reported abstinence in the previous month. Abstinence increases with age, and is more common among women (43%) than men (29%) (MDH, 1994; Figure 1.10). In Minnesota, the prevalence of binge drinking remains higher, and the rate of abstinence lower, than in most other states (Figure 1.11).

Of the 48 states conducting behavioral risk factor surveillance, women of childbearing age in Minnesota report the fourth highest rate of frequent drinking (Centers for Disease Control and Prevention, 1994). Approximately 18% of Minnesota women aged 18-44 report consuming more than 30 drinks in the previous month, and/or more than 5 drinks at any one time in the previous month. Comparable figures ranged from 21% (Wisconsin) to 4% (Mississippi). Women who continue drinking frequently during pregnancy place their children at greater risk for alcohol-related birth defects than women who drink less frequently, or not at all (See chapter 4).

Drinking patterns are clearly different across age and gender categories. Some drinking patterns also vary according to where people live and work. Adult residents of the 7-county metropolitan area consistently report lower abstinence (32%) than adults living elsewhere in the state (42%). The rates of binge and heavy drinking, however, are not measurably different by area of residence (MDH, 1994). Among men, craft workers and laborers report substantially more binge and heavy drinking than people of other occupations[23] (MDH, 1994; Table 1.2).

Alcohol Use Patterns Among Youth

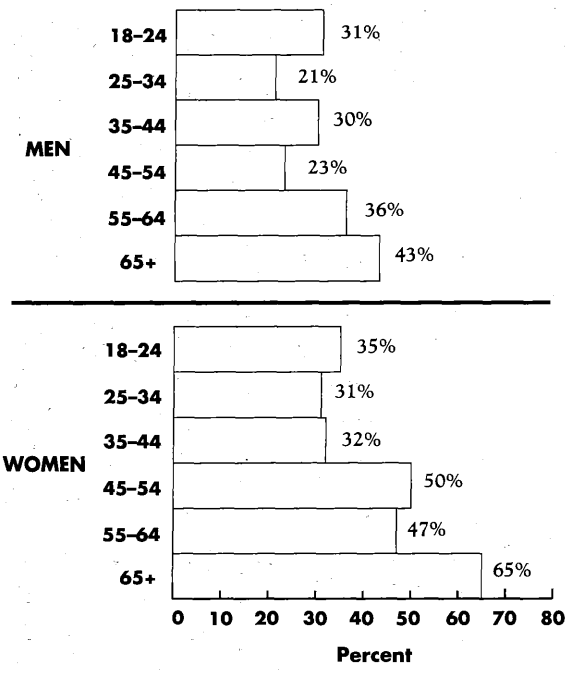
Among youth, promising trends are reported both in this state and nationwide. Throughout the 1980s, current alcohol use among high school seniors fell 15% nationwide, and heavy drinking (five or more drinks in a row on at least one occasion in the two weeks immediately before the survey) fell nearly 10% (Johnston, O'Malley, & Bachman, 1991). Similar trends and patterns are evident in Minnesota, where fewer 9th and 12th grade students in 1992 reported drinking heavily, or drinking to intoxication than students in 1989[24] (MDE, 1992a, 1992b, 1989; Figures 1.12 & 1.13).

However, nearly a third of high school seniors in Minnesota continue to drink to intoxication at least monthly, or have five or more drinks on a typical occasion. These estimates are particularly striking, since alcohol use is illegal until age 21.[25]

Problems related to alcohol use

Self-report surveys address not only *frequency and quantity* of use, but

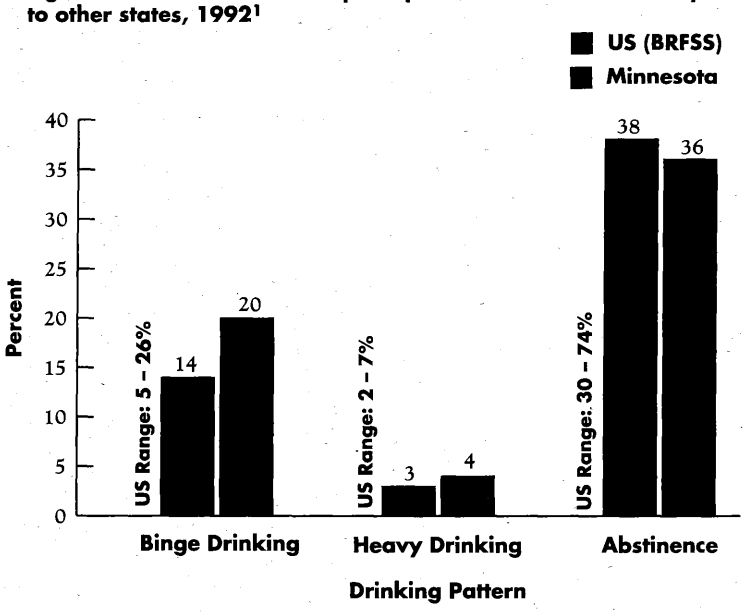
Figure 1.10 – Percent of Minnesota adults who abstain[1] from alcohol, by age and gender, 1992



[1] People are considered abstainers if they report consuming no alcohol in the 30 days prior to a BRFSS telephone interview.

Source: Minnesota Department of Health, 1994.

Figure 1.11 – Alcohol consumption patterns in Minnesota compared to other states, 1992[1]



[1] This figure compares the prevalence of binge drinking, heavy drinking, and abstinence in Minnesota with the median rate for 48 states participating in the Behavioral Risk Factor Surveillance System (BRFSS).

Source: Minnesota Department of Health, 1994.

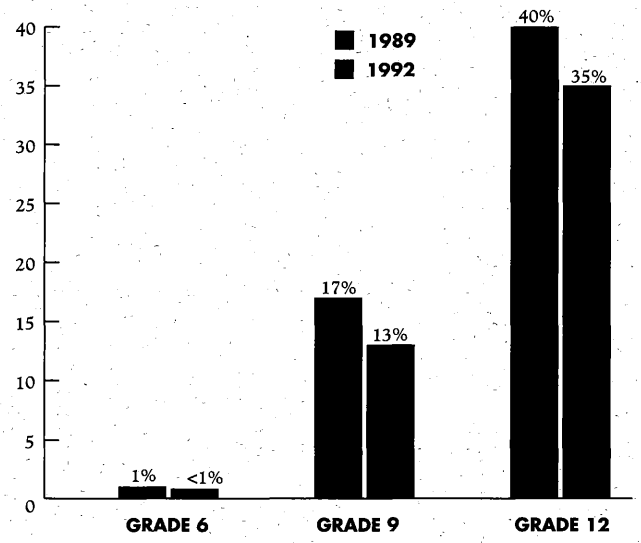
Table 1.2 - Prevalence of binge and heavy drinking, by occupational group, 1992

Occupational Group	Binge Drinking (%)	Heavy Drinking (%)
Managerial/Professional	18	2
Technical/Sales/Clerk	21	4
Service	20	4
Farming	27	2
Crafts	37	9
Laborers	39	9

[1] For more information on the occupational groups, contact the Minnesota Center for Health Statistics, Minnesota Department of Health.

Source: Minnesota Department of Health, 1994.

Figure 1.12 - Percent of Minnesota adolescents who report having *five or more drinks on a typical occasion*, by grade and year



Source: Minnesota Department of Education, 1992a.

also *problems* associated with alcohol use. Thousands of Minnesotans report experiencing alcohol-related health and/or social consequences *each year* (DHS, 1989).

The Alcohol-Related Disease Impact (ARDI) software program (Shultz, Parker & Rice, 1989)[26] estimates that in 1991, 10% of the state adult population experienced one or more symptoms of alcohol dependence[27] and/or experienced at least one of several alcohol-related problems[28] (Figure 1.14).

For the year 1991, ARDI estimates that one in four 18-20 year old men (26%) experienced a symptom of alcohol dependence and/or attributed one or more personally experienced problems to alcohol use. Ironically, 18-20 year old men, for whom alcohol use is illegal, experience more alcohol-related problems and symptoms of dependence than any other single age or gender category (Figure 1.14).

Implications for public health promotion and protection

In Minnesota as in the rest of the US, alcohol is both a popular beverage, and the most frequently used drug. Conventional wisdom around alcohol use and alcohol policy is increasingly challenged by research in economics, epidemiology, and the social sciences:

- Cost-of-illness researchers project that the economic cost of alcohol use exceeds the cost of illicit drugs (Institute for Health Policy, 1993).
- The majority of those who experience many different kinds of alcohol-related problems are moderate drinkers or binge drinkers who are not addicted to

alcohol (Edwards et al., 1994; Kreitman, 1986).

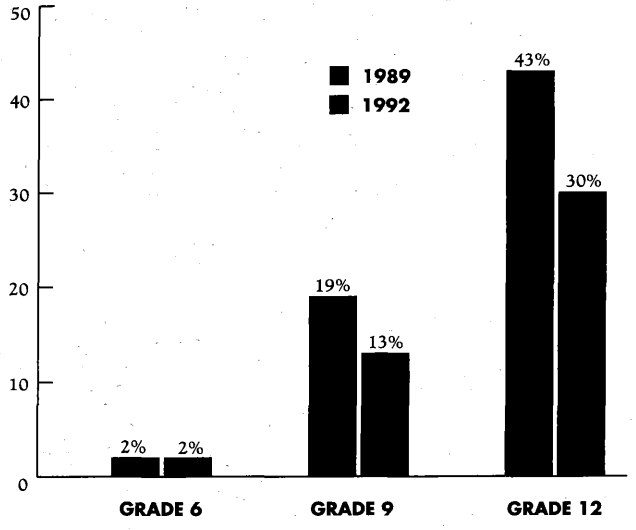
- The costs of alcohol-related problems, many of which cannot be quantified, are borne not only by drinkers, but also by their families[29] and communities[30] (Manning et al., 1991; MDE, 1992b; Wechsler et al., 1994).

Together, this research strongly suggests that public health efforts are needed to influence a shift in drinking norms and public policies. Even modest changes in community-wide drinking norms and drinking patterns could contribute to substantial declines in alcohol-related problems and costs (Edwards et al., 1994; Moore & Gerstein, 1981).

In particular, public health efforts are needed to reduce binge drinking (consuming 5 or more drinks on one occasion in the last month). Binge, or acute, drinking is clearly and consistently associated with numerous health and social problems, and is a far more common pattern of alcohol use than heavy drinking (consuming an average of 2 or more drinks per day). Whereas 4% of Minnesota adults report heavy drinking in the past month, 20% report binge drinking. Furthermore, binge drinking is the norm among young men: The majority of 18-24 year olds (52%) report binge drinking. The rate of binge drinking in Minnesota exceeds the rate in most other states (MDH, 1994).

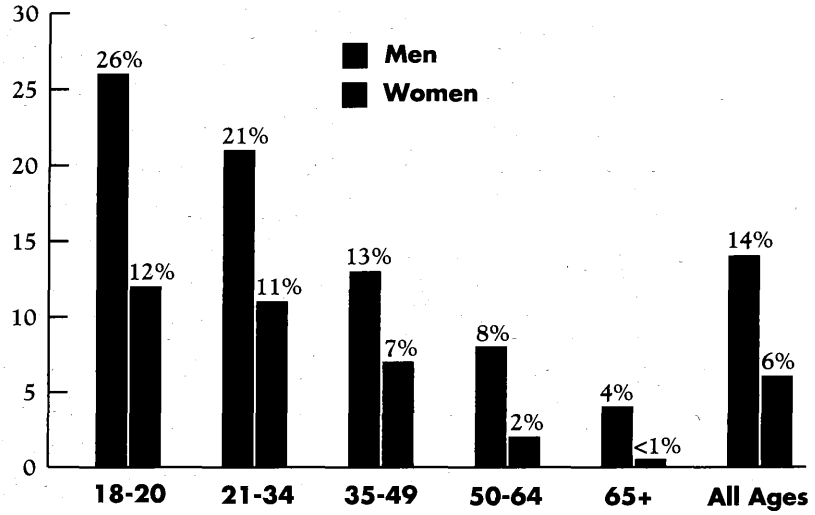
The public health model provides a framework for the promotion and protection of public health. This model identifies three factors which are required for the occurrence of an injury or illness: host, agent, and environment. When applied to prevention of alcohol-related problems, the host is the indi-

Figure 1.13 – Percent of Minnesota adolescents who report *drinking alcohol to intoxication* at least once a month, by grade and year



Source: Minnesota Department of Education, 1992a.

Figure 1.14 – Percent of Minnesota adults who experienced one or more alcohol-related problems,[1] and/or symptoms of dependence,[2] 1991



[1] See Endnote 28 for list of problems.

[2] Symptoms include drinking first thing in the morning, feeling unable to quit drinking, and having hands shake involuntarily in the morning after drinking.

Source: Alcohol-Related Disease Impact Software (Shultz, Parker & Rice, 1989).

vidual drinker; the agent is the alcohol; and the environment refers to anything in the physical or social environment that permits, encourages or promotes harmful interaction between the agent and the host (USDHHS, 1994b).

Prevention of alcohol-related problems is complicated and challenged by varied patterns of alcohol use (host factors), inconsistent and unenforced public policy (agent and host factors), permissive social norms (environmental factors), and the dynamic interaction between these factors. A comprehensive strategy to reduce alcohol-related problems and promote chemical health will target the host (e.g., education in schools, workplaces and other settings), the agent (e.g., product availability, labeling and price), and the environment (e.g., product advertising, media messages,). Primary prevention strategies targeting the agent, host and environment are directed toward healthy populations with the goal of maintaining health and limiting risks.

In contrast, secondary prevention strategies are concerned with early detection and reduction of problems once they have begun. Tertiary prevention strategies are directed at rehabilitation and aftercare. Secondary and tertiary prevention activities are often referred to as crisis intervention, early case-finding, targeted education, peer group intervention, detoxification, recovery and/or treatment (USDHHS, 1994b).

Implementing a mix of primary prevention strategies, in combination with secondary and tertiary prevention strategies, is more likely to achieve public health goals than adopting any approach in isolation (Bradley et al., 1993; Edwards et al., 1994). A broad mix of strategies has been implemented in Minnesota (e.g., see MDH, 1991; Minnesota Department of Public Safety [DPS], 1994; Minnesota Department of Human Services [DHS], 1995). Increasingly, Minnesota efforts seek to reduce the cost of alcohol use not only by preventing the direct experience of alcohol-related problems, but also by building individual and community assets and protective factors (DPS, 1994).

The purpose of this chapter is to provide context for the remaining chapters of the report. Chapter 2 presents data estimating alcohol-related mortality and years of potential life lost in Minnesota during 1991. Chapter 3 presents data estimating the economic cost of alcohol use in Minnesota during 1991. Chapter 4 explores four topics of particular concern: Alcohol-related non-vehicle injuries and violence, alcohol-related driving, alcohol use during pregnancy, and alcohol-related disease. Each chapter concludes with a more extended discussion of public health implications.

Endnotes

[1] This report will limit the definition of "drug" to include the legal chemicals alcohol, tobacco, and inhalants (e.g., gasoline, spray paint, glues), as well as illegal chemicals such as marijuana, cocaine and crack, amphetamines and "ice," LSD, and heroin. By comparison, in the strictest sense, the term drug denotes a much wider array of legal and illegal chemicals, including: caffeine, prescription medications, and preparations available over-the-counter. Refer to *Guidelines for Community-wide Chemical Health Promotion*, prepared by the Minnesota Department of Health (1991b), for a more complete discussion.

[2] The term "chemical" refers to all substances, legal or illegal, that are mood-altering or potentially addictive. Legal chemicals include tobacco, caffeine, alcohol, over the counter medications, and prescription medications. Illegal chemicals include marijuana, cocaine, crack, and heroin.

[3] The figures reported in this chapter are based on several state and national studies. For more information, interested readers are referred to the original sources, cited throughout the text and enumerated in the bibliography.

[4] Ranking only behind soft drinks, milk and coffee, beer is the fourth most popular beverage in the US. Americans consume more beer than bottled water, tea or juice (Jobson Publishing Corporation, 1992).

[5] For example: "Alcoholic beverages supply calories but little or no nutrients. Drinking them has no net health benefit, is linked with many health problems, is the cause of many accidents, and can lead to addiction. Their consumption is not recommended. If adults elect to drink alcoholic beverages, they should consume them in moderate amounts." (USDA & USDHHS, 1990, p. 25).

[6] Moderate alcohol consumption is generally defined as no more than one drink per day for women, and no more than two drinks per day for men (USDA & USDHHS, 1990). However, as Stampfer, Rimm, and Walsch (1993) note, "tolerance to alcohol depends on age, gender, body size, and cultural situation; therefore; no single global definition of 'moderate' can be made" (p. 801).

A "drink" will refer to a standard single serving of alcohol: 12 ounces of beer, 5 ounces of wine, or 1.5 ounces of 80-proof distilled spirits (USDA & USDHHS, 1990).

[7] Cardiovascular diseases (CVD), such as coronary heart disease and stroke, are the leading cause of death in the United States. The leading risk factors for CVD are tobacco use, physical inactivity, high blood pressure, high blood cholesterol, obesity, and diabetes. Primary prevention of CVD includes eliminating tobacco use, increasing physical activity, and promoting healthy food choices. These behaviors are widely recommended not only to reduce risk of CVD, but to enhance overall health (Association of State and Territorial Health Officials, 1994).

[8] Findings from the 1988 National Health Interview Survey (Williams, Dufour, DeBakey et al., 1993) suggest that compared to those who report light or moderate drinking (no more than 2 drinks per day for men, or 1 drink per day for women), a higher percentage of immoderate drinkers (more than 2 drinks per day for men, or 1 drink per day for women) experience each of the following:

- Drinking has hurt chances of a raise or promotion
- Family member has advised cutting down on drinking
- Doctor has advised cutting down on drinking
- Have had to drink more to achieve the same result
- Have had benders or binges that last 2 or more days
- Spouse has threatened to leave because of drinking
- Same amount of alcohol now has less effect
- Have driven after having too much to drink

[9] The Batelle Centers for Public Health Research and Evaluation estimate that nationally, the impact of population-based strategies in the areas of heart disease, stroke, injuries, motor vehicle-related injuries, low birthweight, and gunshot wounds has the potential to avert $69 billion in medical care system spending by the year 2000 (USDHHS, 1994a).

[10] At the time of publication, Rice was preparing an estimate of the economic cost of tobacco based on the same methodology used to calculate the costs reported here for alcohol and illicit drugs. A preliminary estimate amounted to $72.0 billion.

[11] Self-reported use of a drug at any time in one's life.

[12] Self-reported use of a drug in the past 30 days.

[13] The 1989 Minnesota Household Survey, conducted by the Chemical Dependency Program Division of the Minnesota Department of Human Services, was the first statewide survey since 1973 of the incidence and prevalence of alcohol and other drug use among adults in Minnesota. The items included on the personal "face-to-face" interviews mirror those of national household surveys administered by the US Department of Health and Human Services. For more information contact the Chemical Dependency Program, Minnesota Department of Human Services, 612-296-3991.

[14] The Drug and Alcohol Abuse Normative Evaluation System (DAANES) provides a database on statewide drug abuse-related admissions to chemical dependency in-and out-patient treatment programs. For more information, contact the Chemical Dependency Program, Minnesota Department of Human Services, 612-296-3991.

[15] The metro area refers to the seven counties which include and surround the "Twin Cities" of Minneapolis and St. Paul: Hennepin, Ramsey, Anoka, Dakota, Washington, Carver and Scott. Greater Minnesota refers to the remaining counties in Minnesota.

[16] These data do not measure consumption of alcohol directly, but reflect "apparent consumption." As reported here, apparent per capita consumption is calculated by dividing total purchased alcohol by the total population aged 14 years or older. The term "apparent" is used because these estimates artificially attribute consumption to all persons in the population, regardless of their actual consumption. The proportion of purchased alcohol which is actually consumed is unknown.

[17] From 1989 to 1990, total per capita consumption increased 1.2%. This unexpected increase is probably due to a one-time surge in sales as wholesalers, retailers, and consumers tried to avoid the January, 1991 increase in the federal excise tax on alcohol. Market analysts predict that overall drinking rates will continue to decline in the 1990s (Williams et al, 1993).

The 14-year decline in overall per capita consumption from 1977 to 1991 largely reflects a 32% decline in consumption of spirits. By comparison, per capita wine consumption was 3% higher in 1991 than in 1977. Per capita consumption of beer fluctuated during the 1980s, but by 1991 returned to the same level as in 1977 (Williams et al, 1993).

[18] People are considered "abstainers" if they do not report consuming alcohol in the 30 days immediately prior to a telephone interview. Note that this estimate excludes persons under 18, and may include people who are infrequent drinkers, or heavy drinkers who had not consumed alcohol in the preceding month.

[19] The "drinking population" of Minnesota is generalized from the proportion of randomly selected adult Minnesotans who reported drinking alcohol in the month preceding a BRFSS telephone interview.

[20] These estimates entailed a conversion from gallons of ethanol (pure alcohol) to standard servings of beer, wine, and spirits. The conversion coefficients recommended by Williams et al., 1992 are 0.045 (beer), 0.129 (wine), and 0.414 (spirits). In 1991, Minnesotans consumed 1.3 gallons of ethanol from beer, .24 gallons of ethanol from wine, and .82 gallons of ethanol from spirits. Computations are confirmed with Dr. D. Bertolucci, Alcohol Epidemiologic Data System, National Institute of Alcohol Abuse and Alcoholism.

[21] The BRFSS is a monthly random-digit-dialed telephone survey of adults nationwide. All 50 states, plus the District of Columbia participate in this surveillance system. The data presented in this chapter were collected in 1992. At that time, 48 states, plus Washington, DC participated. For additional information, contact Ann Kinney (612-282-5646) in the Center for Health Statistics, Minnesota Department of Health.

[22] Earlier in this chapter we reported an estimate that each drinker in Minnesota averages slightly more than 2 standard servings per day. Readers are reminded that patterns of alcohol use are dynamic and vary by frequency and quantity. For example, some drinkers consume alcohol only one or twice weekly, with only 1 drink per occasion. Others drink more heavily. Those who report drinking an average of 2 or more standard servings per day (60 drinks per month) are defined as heavy drinkers.

[23] Comparable data are not available for women, because the lower rates of binge and heavy drinking do not enable reliable occupational comparisons. Examples of occupations included in each occupational group are as follows: 1) Managerial and professional specialty occupations: executive, administrative, and managerial occupations, professional specialty occupations such as scientists, health professionals, teachers, planners. 2) Technical, sales, and administrative support occupations: technologists and technicians in health, sales representatives, office supervisors, accounting and clerical staff. 3) Service occupations: private household workers, child care, firefighters, police and guards, food service occupations. 4) Farming, forestry and fishing occupations: farm operators, gardeners, groundskeepers, animal caretakers, logging occupations, forestry workers, hunters and trappers. 5) Craft occupations: mechanics and repairers, construction trade workers such as electricians, painters, precision fitters, cabinet makers, sheet metal workers. 6) Laborer occupations: machine operators, motor vehicle operators, railroad workers, equipment cleaners and helpers.

[24] The Minnesota Student Survey, conducted by the Minnesota Department of Education, was first administered in 1989 to students in grades 6, 9, and 12, with a repeat of the survey planned for every 3 years. For more information, contact the Minnesota Department of Education, Prevention and Risk Reduction Unit. Current contact: Jim Colwell, 612-296-5119.

[25] In Minnesota it is illegal for minors to consume alcohol, unless the alcohol is consumed at home in the presence of a parent or legal guardian (DPS, 1994).

[26] Williams, Stinson, Parker et al. (1987) projected the prevalence of alcohol abuse (defined as the experience of one or more of their specific list of problems) and alcoholism in the US in 1985, 1990, and 1995. To apply these national estimates to Minnesota, state-specific population data obtained from the Minnesota Department of Health were entered into ARDI by gender for the same age categories used by Williams and colleagues.

[27] Examples of alcohol dependence include: drinking first thing in the morning; trying to quit drinking, but feeling unable to do so; and having hands shake involuntarily the morning after drinking.

[28] Alcohol-related problems (Williams, Stinson, Parker, Harford & Noble, 1987):

- I have lost a job, or nearly lost one, because of my drinking.
- My drinking contributed to getting hurt in an accident (in a car or elsewhere).
- Drinking led me to quit my job.
- I had an illness connected with drinking which kept me from my regular job for a week or so.
- My drinking contributed to getting involved in an accident in which someone else was hurt or property was damaged.
- I have been arrested for being drunk.
- My drinking was involved in losing a friend or drifting apart from a friend.
- Drinking may have hurt my chances for promotion, or raise, or better jobs.
- My drinking interfered in some way with the way I raised my children.
- People at work indicated that I should cut down on drinking.
- I felt that my drinking was becoming a serious threat to my physical health.
- Friends have indicated that I should cut down on my drinking.
- A policeman questioned me or warned me because of my drinking.
- I spent money on drinks that was needed for essentials like food, clothing, payments.
- I have stayed away from work or gone to work late because of a hangover.
- I have gotten high or tight while on the job.

[29] Nearly 1 in 5 Minnesota adolescents report that alcohol use by a family member has repeatedly caused family, health, job or legal problems (MDE, 1992b).

[30] Post-secondary students who binge drink create problems for classmates who are *not* binge drinkers. Based on their survey of a representative sample of students enrolled at 4 year colleges nationwide, Wechsler et al. (1994) reported that *of students who do not binge drink*, those who are enrolled at schools with higher rates of binge drinking are more likely than students at schools with lower rates of binge drinking to experience problems such as (a) being pushed, hit or assaulted, or (b) experiencing an unwanted sexual advance.

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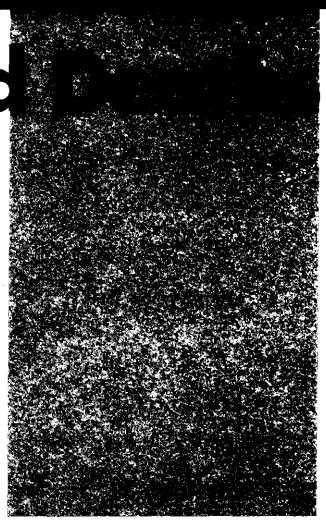
Chapter 2

Summary points

- In 1991, the deaths of approximately 1,581 Minnesotans were related to alcohol use.
- Fatal injuries accounted for more alcohol-related deaths than any other cause of death. Over half of these fatal injuries occurred in motor vehicle crashes.
- Alcohol use was related to 193 violent deaths in Minnesota during 1991.
- Cancer and digestive disease each accounted for 16% of total alcohol-related deaths. Cardiovascular disease accounted for slightly fewer alcohol-related deaths (13%).
- Six of ten alcohol-related deaths occurred among men.
- The four leading causes of alcohol-related death among men were: unintentional injury, cancer, violence, and digestive disease, respectively. The four leading causes of alcohol-related death among women were: unintentional injury, cardiovascular disease, digestive disease, and cancer.
- Relative to women, men were nearly four times as likely to die from an alcohol-related act of violence or mental disorder, and twice as likely to die from an alcohol-related cancer.
- Children, adolescents and young adults accounted for 5% of all deaths in 1991. But this same group (Minnesotans younger than 35) accounted for 17% of all alcohol-related deaths.
- The alcohol-related deaths of an estimated 1,581 Minnesotans in 1991 translate into approximately 34,177 years of potential life lost (YPLL).
- Each of the 1,581 deaths translates into an average of 22 years of lost life per person.
- Injuries accounted for the majority of alcohol-related YPLL, followed by violence and digestive diseases. Together, these three causes of death accounted for 60% of total alcohol-related YPLL.
- Motor vehicle crashes accounted for more years of potential life lost than any other single alcohol-related cause of death. Car crashes were followed by suicide, acute cirrhosis of the liver, and homicide.
- Alcohol-attributable fractions (AAFs) are the basis for calculating the number of alcohol-related deaths for each disease or injury. In most cases AAFs are merely "best estimates" of the true level of alcohol's involvement in death from a disease or injury. Additional scientific study and better methods to detect and measure alcohol consumption are needed in order to achieve greater accuracy.

Chapter 2

Minnesota Alcohol-Related



Chapter overview

The 1991 data presented in this chapter estimate (a) the number of alcohol-related[1] deaths statewide, and (b) the number of years of potential life lost in Minnesota due to alcohol-related early death. Estimates were generated using the Alcohol-Related Disease Impact [ARDI] software program (Shultz, Parker, & Rice, 1989). These estimates form the basis of the cost calculations reported in chapter 3. For a complete discussion of ARDI software and methodology, see the appendix at the end of this chapter.

Total alcohol-related deaths

Approximately 4% of all Minnesota deaths in 1991 were alcohol-related.

The Minnesota Center for Health statistics reports that 35,241 Minnesotans died in 1991. Approximately 1,581 of these deaths (4%) were alcohol-related.[2,3] Almost one-third (31%) of the total number of deaths from both violence and unintentional injury were alcohol-related, as were more than one-fifth (22%) of deaths from digestive diseases (Table 2.1). Injuries accounted for nearly 3 in 10 alcohol-related deaths, more than any other single disease category (Figure 2.1). Together, injuries and violence accounted for more than 40% of the 1,581 alcohol-related deaths.

Table 2.1 - Number and percent of alcohol-related deaths in Minnesota, 1991

Cause of death	Total deaths (n)	Alcohol-attributable Deaths (n)	Alcohol-attributable Percent[2] (%)
Injury	1,456	457	31
Cancer	8,375	260	3
Digestive disease	1,140	250	22
Cardiovascular disease	14,639	204	1
Violence	613	193	31
Mental disorders	840	101	12
Respiratory disease	3,464	77	2
Other causes	4,714	38	1
Total[1]	35,241	1581	4%

[1] The total number of alcohol-attributable deaths may not be the exact sum of alcohol-attributable deaths for each cause of death. The figures for alcohol-attributable death are calculated as the alcohol-attributable percentage of total deaths for each cause of death, rounded to the nearest whole number.

[2] The alcohol-attributable percent refers to the percentage of deaths which are alcohol-related. For more information on methods, see the appendix at the end of this chapter.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

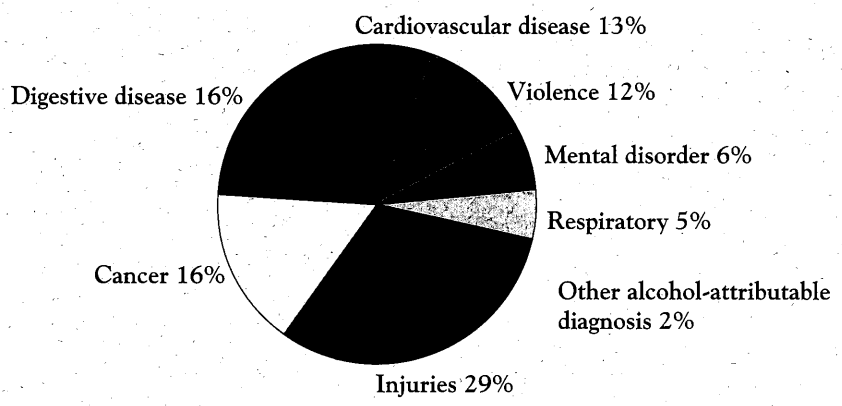
Alcohol-related deaths according to specific causes of death[4]

Injury

Several different types of fatal, unintentional injury have been linked to alcohol use. These injuries include: Vehicle crashes (e.g., motor vehicles, boats, airplanes and snowmobiles), falls, fires, drownings and alcohol poisonings. Of approximately 1,189 injury deaths from these causes statewide in 1991, 457 (38%) were alcohol-related.

Most alcohol-related injury deaths occurred in motor vehicle crashes (54%), and more than one in four

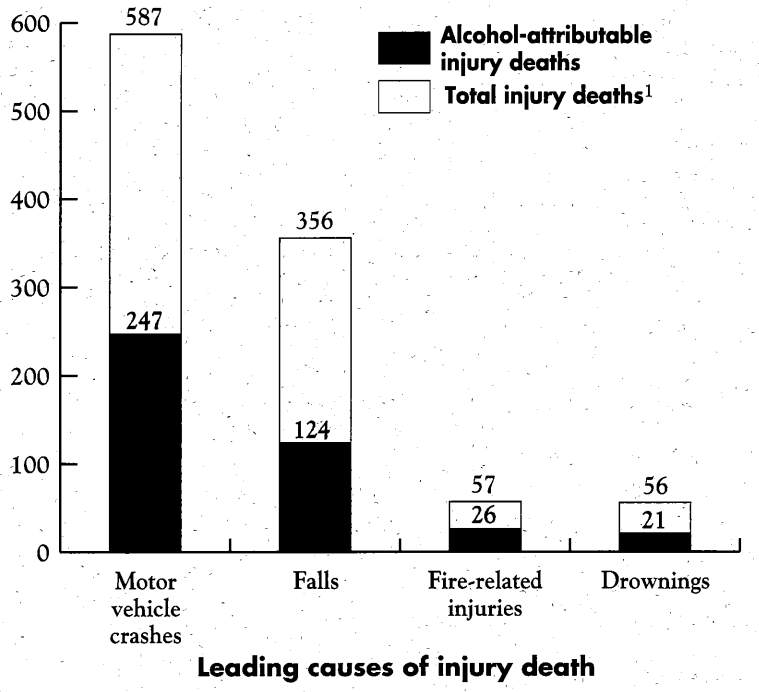
Figure 2.1 – Alcohol-related deaths by cause, Minnesota, 1991



Note: Approximately 1,581 deaths were alcohol-related in Minnesota in 1991. Percentages may not total 100% due to rounding.

Sources: This figure was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

Figure 2.2 – Alcohol-related injury deaths as a proportion of total deaths, for the leading causes of injury death in Minnesota, 1991



[1] Calculated as the sum of the alcohol-attributable injury deaths and injury deaths related to other factors.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

resulted from accidental falls (27%). Other alcohol-related injury deaths stemmed from fire (6%), drowning (5%), alcohol poisoning (3%), other vehicle crashes (2%), and miscellaneous other injuries (4%). For the four leading causes of injury death, Figure 2.2 presents the proportion of total deaths which were alcohol-related.

Violence

Epidemiologists estimate that alcohol use is related to over one quarter of all suicides (28%), and nearly one half of all homicides (46%) each year. When applied to Minnesota mortality data, this estimate suggests that approximately 139 suicides and 54 homicides were alcohol-related in 1991. This amounts to 200 preventable violent deaths statewide.

Cancer

Alcohol-related cancers occur primarily in the gastrointestinal tract. The leading cause of alcohol-attributable cancer death is esophageal cancer, followed by cancer of the mouth or lip, cancer of the stomach, and cancers of the larynx and liver. Approximately 40% of these fatal cancers are alcohol-related[5] (Figure 2.3).

Digestive disease

Alcohol use is related to many types of digestive disease, including cirrhosis, ulcers, and disorders of the stomach, as well as inflammatory diseases of the esophagus, small intestine, and pancreas. Approximately 22% of all digestive disease deaths are alcohol-related.

Of the 250 alcohol-related digestive disease deaths statewide in 1991, nearly two-thirds involved the liver. The single leading cause of alcohol-related digestive disease death was acute cirrhosis of the liver, which

accounted for almost half (48%) of such deaths.

Cardiovascular disease

Alcohol use may reduce risk for some forms of cardiovascular disease (see chapter 1). However, alcohol use increases risk for at least three forms of cardiovascular disease: cardiomyopathy, hypertension, and hemorrhagic stroke[6] (Arria & Van Thiel, 1992). Of 2,972 Minnesota deaths in 1991 from these three forms of cardiovascular disease, 204 (7%) can be attributed to alcohol use. Most of these alcohol-related cardiovascular disease deaths (90%) were from hemorrhagic stroke.

Mental disorders

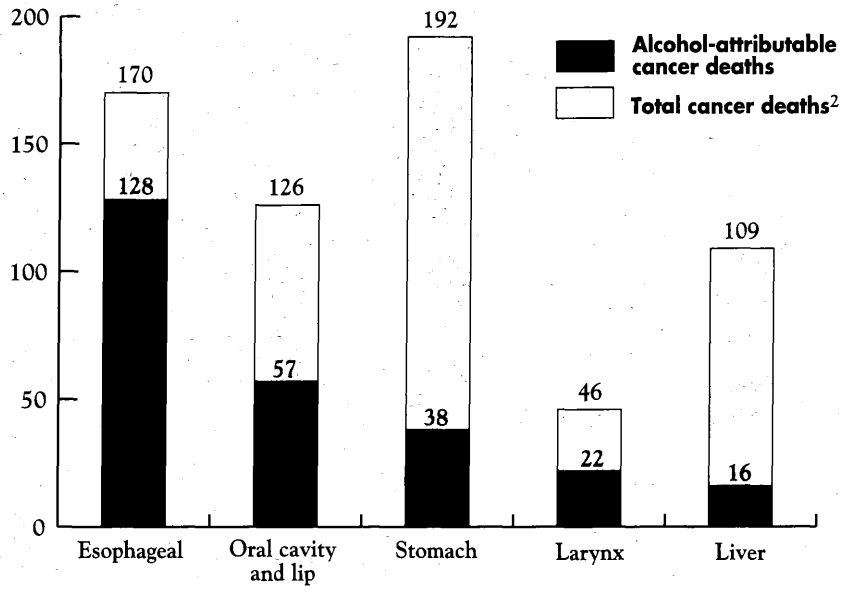
Three mental disorders are alcohol-attributable by definition: alcohol dependence syndrome, alcohol abuse, and alcoholic psychosis.[7] Of the 101 deaths statewide from these three diagnoses in 1991, most (85%) were due to alcohol dependence syndrome.

Alcohol-related deaths according to gender and age

Patterns of alcohol-related deaths are different for men and women, and for people in different age groups.[8] In Minnesota during 1991, 60% of all alcohol-related deaths occurred among men.[9] Proportionately more men than women died within each alcohol-related cause of death category, except for cardiovascular disease and respiratory disease (Figures 2.4 and 2.5). Men were four times more likely to die from an alcohol-related mental disorder or act of violence. Men whose deaths were alcohol-related tended to die at a younger age than women whose deaths were also alcohol-related.

Proportionately more deaths are alcohol-related among young people than among persons 35-64 or 65 and older. In 1991, 15% of all deaths among persons younger than 35 were alcohol-related, compared to 8% among 35 - 64 year olds, and 3% among those older than 65. Whereas Minnesotans younger than 35 accounted for 5% of all deaths in 1991, they accounted for 17% of the total

Figure 2.3 – Alcohol-related cancer deaths, as a proportion of all cancer deaths in each category, Minnesota, 1991[1]



Note: For many types of cancer, the alcohol-attributable fraction (AAF) is unknown. Epidemiologists have estimated an AAF for the 5 types of cancer identified here. In addition to the 643 deaths in 1991 from these types if cancer, there were 497 deaths from cancers that do not have an associated AAF.

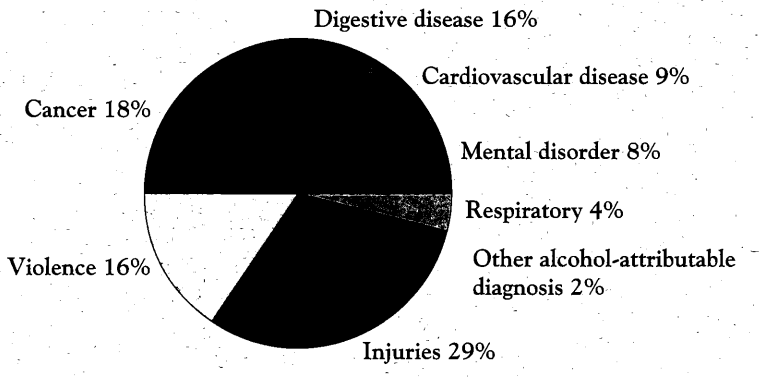
[1] The total number of alcohol-attributable deaths may not be the exact sum of alcohol-attributable deaths for each cause of death. This is because the alcohol-attributable figures are the alcohol-attributable percentage of total deaths for each cause of death, rounded to the nearest whole number.

[2] Calculated as the sum of the alcohol-attributable cancer deaths and cancer deaths related to other factors.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

Men whose deaths were alcohol-related tended to die at a younger age than women whose deaths were also alcohol-related.

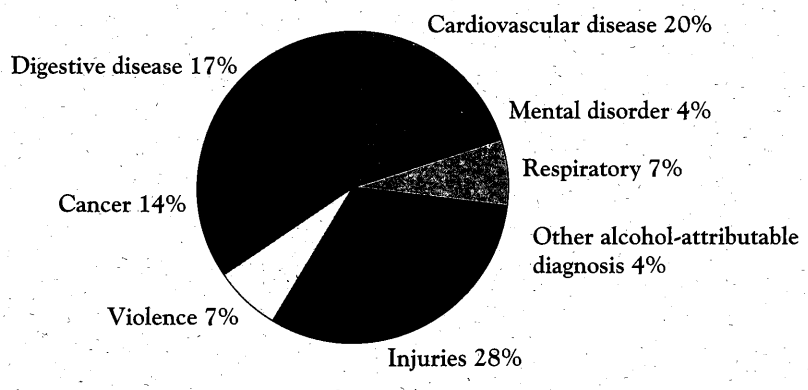
Figure 2.4 – Alcohol-related deaths by cause among Minnesota men, 1991



Note: In 1991, the deaths of approximately 988 men in Minnesota were alcohol-related (5.5% of all male deaths). Percentages may not total 100% due to rounding.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

Figure 2.5 – Alcohol-related deaths by cause among Minnesota women, 1991



Note: In 1991, the deaths of approximately 593 women in Minnesota were alcohol-related (3.4% of all female deaths). Percentages may not total 100% due to rounding.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

Children, adolescents and young adults accounted for 5% of all deaths in 1991. But this same group (Minnesotans younger than 35) accounted for 17% of all alcohol-related deaths.

number of alcohol-related deaths (Table 2.2). Figure 2.6 presents the distribution of alcohol-related deaths by cause and age.

Alcohol-related years of potential life lost

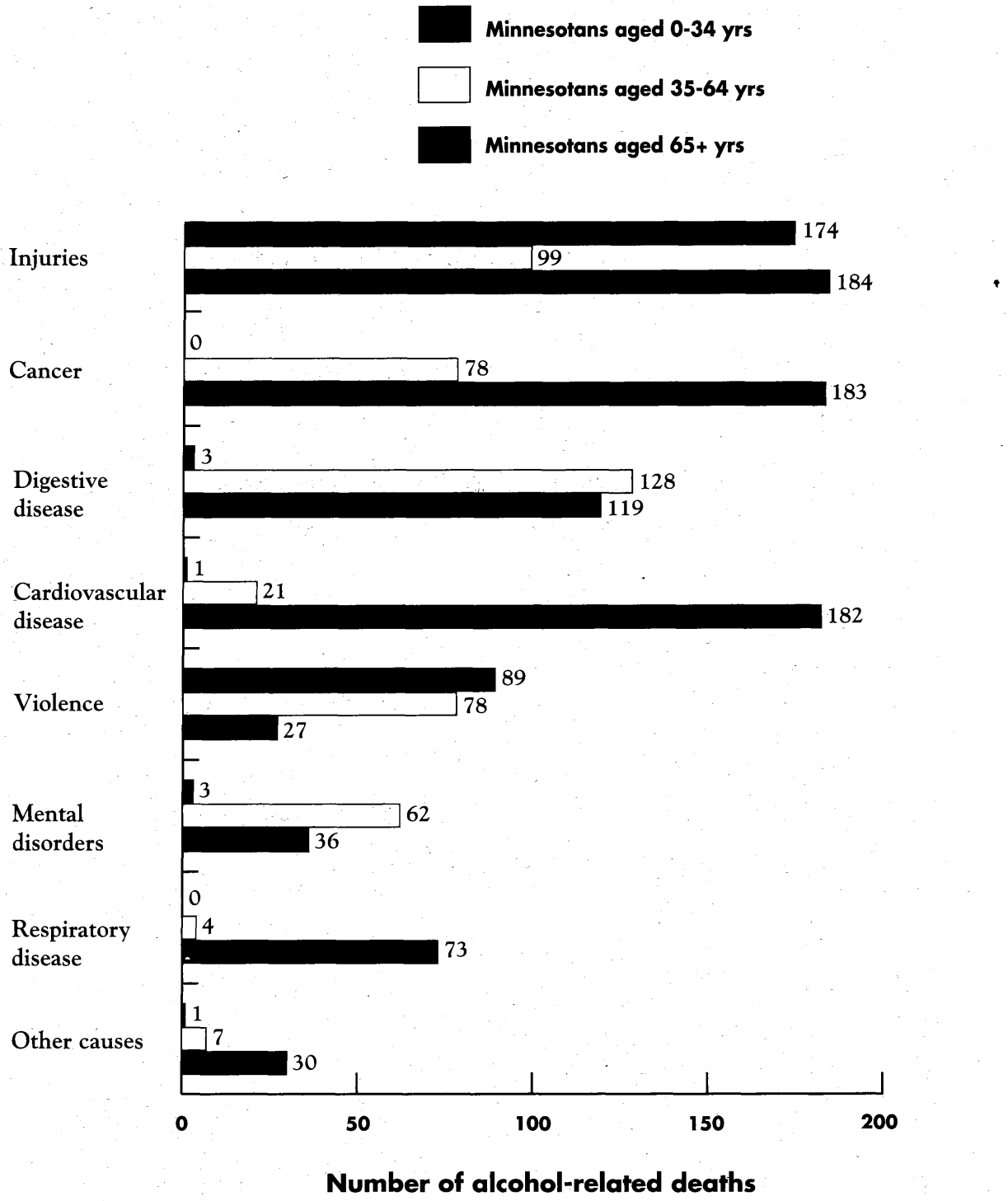
The difference between the expected length of life and the actual age at death is termed years of potential life lost (YPLL).[11] Calculation of YPLL[12] is especially relevant when estimating the public health impact of alcohol use, since alcohol-related deaths are relatively young deaths compared to deaths from other causes (Table 2.2).

The 1,581 alcohol-related deaths in Minnesota in 1991 translate into 34,177 years of potential life lost (YPLL). On the average, each alcohol-related death occurred 22 years before full life expectancy, or 22 years prematurely. Alcohol-related injuries accounted for most YPLL, followed by alcohol-related violence (Figure 2.7). This reflects the greater proportion of injury and violent death among young persons. As shown in Figure 2.6, among Minnesotans younger than 35, almost every alcohol-related death (97%) was due to an alcohol-related injury or act of violence.

Men lost proportionately more years to violence and mental disorders; whereas women lost proportionately more years to digestive disease. Overall, men accounted for two-thirds of the total YPLL. This is related to three underlying trends:

- Men report lower rates of abstinence, and higher rates of binge and heavy drinking (chapter 1).
- Alcohol-related deaths are more common among men (Table 2.2).
- The age of alcohol-related death is consistently younger among men than among women.

Figure 2.6 – Alcohol-related deaths by cause of death and age, Minnesota, 1991[1]



[1] The total number of alcohol-related deaths (n=1,581) may not be the exact sum of alcohol-related deaths for each cause of death. The estimates of alcohol-related death were calculated as the alcohol-attributable percentage of total deaths for each cause of death, rounded to the nearest whole number. See this chapter's appendix for a complete discussion.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

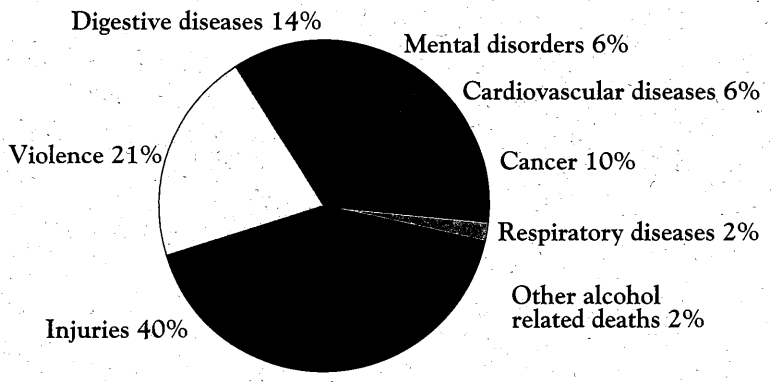
Table 2.2 – Alcohol-related deaths as a proportion of total deaths for each age group, Minnesota, 1991

Age	Total deaths (n)	Total deaths (%)	Alcohol-related deaths (n)	Alcohol-related deaths (%)	Alcohol-related deaths as % of total deaths
0-34	1820	5	271	17	15
35-64	5753	16	477	30	8
65+	27666	79	833	53	3
Total	35241[1]	100%	1581	100%	4%

[1] The figure for total deaths includes 2 deaths of persons whose age was unknown.

Sources: This figure was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

Figure 2.7 – Alcohol-related years of potential life lost (YPLL), by cause of death, Minnesota, 1991[1]



Note: ARDI software estimates that 1,581 alcohol-related deaths in Minnesota during 1991 resulted in approximately 34,177 years of potential life lost.

[1] Percentages may not total 100% due to rounding.

Sources: This figure was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

Table 2.3 presents alcohol-related deaths and YPLL by specific cause of death. The average YPLL ranged from 34 years (drownings) to less than 1 year (stomach, larynx and liver cancer; chronic pancreatitis and respiratory tuberculosis).[13] Motor vehicle crashes accounted for the most years of potential life lost, due in part to the high number of alcohol-related motor vehicle crash deaths among young adults. Together, car crashes, homicides, suicides, and acute cirrhosis of the liver accounted for over half of total alcohol-related YPLL. No other single cause of death contributed more than 6% to the total YPLL.

Implications for public health promotion and protection

Each year, a substantial number of preventable, premature deaths in Minnesota are alcohol-related. These alcohol-related deaths encompass a variety of chronic diseases, unintended injuries, and acts of violence.

More than half of all alcohol-related deaths in Minnesota during 1991 stemmed from chronic diseases such as cancer, digestive disease,

Table 2.3 – Alcohol-related deaths and years of potential life lost YPLL for specific causes of death, Minnesota, 1991[1]

Cause of death	Alcohol-related deaths		YPLL	
	n	%	n	%
Injuries				
Motor vehicle crashes	247	16	9417	28
Accidental falls	124	8	1286	4
Injuries by fire	26	2	973	3
Drownings	21	1	952	3
Other injuries	18	1	437	1
Alcohol poisoning	13	1	407	1
Air/Space transport	4	<1	155	1
Boating	4	<1	108	<1
Other vehicle crashes	1	<1	27	<1
Subtotal	457	29	13762	41
Violence				
Suicide	139	9	4933	14
Homicide	54	3	2133	6
Subtotal	193	12	7066	20
Digestive diseases				
Acute cirrhosis of the liver	119	8	2444	7
Other cirrhosis	59	4	871	3
Alcoholic liver damage	26	2	529	2
Diseases of esophagus/stomach	16	1	159	1
Acute alcoholic hepatitis	15	1	400	1
Acute pancreatitis	13	1	185	1
Chronic pancreatitis	1	<1	14	<1
Alcoholic fatty liver disease	1	<1	38	<1
Subtotal	250	17	4640	15
Mental disorders				
Alcohol dependence syndrome	86	5	1818	5
Alcohol use	8	1	214	1
Alcohol psychosis	7	<1	88	<1
Subtotal	101	6	2120	6
Cancer				
Esophagus	128	8	1712	5
Mouth & lip	57	4	838	3
Stomach	38	2	456	1
Larynx	22	1	272	1
Liver	16	1	210	1
Subtotal	260	16	3488	11
Cardiovascular disease				
Cerebrovascular disease	184	12	1634	5
Essential hypertension	11	1	104	<1
Alcoholic cardiomyopathy	9	1	244	1
Subtotal	204	14	1982	6
Respiratory diseases				
Respiratory TB	1	<1	3	<1
Pneumonia/influenza	77	5	608	2
Subtotal	77	5	611	2
Other alcohol-related deaths	38	2	508	2
TOTAL	1581	100%	34177	100%

[1] The subtotals and total number of alcohol-attributable deaths may not be the exact sum of alcohol-attributable deaths for each cause of death. This is because the alcohol-attributable figures are the alcohol-attributable percentage of total deaths for each cause of death, rounded to the nearest whole number. Percentages may not total 100% due to rounding. YPLL is calculated to full life expectancy.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 mortality data from the Minnesota Center for Health Statistics, Minnesota Department of Health (MCHS, 1992).

cardiovascular disease, mental disorders, and respiratory disease. Together these deaths accounted for more than 13,000 years of lost life.

The cost of alcohol use in terms of fatal injuries and acts of violence is particularly dramatic and tragic. In 1991, fatal unintended injuries and acts of violence accounted for 41% of total alcohol-related mortality, and more than 20,000 years of potential life lost.

Furthermore, almost one-third of *all* injury deaths in Minnesota (31%) were attributable to alcohol use. This includes 42% of motor vehicle crash deaths, 45% of fatal fire injuries, 38% of drownings, 35% of fatal falls, and 20% of boating deaths.[14] The loss of life from alcohol-related violence is equally compelling: approximately 3 in every 10 suicides, and nearly 5 in every 10 homicides are alcohol-related.

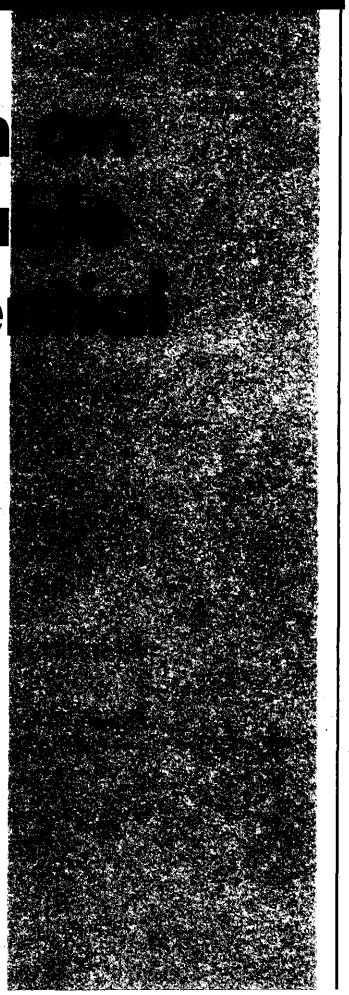
These fatal alcohol-related injuries and acts of violence claim large numbers of young lives and exact a particularly heavy toll in terms of lost years of life. In 1991, almost all alcohol-related deaths among Minnesotans younger than 34 years of age (97%) were due to unintentional injuries and violence.

Overall, young people account for a disproportionate share of alcohol-related deaths. Whereas children, adolescents and young adults account for only 5% of deaths from all causes, these Minnesotans (younger than 34) account for 17% of all alcohol-related deaths.

Even when considering the previously noted methodological limitations, the estimates presented here suggest that alcohol use contributes substantially to premature mortality in Minnesota. Indeed, the public health impact of alcohol use is magnified still further when considering not only alcohol-related mortality, *but also* alcohol-related illness and disability.

Chapter 2 • Appendix

Supplementary Information Estimating Alcohol-attributa Mortality and Years of Pote Life Lost



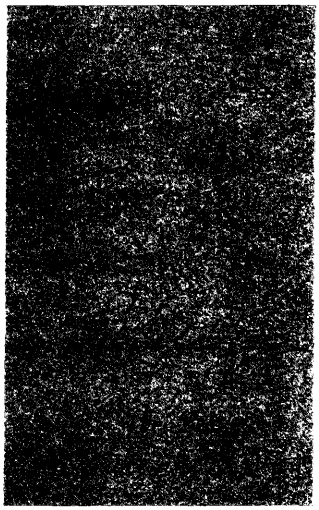
Alcohol-attributable mortality

Alcohol-related mortality calculations are based on estimates of the proportion of deaths that are related to alcohol use. This proportion is termed the *alcohol attributable fraction*, and is defined as "the percent of cases of disease or injury that could have been prevented in the absence of alcohol use or misuse" (Shultz et al., 1989, p. 40).

In developing the ARDI software used to generate this report, Shultz et al. (1989) estimated the alcohol-attributable fractions (AAFs) for a set of diseases, injuries, and acts of violence (Table 2.4). AAFs for chronic diseases were estimated from clinical case series studies and analytical epidemiological studies. The AAFs for injuries were estimated from injury surveillance studies that reported alcohol involvement.

The alcohol attributable fraction (AAF) refers to the percent of cases of disease or injury that are alcohol-related, and are therefore preventable.

As shown in Table 2.4, all AAFs range from 0.0 to 1.0. For diagnoses that are alcohol-attributable by definition (e.g., alcohol dependence syndrome, alcohol poisoning, and acute cirrhosis of the liver), the AAF equals 1.0 (100%). Assuming accurate diagnosis, all deaths and economic costs from these conditions are attributable to alcohol use. For most alcohol-related diagnoses, however, epidemiologic and surveillance studies have identified alcohol use as a *contributing*, not a *defining*, factor (e.g., ARDI software estimates that a percentage of all fatal fire injuries [45%] can be attributed to alcohol use). AAFs used in this report range from .05 for pneumonia (i.e., 5% of all pneumonia deaths are related to alcohol use, and 95% are related to other factors) to 1.0 for deaths from conditions such as alcoholic psychosis, alcohol poisoning, and excess blood alcohol.



Total alcohol-related mortality includes all deaths from diagnoses that are alcohol-attributable by definition, and a proportion of other deaths for which alcohol use was a contributing factor. Alcohol-attributable mortality for Minnesota is calculated as the total number of deaths from all causes statewide, multiplied by the alcohol-attributable fraction for each cause of death (Shultz et al., 1989).

Table 2.4 – Alcohol-Attributable Fractions (AAF) used to estimate alcohol-related mortality

ICD9 Code	Diagnoses	AAF
	Infectious Diseases	
011 – 012	Respiratory Tuberculosis	.25
	Neoplasms	
140 – 149	Cancer of the Oral Cavity	.50M,[1] .40F[2]
150	Cancer of the Esophagus	.75
151	Cancer of the Stomach	.20
155	Cancer of the Liver	.15
161	Cancer of the Larynx	.50M, .40F
	Mental Disorders	
291	Alcohol Psychosis	1.00
303	Alcohol Dependence Syndrome	1.00
305.0	Alcohol Abuse	1.00
	Cardiovascular	
401	Essential Hypertension	.076
425.5	Alcoholic Cardiomyopathy	1.00
430 – 438	Cerebrovascular Disease	.065
	Respiratory Diseases	
480 – 487	Pneumonia and Influenza	.05
	Digestive Diseases	
530 – 537	Diseases of Esophagus, Stomach	.10
535.3	Alcoholic Gastritis	1.00
571.0	Alcoholic Fatty Liver	1.00
571.1	Acute Alcoholic Hepatitis	1.00
571.2	Acute Cirrhosis of the Liver	1.00
571.3	Alcoholic Liver Damage Unspecified	1.00
571.5 – 571.6	Other Cirrhosis	.50
577.0	Acute Pancreatitis	.42
577.1	Chronic Pancreatitis	.60
	Injuries	
E810 – E825	Motor Vehicle Crashes	.42
E825, 6, 9	Other Road Vehicle Accidents	.20
E830 – E838	Watercraft Injuries	.20
E840 – E845	Air and Space Transport Accidents	.16
E860.0,.1	Alcohol Poisoning, Poisoning Unspecified	1.00
E880 – E888	Accidental Falls	.35
E890 – E899	Injuries Caused by Fires	.45
E910	Drownings	.38
	Other Alcohol-Related Injuries	.25
	Violence	
E950 – E959	Suicide	.28
E960 – E969	Homicide	.46
	Other Diagnoses	
250	Diabetes Mellitus	.05
357.5	Alcoholic Polyneuropathy	1.00
790.3	Excess Blood Alcohol	1.00

[1] M=Male.

[2] F=Female.

Source: Shultz, Parker and Rice, 1989, p. 45.

The ARDI software program has the capacity to calculate alcohol-related mortality by gender and five-year age category. However, age- and gender-specific AAFs are rarely available. Instead, a single AAF for each alcohol-related diagnosis is applied uniformly across age groups and genders. To the extent that the alcohol attributable fraction varies by age and/or gender for one or more cause of death categories, the use of a single AAF for each cause of death may lead to inaccuracies in the data.

Several notable limitations inherent in the current estimation methods for AAFs are summarized by Shultz, Rice, and Parker (1990):

> *Further epidemiologic studies are needed to allow direct computation of AAFs for most diagnoses. AAFs require a consistent definition of alcohol exposure prevalence and robust, diagnosis-specific relative risk measures. For most alcohol-related diseases and injuries, such measures have not yet been determined by rigorous epidemiologic investigation; quantity, volume, and frequency measures of alcohol consumption vary among studies of alcohol-related chronic diseases. In addition, injury surveillance data are constrained by a lack of standardized units for measuring blood-alcohol concentrations and disparities in defining measurement thresholds for intoxication. Finally, consensus must be developed regarding the appropriate comparison population for relative risk calculations—specifically, whether abstinence or moderate drinking provide an optimal baseline (p. 176).*

Although many medical and social problems are alcohol related, they are also closely connected to many other personal, lifestyle and environmental factors. These factors can interact in complex ways to influence health status. This multifactorial etiology, coupled with co-morbidity (concurrent

diagnoses), may lead to inaccuracies in estimating the AAF. As Shultz et al. (1989) note, the sole focus on alcohol use as a factor contributing to premature death is an "intentional oversimplification" of the many factors that influence health status (p. 40).

It is important to note that the AAF does not indicate a causal relationship. For example, the AAF for homicide is .46. Few would argue that alcohol directly causes nearly 50% of all homicides. Instead, we assume for the purposes of this report that in a substantial percentage of all homicides (46%), alcohol use was a strongly contributing factor.

The AAF is a critical element in economic cost calculations. Nonetheless, AAFs employed by ARDI are *best estimates* (Shultz et al., 1989). Despite a lack of precision surrounding the AAF, research clearly indicates that each year a substantial number of preventable, premature deaths in Minnesota are alcohol-related.

Years of potential life lost

Years of potential life lost (YPLL) represents the difference between the expected length of life and the actual age of death. As a measure of disease impact, YPLL is sensitive to the absolute numbers of deaths, as well as the prematurity of death (Shultz et al., 1989). YPLL is particularly useful when describing the impact of alcohol use, since alcohol-related deaths occur disproportionately among adolescents and young adults, long before they have achieved their full life expectancy.

YPLL is calculated by multiplying the number of alcohol-related deaths per age group by the number of years remaining to life expectancy. The number of years remaining to life expectancy is reported in Table 2.5 for each age category.

Despite a lack of precision surrounding the AAF, research clearly indicates that each year a substantial number of preventable, premature deaths in Minnesota are alcohol-related.

Table 2.5 – Years of potential life remaining to average life expectancy, by age of death

Age of Death	Life Expectancy
0-4	70.1
5-9	65.3
10-14	60.3
15-19	55.5
20-24	50.9
25-29	46.3
30-34	41.7
35-39	37.1
40-44	32.5
45-49	28.1
50-54	23.9
55-59	20.1
60-64	16.5
65-69	13.3
70-74	10.5
75-79	8.1
80-84	6.1
85+	5.1

Source: National Center for Health Statistics, 1988

Endnotes

[1] For the purposes of this report, alcohol-*attributable* mortality is used interchangeably with alcohol-*related* mortality, as are the terms alcohol-related *death* and alcohol-related *mortality*.

[2] Recent research has indicted that moderate alcohol use may reduce risk for some forms of cardiovascular disease. Recommendations to increase alcohol use for this purpose remain controversial. The calculations reported here do not incorporate an estimate of lives saved by alcohol use.

[3] The data presented in this report underestimates the total number of violent deaths in MN (suicide and homicide) by 4% (n=25), and the number of alcohol-attributable acts of violence (suicide and homicide) by 5% (n=10).

[4] For an overview of the epidemiologic research for each category of alcohol-related death, see chapter 4.

[5] As Shultz et al. (1989) note: "Estimates of the percent of cancers attributable to alcohol are difficult to derive because of the apparent synergy between alcohol use and smoking (Breedon, 1984) and alcohol-nutrient interactions (Ziegler, 1986)" (p. 46).

[6] There are two broad types of stroke, hemorrhagic and ischemic. As explained in Arria & Van Thiel (1992): "Hemorrhagic stroke is associated with thinning blood and results in blood leakage into an area of the brain. Ischemic stroke refers to a loss of blood flow to an area of the brain" (p. 211).

[7] The *International Classification of Disease* (ninth revision, clinical modification) definitions for the alcohol-related mental disorders are reproduced below:

Alcohol (drug) abuse includes cases where an individual, for whom no other diagnosis is possible, has come under medical care because of the maladaptive effect of a drug on which he is not dependent and that he has taken on his own initiative to the detriment of his health or social functioning.

Alcohol dependence syndrome is a state, psychic and usually also physical, resulting from taking alcohol, characterized by behavioral and other responses that always include a compulsion to take alcohol on a continuous or periodic basis in order to experience its psychic effects, and sometimes to avoid the discomfort of its absence; tolerance may or may not be present.

Alcoholic psychosis is defined as an organic state due mainly to excessive consumption of alcohol.

[8] Researchers have estimated very few age- and gender-specific alcohol-attributable fractions. As a result, ARDI software used a single AAF for each age group and gender. These estimates may be inaccurate to the extent that the proportion of alcohol-related deaths varies by age and gender.

[9] The higher number of deaths among men is based in part on their higher rates of binge and heavy drinking, and higher rates of alcohol use combined with cigarette smoking (Parker et al., 1985; see chapter 1 to review gender patterns of alcohol consumption in Minnesota).

[11] Estimates of YPLL depend on a definition of life expectancy. Throughout this report, life expectancy is defined as age 75 years (NCHS, 1988). Therefore, the number of potential years lost to alcohol use is consistently calculated to age 75.

[12] For more information on methods used to calculate alcohol-related years of potential life lost, see the appendix at the end of this chapter.

[13] The average YPLL for a specific cause of death is calculated as the total YPLL, divided by the number of alcohol-related deaths. For example, since 139 suicides contributed 4,933 YPLL, the average YPLL per suicide is 35 years.

[14] These percentages are from the Alcohol-Related Disease Impact software used in this report. They are based on injury surveillance studies throughout the United States (see appendix to this chapter). These percentages may differ from Minnesota agency estimates. For example, the Minnesota Department of Natural Resources has estimated a higher percentage of alcohol-related drowning and boating deaths. See chapter 4 for further discussion.

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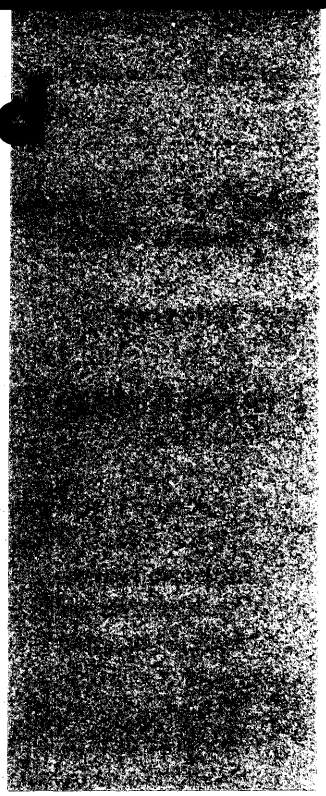
Chapter 3

Summary points

- The economic cost of alcohol use in Minnesota in 1991 totaled $1.74 billion, or nearly $400 for every resident of the state.
- The economic cost figure includes: (1) direct health care costs; (2) indirect mortality costs; (3) indirect morbidity costs; (4) fetal alcohol syndrome costs; and (5) non-health sector costs.
- Indirect morbidity, or the costs of lost economic productivity due to non-fatal alcohol-related problems, accounted for the largest portion of total costs, more than any other single cost category.
- Taken together, indirect morbidity and indirect mortality costs comprised nearly three-fourths of the total cost. The remaining categories—direct health care, non-health care, and fetal alcohol syndrome—together accounted for the remaining one-fourth of total costs.
- Estimated alcohol-related costs in the United States in 1990 totaled $98.62 billion (Rice, 1993).
- Cost estimates must be regarded as "best estimates" due to limitations of data and methodology inherent in any cost-of-illness study.

Chapter 3

Minnesota Alcohol-Related Economic Costs

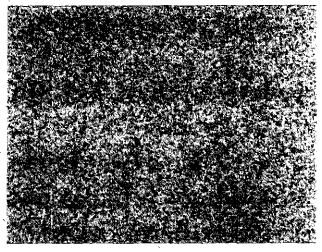


Chapter overview

This chapter presents an estimate of the economic costs associated with alcohol use in Minnesota in 1991. The economic cost of alcohol use is one key measure of the burden that alcohol places on individuals and society. Although such a cost estimate involves complex calculations, it provides policy makers, program planners, and community activists with useful information about the types of costs incurred and the effect of alcohol use on various parts of the economy. Cost estimates are especially useful for measuring the impact of alcohol use on health care systems and financing, and the impact on the productivity of a population group (Harwood, Napolitano, Kristiansen, & Collins, 1984; Parker, Shultz, Gertz, Berkelman, & Remington, 1987; Rice, Kelman, Miller, & Dunmeyer, 1990).

Studies of the cost of alcohol use are limited in that they do not suggest effective remedies for alcohol problems, nor do they provide any cost figures for possible remedies (US Department of Health and Human Services [USDHHS], 1991). However, they can show decision makers the sources of greatest cost to society, which may help to prioritize strategies for action.

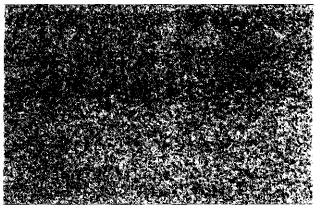
It is estimated that alcohol-related costs to the United States economy were $98.6 billion in 1990.



Depending on the chosen methods, cost estimates vary significantly across studies; but in every instance, the estimated cost of alcohol-related problems is high. For example, alcohol-related costs to the US economy were estimated at $70.3 billion in 1985, $85.8 billion in 1988, and $98.6 billion in 1990 (Rice et al., 1990; Rice, Kelman, & Miller, 1991b; Rice, 1993). Using the current available methods provided by the Rice et al. studies and Minnesota and national data from the late 1980s and early 1990s, this study estimates that the annual cost related to alcohol use in Minnesota totaled over $1.7 billion in 1991 (Table 3.1). This amounted to a cost of about $400 for every Minnesota resident.

This study estimates that the annual cost related to alcohol use in Minnesota totaled over $1.7 billion in 1991, or about $400 for every Minnesota resident.

Alcohol-Related Disease Impact (ARDI) software (Shultz, Parker, & Rice, 1989) was used to calculate all costs.



Costs must be viewed as estimates rather than precise figures.

Table 3.1 – Summary of economic costs of alcohol use, Minnesota, 1991

Cost Category	Cost (in millions of dollars)
1. DIRECT HEALTH CARE	178.6
Treatment	
Hospitals	84.1
Specialty institutions	47.0
Office-based physicians	3.9
Nursing homes	7.5
Professional services	4.8
Federal providers	18.5
Support	
Training, research, net cost of private health insurance, program admin.	12.8
2. INDIRECT MORTALITY	393.3
3. INDIRECT MORBIDITY	891.8
Non-institutionalized	883.7
Institutionalized	8.1
4. FETAL ALCOHOL SYNDROME	44.8
5. NON-HEALTH SECTOR	228.1
Direct costs	
Crime expenditures	91.9
Motor vehicle crashes	55.9
Fire destruction	9.9
Social welfare administration	1.9
Indirect costs	
Lost earnings of crime victims	10.1
Lost earnings: incarceration	58.4
TOTAL ALL COSTS	1,736.6

Cost per person (in actual dollars, not millions): $396.93

Sources: This table was generated using ARDI software (Shultz et al., 1989) and various additional sources (see individual categories for descriptions).

Contents of this chapter

The introduction to this chapter provides some basic information about the definitions, data sources, and methods used in this report.

The separate sections on individual cost categories presented later in this chapter contain findings and more detailed information on: (1) direct health care costs; (2) indirect mortality costs; (3) indirect morbidity costs; (4) fetal alcohol syndrome costs; and (5) non-health sector costs.

The appendix entitled "Supplementary information on economic cost calculations" contains additional information for readers interested in a more in-depth explanation of the definitions, data, methods, issues, and assumptions underlying the cost estimates of this report and other studies.

The appendix also briefly reviews the history of studies of the economic cost of alcohol use, discusses issues and limitations of such studies, and compares this report to the 1985 Minnesota study "Review and Cost of Alcohol Abuse in Minnesota" (Parker et al., 1985).

Indirect morbidity, or the costs of lost economic productivity due to non-fatal alcohol-related problems, accounted for the largest portion of total costs, more than any other single cost category (see Figure 3.1). Taken together, indirect morbidity and indirect mortality costs comprised nearly three-fourths of the total. (Indirect mortality costs are the costs of lost economic productivity due to alcohol-related deaths.) The remaining categories—direct health care, non-health care, and fetal alcohol syndrome—together accounted for the remaining one-fourth of total costs.

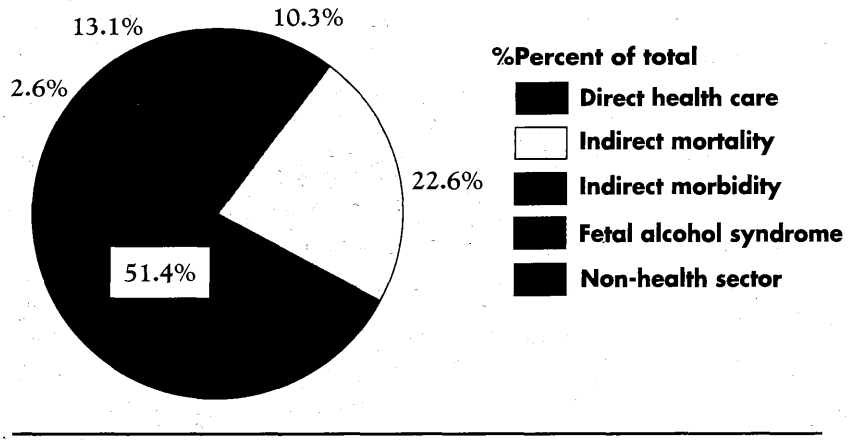
These costs must be viewed as estimates rather than precise figures due to data and methodological limitations. The economic assumptions and categorical definitions which must be made in order to calculate cost figures greatly affect the resulting estimates. In some cost-of-illness studies, a range of possible costs is presented, reflecting the variation which results from different assumptions. One might therefore consider the cost estimates given in this study as falling somewhere within a range of possible costs.

The cost estimates presented here are likely to be a lower bound of a range of costs. The Minnesota cost estimation in this chapter was calculated using Alcohol Related Disease Impact (ARDI) software, which is largely based on national economic data. However, because numerous measures of per capita alcohol consumption in Minnesota exceed national levels (see chapter 1), these estimates may be conservative.

In addition, direct health care and lost productivity costs are often not included for individuals who themselves were not drinking alcohol at the time of injury, but who were injured due to the actions of a person under the influence of alcohol. These unrecorded costs may be substantial.

Despite their limitations, these data are useful for comparing costs across categories, examining costs by age and gender, and identifying areas for further research and action.

Figure 3.1 – Proportion of total alcohol-related costs, by category, Minnesota, 1991



Sources: This figure was generated using ARDI software (Shultz et al., 1989) and various additional sources (see individual categories for descriptions).

Economic cost categories—definitions

The ARDI software used in this study classifies the economic costs of alcohol use into five major categories: direct health care, indirect mortality, indirect morbidity, fetal alcohol syndrome, and non-health sector. These categories are briefly defined in Table 3.2. Each cost category is addressed in a separate section of this chapter.

These cost categories are classified according to their characteristics, i.e., whether the costs are "direct" or "indirect" and whether they include "core" or "related" costs. Table 3.3 shows the cost characteristics represented by each of the five cost categories. Economic estimates include *direct costs* for alcohol-related disease and injury expenditures, as well as *indirect costs* of lost productive capacity of people affected by alcohol use through disease, injury, or premature death. Health-related direct and indirect costs typically are called *core costs*, and non-health direct and indirect costs are called *related costs* (Rice, Kelman, & Miller, 1991a). The text below describes these cost characteristics in more detail.

Table 3.2 – Cost category definitions

Direct health care costs =

Costs of detection, treatment, and rehabilitation of people with alcohol-related diseases and injuries.

Indirect mortality costs =

The value of lost economic productivity of people due to alcohol-related premature death, measured by lost earnings.

Indirect morbidity costs =

The value of lost economic productivity due to non-fatal effects of alcohol use disorders, measured by reductions in personal income.

Fetal alcohol syndrome costs =

Costs for care and treatment of people with fetal alcohol syndrome.

Non-health sector costs =

Alcohol-related costs outside the health sector (e.g., crime costs).

TOTAL ECONOMIC COSTS =

Direct health care costs
+ Indirect mortality costs
+ Indirect morbidity costs
+ Fetal alcohol syndrome costs
+ Non-health sector costs

Cost characteristics

- ***Direct costs** are the alcohol-related expenditures for goods and services for either health or non-health items.* Society may need to produce certain goods and services to cope with the consequences of alcohol use and forego the alternative goods and services that could have been produced if alcohol use had not generated such consequences (Berry & Boland, 1977). Examples of direct costs include law enforcement costs for alcohol-related offenses, and emergency room charges for treating alcohol-related injuries.
- ***Indirect costs** are the costs of lost economic production of individuals affected by alcohol use.* These costs to society are calculated by estimating the value of lost work time or lowered productivity at work for people affected by alcohol use. Examples of indirect costs include tardiness due to hangovers, and lowered occupational achievement.
- ***Core (health-related) costs** are the alcohol-attributable fraction of health costs resulting from diseases and injuries.* These can include direct health sector costs such as treatment in a hospital, as well as indirect costs, which estimate lost economic production of a person due to an alcohol-related health problem.
- ***Related (non-health) costs** include any alcohol use costs outside the health sector.* These include the alcohol-attributable fraction of costs from crime and property losses, among others. Non-health costs can be either direct, such as court costs, or indirect, such as lost work time incurred by the victim of a crime perpetrated while under the influence of alcohol.

Data and methods

The data used for calculations in this report came from both Minnesota and national sources. Data sources included:

- 1991 Minnesota mortality data (Minnesota Center for Health Statistics, 1992)
- 1990 Census data for Minnesota (US Department of Commerce, 1991)
- Minnesota-specific 1989 direct health care cost data[1] and
- national economic cost data collected by Rice et al. (1990).

The Rice data were for 1985 and were inflated to 1989 levels to be consistent with the more current Minnesota direct health care cost data.[2]

Using ARDI software, a proportion of the national cost data was applied to Minnesota. With the exception of the Minnesota-specific health care cost data mentioned above, all costs were nationally derived and applied to Minnesota population and mortality figures. Data sources, year of data, and cost adjustments are presented in Table 3.4.

Because costs for 1985 and 1989 were applied to 1990 population and 1991 mortality data, the true costs of alcohol use in 1991 might be higher than the estimates using the available cost data. More current cost data for 1990 or 1991 were not available.

Costs in this study are prevalence-based, which means that they estimate the economic burden incurred in a period of time (e.g., one year) as a result of the prevalence of alcohol-related conditions. For example, prevalence-based costs for 1991 would include the treatment costs in 1991 for an individual with alcoholic cirrhosis of the liver, but not the lifetime costs of cirrhosis treatment for that same individual.

Table 3.3 – Characteristics of the five economic cost categories used in this report

	Direct cost	Indirect cost
Core (health) cost		
1. Direct health care	x	
2. Indirect mortality (lost production due to premature death)		x
3. Indirect morbidity (lost production due to non-fatal effects of alcohol use)		x
4. Fetal alcohol syndrome	x	
Related (non-health) cost		
5. Non-health costs	x	x

Source: Alcohol-Related Disease Impact software (Shultz, Parker, & Rice, 1989)

For a given year, therefore, prevalence costs measure the costs for that year alone, for all individuals with a disease regardless of date of onset. In contrast, incidence costs for a given year measure the lifetime costs of a disease, but only for the individuals who were diagnosed in the year of the study.

More extensive information on data, methods, and issues pertinent to each cost category can be found in separate sections later in this chapter, as well as in the appendix.

Direct Health Care Costs

Summary points

- Direct health care costs are the costs of detection, treatment, and rehabilitation of people with alcohol-related diseases and injuries.
- Total alcohol-related direct health care costs for Minnesota in 1991 were $178.6 million, or about $41 per Minnesota resident.
- The majority of costs were for treatment of young to middle-aged men.
- Over 90% of direct health care costs were for treatment, while less than 10% went to support costs such as training, research, and health insurance administration.

Table 3.4 – Economic costs: data sources, dates, and cost adjustments[1]

Cost category	Data sources	Year of data	Cost adjustment	Year of value after adjustment
DIRECT HEALTH CARE				
Hospitals Office-based physicians Nursing homes Other professional services	MN-specific data from Health Care Financing Administration (1992)	1989	-	1989
Specialty institutions Federal providers Support costs	National figures from Rice et al (1990)	1985	Multiplied by 1.44, the ratio of 1989: 1985 nat'l. personal health expenditures[2]	1989
	MN population (US Dept. of Commerce [USDC], 1991)	1990	-	1990
INDIRECT MORTALITY	Present value of future earnings (Rice et al, 1990)	1985	Multiplied by 1.12, the earnings inflator for 1989:1985 earnings ratios[3]	1989
	MN mortality figures (MN Center for Health Statistics, 1992)	1991	-	1991
INDIRECT MORBIDITY	Age- and gender-specific morbidity costs (Rice et al, 1990)	1985	Multiplied by 1.12 earnings inflator	1989
	MN population (USDC, 1991)	1990	-	1990
NON-HEALTH SECTOR	National cost figures from Rice et al (1990)			
	Indirect costs	1985	Multiplied by 1.12 earnings inflator	1989
	Direct costs	1985	-	1985[4]
	MN population (USDC, 1991)	1990	-	1990
FETAL ALCOHOL SYNDROME	National cost estimate	1985	Multiplied by 1.44 health expenditures inflator	1989
	MN population (USDC, 1991)	1990	-	1990

[1] For national data, a proportionate amount is applied to Minnesota.

[2] Health Care Financing Administration (Lazenby & Letsch, 1990).

[3] US Department of Labor (1992), Table C-1: Average hours and earnings of production or nonsupervisory workers.

[4] These costs were not adjusted because an accurate inflator was not identified.

Alcohol-related direct health care costs are the costs of detection, treatment, and rehabilitation of people with alcohol-related diseases and injuries. Minnesota's direct health care costs for 1991 were estimated to total $178.6 million.

Definition

Direct health care costs fall within two main groups: treatment costs by providers, and associated support costs. Treatment costs are classified by the type of provider offering care. "Treatment" refers both to medical care provided for alcohol-related diseases and injuries, as well as chemical dependency treatment for alcohol use. The general descriptor "treatment costs" includes detection, treatment, and rehabilitation. "Support costs" are the costs of research, training, administration, and private health insurance associated with detection, treatment, and rehabilitation.

The Alcohol-Related Disease Impact (ARDI) software (Shultz et al., 1989) used to generate the figures in this report, as well as the study by Rice et al. (1990) on which it is based, do not specifically address prevention costs. However, some of the treatment activities for which costs were calculated may also include prevention efforts. This is especially true for efforts to curtail or prevent further alcohol use among individuals in treatment, or to prevent relapse of former alcoholics who have undergone treatment.

The six treatment cost classes are: hospitals, specialty institutions such as freestanding (non-hospital-based) chemical dependency treatment centers, office-based physicians, nursing homes, other professional services, and federal providers.

Data and methods

Hospital stays, office-based physicians, nursing homes, and other professional services

For hospital stays, office-based physicians, nursing homes, and other professional services, Minnesota-specific cost data were available through the Health Care Financing Administration (1992). The alcohol-related proportion of costs in each of these four categories was determined using nationally-based studies (Rice et al., 1990).

In summary, alcohol-related direct health care costs for each of these four sources of treatment were estimated as follows:

Alcohol-related direct health care costs
(for hospitals, office-based physicians, nursing homes, and other professional services)
= Total 1989 state cost for each component
x National estimate of the alcohol-related proportion of each cost item
(Adapted from Shultz et al., 1991)

Specialty institutions, federal providers, and support

For the remaining three direct health care cost components—specialty institutions, federal providers, and support costs—Minnesota-specific HCFA cost data were not available, so both national cost data as well as national alcohol-related proportions were used.

Table 3.5 – Alcohol-related direct health care costs, Minnesota, 1991 (in millions of dollars[1])

Cost	Male	Female	M:F ratio	Total population	(%)
TREATMENT COSTS					
Hospitals	$61.9	$22.2	2.8/1	$84.1	(47.1%)
Specialty institutions	37.3	9.7	3.8/1	47.0	(26.3)
Office-based physicians	2.8	1.1	2.5/1	3.9	(2.2)
Nursing homes	2.0	5.4	0.4/1	7.5	(4.2)
Professional services				4.8	(2.7)
Federal providers	n/a			18.5	(10.3)
SUPPORT COSTS				12.8	(7.2)
(training, research, public and philanthropic administration, net costs of private insurance)	n/a				
TOTAL				$178.6	

Total cost, per person (in actual dollars, not millions): $41 per person

[1] Numbers may not total exactly due to rounding.

Sources: This table was generated using ARDI software (Shultz et al, 1989), Health Care Financing Administration data for Minnesota (HCFA, 1992), national data collected by Rice and colleagues (1990), and 1990 Minnesota population data (US Department of Commerce, 1991).

The costs for these three treatment sources were calculated for each component source, by five-year age and gender group, as follows:

Alcohol-related direct health care costs
(for specialty institutions, federal providers, and support)
= Total 1985 US alcohol-related direct health care cost for each component/US population
x Minnesota population
x Inflator for 1985 to 1989 cost increase
(Adapted from Shultz et al., 1991)

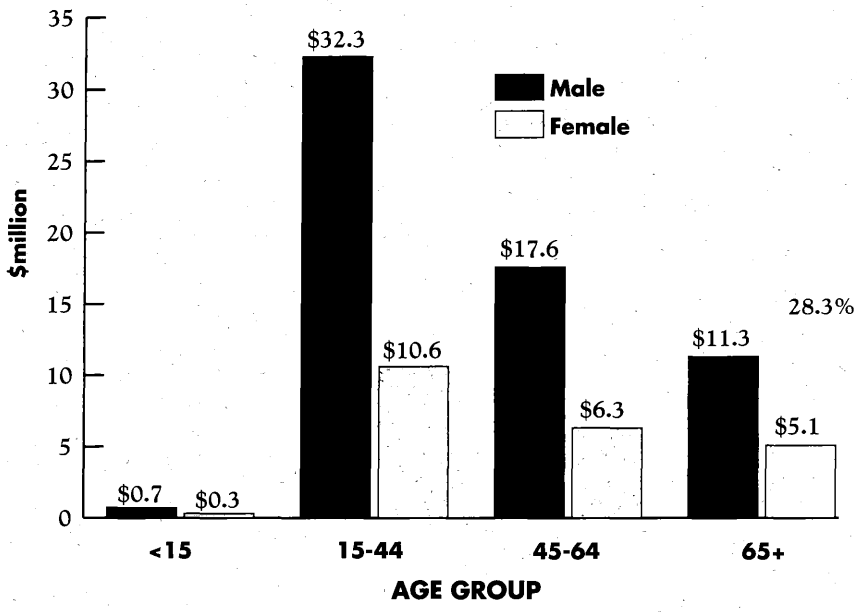
It should be noted that state-level data on the costs of chemical dependency treatment are available through the Minnesota Department of Human Services (1993). Due to software limitations, these data were not used in ARDI cost calculations for this report, but are presented in the appendix for comparative purposes.

Findings

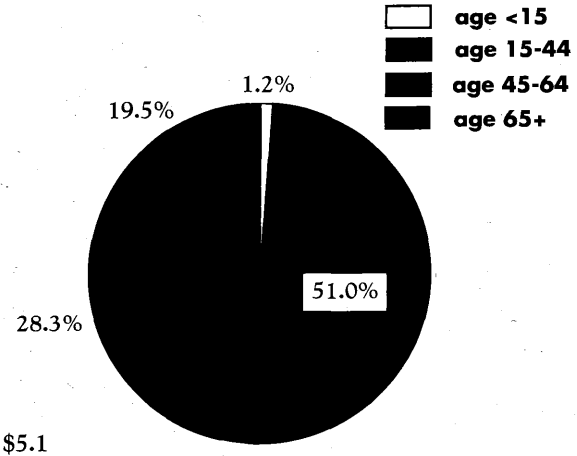
Alcohol-related direct health care costs for Minnesota totaled $178.6 million for 1991 (Table 3.5), about 10% of all alcohol-related costs. Dividing the total direct health care cost by the Minnesota population, the economic cost for each person in Minnesota totaled approximately $41. Hospital costs comprised almost half of total direct health care costs. These costs, together with the costs of specialty institutions such as chemical dependency treatment centers, accounted for almost three-fourths of the total.

With the exception of nursing home costs, men generally incurred costs between two and four times the costs for women (Figures 3.2-3.5).

Figure 3.2 – Alcohol-related hospital costs Minnesota, 1991 (in millions of dollars[1])



% of total costs by age group



[1] Numbers may not total exactly due to rounding.

Sources: This table was generated using ARDI software (Shultz et al., 1989), 1989 Minnesota hospital cost data from the Health Care Financing Administration (HCFA,1992), and 1990 Minnesota population data (US Department of Commerce, 1991).

Most of the mens' costs occurred between their teen years and their early 40s. For hospital costs and office-based physician charges, men aged 15-44 years had the highest costs, at about two-fifths of the total for both sexes combined (Figures 3.2 and 3.4). For specialty institutions, one-third (34%) of the cost was for chemical dependency treatment and rehabilitation of men aged 25-44 (Figure 3.3).

In contrast, womens' nursing home costs exceeded mens' costs. Women over 85 years had the highest portion of nursing home expenses, at over one-third of the total alcohol-related nursing home costs (Figure 3.5). The nursing home ratio reflects the greater longevity of women compared to men.

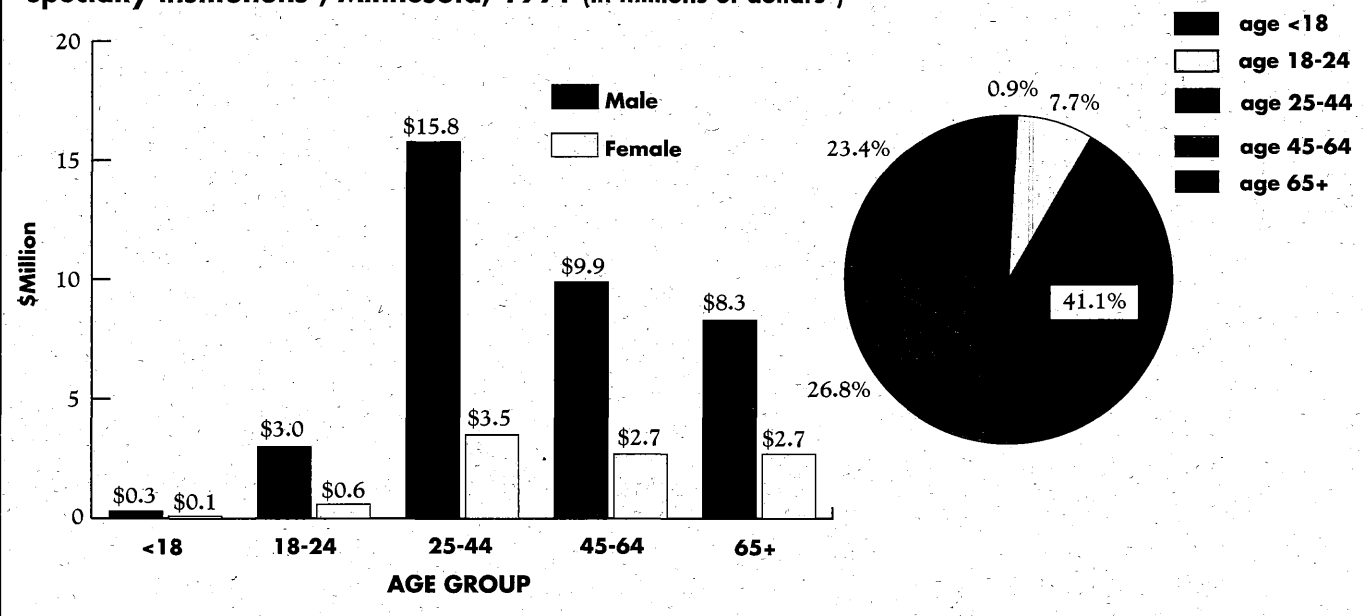
Alcohol-related medical and chemical dependency treatment costs comprised almost all direct health care costs. Less than one-tenth of the costs were for the support activities of training, research, program administration, and net costs of private health insurance.

Issues and limitations

The direct health care cost estimates presented here must be viewed as best estimates for several reasons, including: (1) use of both national and Minnesota data in the calculations; (2) differing dates used for state population, mortality, and cost data; (3) probable underreporting of alcohol involvement in hospital records; and (4) lack of explicit inclusion of prevention costs.

These estimates are likely to be conservative, especially given Minnesota's higher-than-average alcohol consumption levels (see chapter 1), and underreporting of alcohol involvement in disease and injury diagnoses.

Figure 3.3– Alcohol-related costs for admissions to specialty institutions[1], Minnesota, 1991 (in millions of dollars[2])



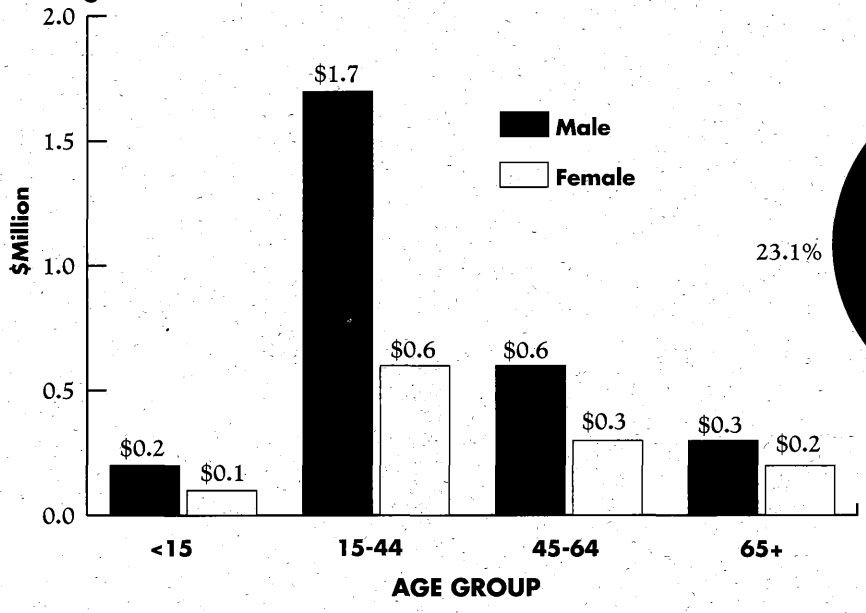
% of total costs by age group

[1] Specialty institutions include institutions such as freestanding alcohol, drug and mental health care organizations.

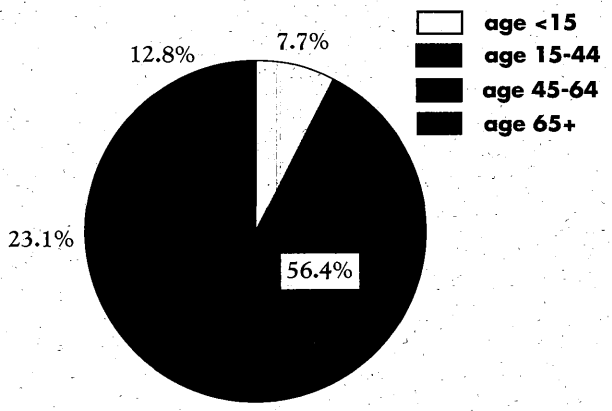
[2] Numbers may not total exactly due to rounding.

Sources: This table was generated using ARDI software (Shultz et al., 1989), US specialty institution cost data (Rice et al., 1990), and 1990 Minnesota population data (US Department of Commerce, 1991).

Figure 3.4 – Alcohol-related office-based physician charges, Minnesota, 1991 (in millions of dollars[1])



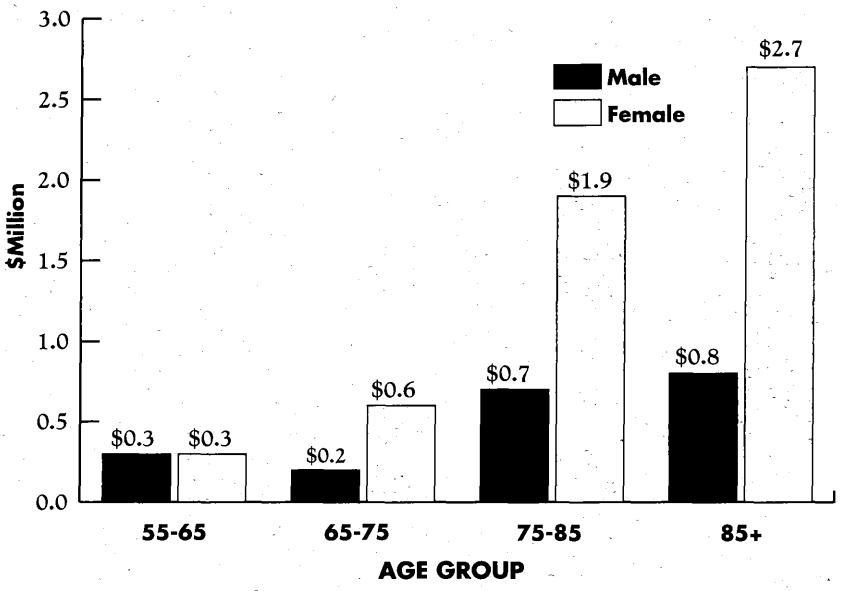
% of total charges by age group



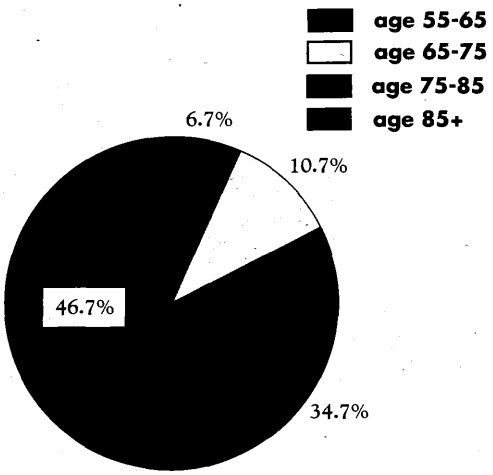
[1] Numbers may not total exactly due to rounding.

Sources: This table was generated using ARDI software (Shultz et al., 1989), 1989 Minnesota office-based physician cost data from the Health Care Financing Administration (HCFA,1992), and 1990 Minnesota population data (US Department of Commerce, 1991).

Figure 3.5 – Alcohol-related nursing home charges Minnesota, 1991 (in millions of dollars[1])



% of total charges by age group



[1] Numbers may not total exactly due to rounding.

Sources: This table was generated using ARDI software (Shultz et al., 1989), 1989 Minnesota office-based physician cost data from the Health Care Financing Administration (HCFA,1992), and 1990 Minnesota population data (US Department of Commerce, 1991).

For additional information on the definitions, data and methods, and issues and limitations regarding direct health care costs, please refer to the appendix to this chapter.

Indirect Mortality Costs

Summary points

- Indirect mortality costs estimate the lost economic productivity of people who die prematurely from alcohol-related causes. This lost productivity is measured by the value of the earnings a person would have gained if he or she had not died prematurely.
- Minnesota's indirect mortality costs totaled $393.3 million in 1991. This translated to a cost of about $90 for every Minnesotan.
- Deaths from alcohol-related injuries accounted for the highest percentage of indirect mortality costs, at 43.9%. Violent deaths were the second highest category, leading to 27.7% of all indirect mortality costs.
- The five specific causes of death leading to the highest costs were, in order (in millions of dollars): motor vehicle crashes ($124.6); suicide ($76.0); homicide ($32.9); acute cirrhosis of the liver ($26.1); and alcohol dependence syndrome ($22.9).

- Almost four-fifths of all indirect mortality costs were related to male deaths. This is due in part to the higher numbers of deaths and the higher earnings of males than females.
- For young people, costs from deaths by injury or violence were highest. For older people, costs from diseases were more predominant.

Definition

Indirect mortality costs are the value of lost economic productivity of people who die prematurely from alcohol-related causes. The alcohol-related costs of indirect mortality in Minnesota in 1991 totaled $393.3 million in 1991.

Because productivity is difficult to quantify, an individual's earnings are commonly used as a measure of his or her productivity. The earnings that are lost due to premature death therefore serve as a proxy measure of lost economic productivity. This use of earnings as a measure of productivity is based on the "human capital" approach, which is described in more detail in the appendix.

Indirect mortality is the economic equivalent of the years of potential life lost (YPLL) epidemiological measure (see chapter 2). Indirect mortality calculations assign a monetary value to years of life lost as a result of alcohol-related early deaths (Shultz et al., 1989). An individual's productivity loss for future years is assigned to the year of his or her death.

Data and methods

For each alcohol-related diagnosis, ARDI software was used to calculate the estimated lost earnings due to premature alcohol-related death in Minnesota in 1991. Mortality data from the Minnesota Center for Health Statistics (1992) were used in combination with nationally derived alcohol-attributable fractions to obtain alcohol-related mortality for each diagnosis.

Indirect mortality costs were calculated as follows for each five-year age and gender group in each diagnosis:

Alcohol-related indirect mortality costs

= Minnesota deaths
x AAF x PVFE x Inflator
where
AAF = alcohol-attributable fraction of deaths, and
PVFE = present value of future earnings
(Adapted from Shultz et al., 1991)

Findings

Alcohol-related indirect mortality costs

The 1991 total value of lost productivity due to premature alcohol-related deaths in Minnesota totaled approximately $393.3 million. This translates to a cost of about $90 for every Minnesotan in 1991. These costs of premature death—indirect mortality costs—totaled nearly one-fourth (23%) of all alcohol-related costs. They were second only to the costs of lost productivity due to alcohol-related disorders ("indirect morbidity" costs—see next section of chapter 3).

Table 3.6 shows the number of alcohol-attributable deaths, total years of potential life lost, and indirect mortality costs by cause of death. Injuries accounted for the highest percentage of deaths, years of life lost, and cost.

Table 3.6 – Alcohol-attributable deaths, years of potential life lost (YPLL), and indirect mortality costs, Minnesota, 1991[1]

Cause of death category	Alcohol attributable deaths	(% of total)	YPLL to life expectancy	(% of total)	Indirect mortality cost (in millions of dollars)[2]	(% of total)
Injuries	457	29%	13,762	40%	$172.7	44%
Violence	193	12%	7,066	21%	108.9	28%
Digestive diseases	250	16%	4,640	14%	46.4	12%
Mental disorders	101	6%	2,120	6%	26.8	7%
Cancers	260	16%	3,488	10%	23.5	6%
Cardiovascular diseases	204	13%	1,982	6%	9.7	2%
Respiratory diseases	77	5%	611	2%	1.7	0.4%
Other diagnoses[3]	38	2%	508	2%	3.6	1%
Total	1,581		34,177		$393.3	

Cost per person (in actual dollars, not millions): $90

[1] The total number of alcohol-attributable deaths may not be the exact sum of alcohol-attributable deaths for each cause of death. This is because the alcohol-attributable figures are the alcohol-attributable percentage of total deaths for each cause of death, rounded to the nearest whole number.

[2] Costs were calculated using a four percent discount rate and a 1989:1985 earnings inflator of 1.12 (see text for explanation).

[3] Excess blood alcohol and diabetes mellitus.

Sources: This table was generated using ARDI software (Schultz et al., 1989) and 1991 Minnesota mortality data (Minnesota Center for Health Statistics, 1992)

Injuries and violent deaths (suicide and homicide) together accounted for almost two-thirds of all indirect mortality costs. This was due to several factors:

- Almost half of all alcohol-related deaths are due to injuries and violence.
- Many of these deaths happen at relatively young ages, leading to high losses of lifetime earnings.
- Over twice as many deaths due to injuries and violence occur among males compared to females. Since males have generally higher earnings than females, the resulting lost earnings will be higher (Parker et al., 1985).

Table 3.7 elaborates on the data in Table 3.6, listing figures by specific cause of death within each broader diagnostic category. Table 3.8 ranks the five leading specific causes of death in terms of indirect mortality costs. Motor vehicle crashes were by far the greatest single contributor to costs, accounting for nearly one-third of all indirect mortality costs in Minnesota in 1991.

Table 3.9 displays indirect mortality costs by gender for each cause of death category. The high proportion of costs attributable to male alcohol-related deaths was mainly due to the greater number of deaths and the higher earnings of men compared to women.[3]

Table 3.7 – Alcohol-related deaths, YPLL to life expectancy, and indirect mortality costs for specific cause of death, Minnesota, 1991[1],[2]

Cause of death	Alcohol-related deaths	YPLL Years	YPLL (% of total)	Indirect mortality cost $ mill	Indirect mortality cost (% of total cost)
Injuries					
Motor vehicle crashes	247	9,417	27.6	$124.6	31.7
Accidental falls	124	1,286	3.8	8.6	2.2
Injuries by fire	26	973	2.8	11.0	2.8
Drownings	21	952	2.8	11.1	2.8
Other injuries	18	437	1.3	5.8	1.5
Alcohol poisoning	13	407	1.2	7.0	1.8
Air/Space transport	4	155	0.5	2.5	0.6
Boating	4	108	0.3	1.7	0.4
Other vehicle crashes	1	27	<0.1	0.5	0.1
Subtotal	**457**	**13,762**	**40.3**	**172.7**	**43.9**
Violence					
Suicide	139	4,933	14.4	76.0	19.3
Homicide	54	2,133	6.2	32.9	8.4
Subtotal	**193**	**7,066**	**20.7**	**108.9**	**27.7**
Digestive diseases					
Acute cirrhosis of the liver	119	2,444	7.2	26.1	6.6
Other cirrhosis	59	871	2.5	6.8	1.7
Alcoholic liver damage	26	529	1.5	5.6	1.4
Diseases of esophagus/stomach	16	159	0.5	0.7	0.2
Acute alcoholic hepatitis	15	400	1.2	5.3	1.3
Acute pancreatitis	13	185	0.5	1.5	0.4
Chronic pancreatitis	1	14	<0.1	<0.1	<0.1
Alcoholic fatty liver disease	1	38	0.1	0.4	0.1
Subtotal	**250**	**4,640**	**13.6**	**46.4**	**11.8**
Mental disorders					
Alcohol dependence syndrome	86	1,818	5.3	22.9	5.8
Alcohol abuse	8	214	0.6	3.2	0.8
Alcohol psychosis	7	88	0.3	0.7	0.2
Subtotal	**101**	**2,120**	**6.2**	**26.8**	**6.8**
Cancers					
Esophagus	128	1,712	5.0	12.0	3.1
Mouth & lip	57	838	2.5	6.3	1.6
Stomach	38	456	1.3	2.6	0.7
Larynx	22	272	0.8	1.4	0.4
Liver	16	210	0.6	1.2	0.3
Subtotal	**260**	**3,488**	**10.2**	**23.5**	**6.0**
Cardiovascular diseases					
Cerebrovascular disease	184	1,634	4.8	5.5	1.4
Essential hypertension	11	104	0.3	0.4	0.1
Alcoholic cardiomyopathy	9	244	0.7	3.8	1.0
Subtotal	**204**	**1,982**	**5.8**	**9.7**	**2.5**
Respiratory diseases					
Respiratory TB	1	3	<0.1	<0.1	<0.1
Pneumonia/influenza	77	608	1.8	1.7	0.4
Subtotal	**77**	**611**	**1.8**	**1.7**	**0.4**
Other alcohol-related deaths	**38**	**508**	**1.5**	**3.6**	**0.9**
TOTAL	**1,581**	**34,177**	**100**	**393.3**	**100**

[1] The subtotals and total number of alcohol-attributable deaths may not be the exact sum of alcohol-attributable deaths for each cause of death. This is because the alcohol-attributable figures are the alcohol-attributable percentage of total deaths for each cause of death, rounded to the nearest whole number. In addition, cost and percentage figures may not total exactly due to rounding.

[2] Costs discounted at 4% and a 1989:1985 earnings inflator of 1.12 was used.

Sources: This table was generated using ARDI software Shultz et al., 1989 and 1991 Minnesota mortality data Minnesota Center for Health Statistics, 1992.

Table 3.10 lists indirect mortality costs by cause of death and age category. Figure 3.6 combines all deaths from diseases into one group and all deaths from injuries and violence into a second group, then depicts the percentage of indirect mortality costs caused by each of these two groups for each of the three age categories. Most striking is the finding that alcohol-related deaths from injuries and violence contributed to 97% of all indirect mortality costs for young people (0-34 years).

Table 3.11 shows how the highest three contributors to indirect mortality costs varied between males and females across age categories. For both males and females under 35 years, motor vehicle crashes, suicide, and homicide accounted for over 80% of lost earnings in this age group. In the middle years (35-64 years), indirect mortality costs from alcohol-related diseases became more prominent, although motor vehicle crashes and suicide remained important causes. For people 65 years and older, diseases became the leading contributor to costs.

For more information about diseases, injuries, and violence, see chapter 4.

Alcohol-related indirect mortality cost rates

The ARDI software also calculates age- and gender-specific alcohol-related indirect mortality cost rates per 100,000 population and age-adjusted mortality cost rates per 100,000 population. Adjustment to a standard population (the US population) permits comparisons to other states with different age structures. The unadjusted and age-adjusted indirect mortality cost rates are presented in Table 3.12.

Table 3.8 – The five specific causes of death leading to highest indirect mortality costs, Minnesota, 1991

Specific cause of death	Cost (in millions of dollars)	Percent of total cost
Motor vehicle crashes	$124.6	31.7%
Suicide	76.0	19.3
Homicide	32.9	8.4
Acute cirrhosis: liver	26.1	6.6
Alcohol dependence syndrome	22.9	5.8

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 Minnesota mortality data (Minnesota Center for Health Statistics, 1992).

Table 3.9 – Alcohol-related indirect mortality costs by cause of death and gender, Minnesota, 1991[1]

	Cost (in millions of dollars)		
Cause of death category	Males	Females	Total
Injuries	$ 135.5	$ 37.1	$ 172.7
Violence	93.2	15.7	108.9
Digestive diseases	30.9	15.5	46.4
Mental disorders	23.7	3.2	26.8
Cancers	18.3	5.2	23.5
Cardiovascular diseases	6.8	2.9	9.7
Respiratory diseases	1.0	0.7	1.7
Other diagnoses	2.4	1.2	3.6
TOTAL	$ 311.9	$ 81.5	$ 393.3

[1] Numbers may not total exactly due to rounding. Costs were calculated using a four percent discount rate and a 1989:1985 earnings inflator of 1.12.

Source: This table was generated using ARDI software (Shultz et al., 1989) and 1991 Minnesota mortality data (Minnesota Center for Health Statistics, 1992).

Issues and limitations

Major issues and limitations of indirect mortality costs estimates include the following:

1. The human capital method of measuring the cost of an alcohol-related premature death uses the economic value of lost potential productivity of an individual. This is the most accepted economic method to evaluate the loss of a human life, but it has several limitations.

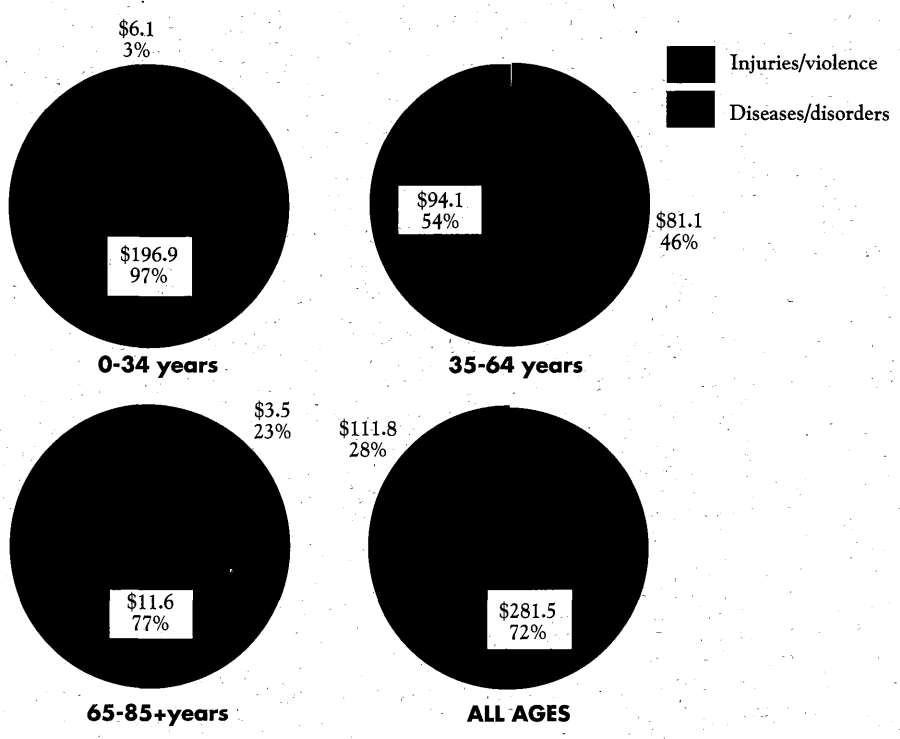
Table 3.10 – Alcohol-related indirect mortality costs, by cause of death and age, Minnesota, 1991 (in millions of dollars[1])

Cause of death category	0-34 yrs	35-64 yrs	65-85+ yrs	All ages (%)
Injuries	$127.1	$ 42.7	$ 2.8	$172.7 (43.9%)
Violence	$ 69.7	$ 38.5	$ 0.7	$108.9 (27.7%)
Digestive diseases	$ 2.0	$ 41.4	$ 3.0	$ 46.4 (11.8%)
Mental disorders	$ 2.4	$ 23.4	$ 1.0	$ 26.8 (6.8%)
Cancers	$ 0	$ 19.3	$ 4.3	$ 23.5 (6.0%)
Cardiovascular diseases	$ 0.8	$ 6.8	$ 2.1	$ 9.7 (2.5%)
Respiratory diseases	$ 0	$ 1.1	$ 0.6	$ 1.7 (0.4%)
Other diagnoses	$ 0.8	$ 2.2	$ 0.6	$ 3.6 (0.9%)
TOTAL	$203.0	$175.2	$ 15.1	$393.3 (100%)

[1] Numbers may not sum exactly due to rounding. Calculated at 4% discount rate and 1989:1985 earnings inflator of 1.12.

Source: This table was generated using ARDI software (Shultz et al., 1989) and 1991 Minnesota mortality data (Minnesota Center for Health Statistics, 1992).

Figure 3.6 – Indirect mortality cost of diseases vs. injuries and violence, Minnesota, 1991 (in millions of dollars[1])



[1] May not total exactly due to rounding. Costs calculated using a four percent discount rate and a 1989:1985 earnings inflator of 1.12.

Source: This figure was generated using ARDI software (Shultz et al., 1989) and 1991 Minnesota mortality data (Minnesota Center for Health Statistics, 1992).

2. The discount rate selected to collapse future earnings to their present value will greatly affect the resulting estimate of lost productivity due to alcohol-related death.

3. For each disease or injury death, applying a single alcohol-attributable fraction for all age and gender groups tends to underestimate alcohol-related costs (Shultz et al., 1989).

4. Alcohol-related consumption and mortality vary across occupations, which may not be adequately reflected in indirect mortality costs.

For additional information on the data and methods, issues, and limitations regarding indirect mortality costs, please refer to the appendix to this chapter.

Table 3.11 - Three causes of death with highest indirect mortality costs, by age and gender, Minnesota, 1991

	Males	Females
0-34 years	Motor vehicle crashes Suicide Homicide	Motor vehicle crashes Suicide Homicide
35-64 years	Suicide Alcohol dependence syndrome Motor vehicle crashes	Acute cirrhosis: liver Motor vehicle crashes Suicide
65-85+ years	Cancer: esophagus Cerebrovascular disease Alcohol dependence syndrome	Cerebrovascular disease Motor vehicle crashes Acute cirrhosis: liver

Sources: ARDI software (Shultz et al., 1989) and 1991 Minnesota mortality data (Minnesota Center for Health Statistics, 1992).

Table 3.12 - Unadjusted and age-adjusted indirect mortality cost rates, Minnesota, 1991[1]

	Cost (in millions of dollars)		
Cause of death category	Males	Females	Total
Unadjusted rate per 100,000 pop.	$ 14.5	$ 3.7	$ 9.0
Age-adjusted rate per 100,000 pop.	$ 14.8	$ 3.8	$ 9.2

[1] In millions of dollars. Minnesota figures are standardized to US population by five-year age groups.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1991 Minnesota mortality data (Minnesota Center for Health Statistics, 1992).

Indirect Morbidity Costs

Summary points

- Indirect morbidity costs estimate the lost economic productivity of people due to non-fatal effects of alcohol use disorders, measured by the reductions in personal income that result from such use.
- Indirect morbidity costs totaled $891.8 million in 1991, making this category the greatest source of alcohol-related costs in Minnesota. The cost per Minnesota resident was about $204 in 1991.
- The highest cost component within indirect morbidity costs was for males aged 35-54 years, which reflects not only the level of alcohol consumption, but also such factors as the higher earnings and labor force participation of males compared to females.
- Productivity losses are difficult to measure and can only be calculated indirectly through such means as estimated alcohol-related income losses.

Indirect morbidity costs are the value of lost economic productivity of people due to non-fatal effects of alcohol use disorders. These costs represent the value of goods and services that could have been produced for society if these individuals had been fully productive (Shultz, Parker, & Rice, 1989). Indirect morbidity costs in Minnesota were estimated to total $891.8 million in 1991, over half of all alcohol-related costs.

Definition

Indirect *morbidity* costs differ from indirect *mortality* costs in that alcohol-related morbidity costs are incurred while a person is living, whereas mortality costs are the costs of lost productivity after a person has died from an alcohol-related disease or injury. Indirect morbidity costs measure those costs that occur *during the year of study*. Indirect mortality costs include costs *for the year of study and all succeeding years* for people who died during the study year.

Table 3.13 – Alcohol-related percentage earned income lost due to alcohol abuse or dependence

Age group	Male	Female
18-24	1.4%	0.8%
25-34	3.0	2.8
35-54	5.5	11.9
55-64	9.3	18.7

Source: Rice et al., 1990.

Because productivity is difficult to quantify, a person's income is used here as a measure of his or her productivity. Income includes wages or salary earnings, transfer payments such as welfare support, and property income such as dividends. Measurement of alcohol-related income loss is based on the difference between the average personal income of individuals given a diagnosis of alcohol abuse or alcohol dependence and the average personal income of non-abusing, non-dependent individuals. The difference is then multiplied by the number of individuals estimated to be abusing or dependent on alcohol.

The income reductions used by ARDI software to generate indirect morbidity figures for Minnesota were based on calculations by Rice, Kelman, Miller, and Dunmeyer (1990). Table 3.13 lists the age- and gender-specific estimated percentage of income lost related to alcohol consumption. These estimated reductions are based on six classes of alcohol-related productivity losses. Two of these result from *reduced on-the-job productivity*:

- lowered occupational achievement, and
- lower levels of work effectiveness.

The other four classes result from *total losses of productivity due to time off work*:

- reduced labor force participation,
- increased unemployment,
- increased part-time work, and
- lost time due to absenteeism or tardiness.

(Cruze, Harwood, Kristiansen, Collins, & Jones, 1981; Rice et al., 1990).

Data and methods

Indirect morbidity costs were calculated for both non-institutionalized and institutionalized people. Institutionalized individuals include residents of nursing homes and state and county mental hospitals (Rice et al., 1990).

Data sources included the 1990 Census (US Department of Commerce, 1991) for Minnesota population figures; and Rice et al. (1990) for alcohol-related income loss percentages and average income levels.

For *non-institutionalized* individuals, indirect morbidity costs were calculated for each age and gender group as follows, then summed.

Alcohol-related indirect morbidity costs for non-institutionalized people

= Minnesota non-institutionalized population
x Prevalence of alcohol abuse and/or dependence
x Average 1985 income
x Alcohol-related percentage of income lost
x Inflator for 1985 to 1989 cost increase
(Adapted from Shultz et al., 1991)

For *institutionalized* individuals, indirect morbidity costs were calculated for each age and gender group as follows, then summed.

Alcohol-related indirect morbidity costs for institutionalized people

= Minnesota population institutionalized related to alcohol abuse or dependence
x Labor force participation rate
x Average 1985 earnings and wage supplements
x Inflator for 1985 to 1989 cost increase

Findings

The 1991 indirect morbidity costs for Minnesota were estimated at $891.8 million, comprising the largest single portion (51%) of all alcohol-related costs in the state. The cost of alcohol-related indirect morbidity was approximately $204 for every Minnesotan in 1991.

Productivity losses by non-institutionalized individuals led to $883.7 million in indirect morbidity costs, or about $202 for each Minnesota resident (Table 3.14). These non-institutionalized population costs accounted for 99% of the total indirect morbidity costs. For institutionalized individuals, the cost was $8.1 million, or $2 per Minnesotan (Table 3.15).

For the non-institutionalized population, the largest cost component was for males aged 35-54 years. The higher figures for males reflect not only the higher level of alcohol consumption, but also such factors as higher earnings and labor force participation of males compared to females. However, the total cost for non-institutionalized females is likely to be an underestimate, since no figure was available for 18-24 year-old women.

Table 3.14 – Indirect morbidity costs, non-institutionalized population, Minnesota, 1991 (in millions of dollars[1])

Age group	Male	Female	Both
18-24	$ 0.8	$ n.a.	$ 0.8
25-34	247.5	61.8	309.3
35-54	441.3	47.6	489.0
55-64	83.9	0.7	84.6
TOTAL	$773.6	$110.1	$883.7

Cost per person: $202
(in actual dollars, not millions)

[1] Numbers may not total exactly due to rounding

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1990 Minnesota population figures (US Department of Commerce, 1991).

Table 3.15 – Indirect morbidity costs, institutionalized population, Minnesota, 1991 (in millions of dollars[1])

Age group	Male	Female	Both
18-24	$ < 0.1	$ < 0.1	$ 0.1
25-44	1.1	0.2	1.2
45-64	6.4	0.1	6.5
65+	0.2	< 0.1	0.2
TOTAL	$7.7	$0.4	$8.1

Cost per person: $2
(in actual dollars, not millions)

[1] Numbers may not total exactly due to rounding

Sources: This table was generated using ARDI software (Shultz et al., 1989) and 1990 Minnesota population figures (US Department of Commerce, 1991).

Issues and limitations

Indirect morbidity and indirect mortality costs are difficult to measure because they are estimates of what is *not* produced, such as lost earnings due to alcohol-related impairments (Rice et al., 1990). This contrasts with direct costs, which measure the value of goods and services that *are* produced, such as hospital care.

In general, most studies find that heavy, abusive, and dependent drinking leads to decreased personal and household income, though effects of moderate drinking on work performance are less clear (Mullahy & Sindelar, 1992).

For additional information on the data and methods, issues, and limitations regarding indirect morbidity costs, please refer to the appendix to this chapter.

Fetal Alcohol Syndrome Costs

Summary points

- Fetal alcohol syndrome costs are the costs for care and treatment of individuals with fetal alcohol syndrome (FAS). The costs of fetal alcohol effects (FAE) were not included here, due to difficulties in estimating the incidence and prevalence of FAE, as well as complexities involved in assessing the nature and amount of costs associated with FAE.
- The incidence and prevalence of FAS are difficult to assess, and many costs associated with FAS cannot yet be adequately estimated. Some recent estimates of FAS incidence have ranged from 0.33 to 1.9 per 1,000 live births. The FAS cost estimate in this report is based on the 1.9/1,000 incidence.
- Total estimated FAS costs in Minnesota for 1991 were $44.8 million, or about $10 for every person in Minnesota. This includes all costs that were incurred for individuals of all ages with FAS. It does not include the FAS-related costs for these individuals in years other than 1991.
- Costs for adults with FAS are a major portion of total FAS costs. Nationwide, over four-fifths of FAS costs are for residential care and support of adults with FAS.
- It is estimated that FAE is approximately three times as common as FAS.

Definition

Fetal alcohol syndrome costs are the costs for care and treatment of individuals with fetal alcohol syndrome (FAS). Fetal alcohol syndrome is a condition characterized by a distinct set of physical and mental abnormalities observed in children born to mothers who drank heavily during pregnancy. The costs of FAS in Minnesota were estimated to be $44.8 million in 1991.

Major FAS cost components include (a) neonatal intensive care for treating growth retardation, (b) surgical correction for abnormalities, (c) full-time residential care for youth with severe mental impairments, (d) semi-independent

supervised care for youth with moderate mental impairments, (e) residential and support services for adults over 21 who are mentally impaired, and (f) Minnesota's portion of federal research.

Data and methods

The costs of FAS in Minnesota were estimated as Minnesota's proportion of the national costs of FAS (Abel & Sokol, 1987; Rice et al., 1990). The national cost of FAS in 1985 was estimated to total over $1.6 billion. The Minnesota cost was calculated based on Minnesota's proportion of the US population. Cost figures were updated using an inflator to reflect the rise in health care costs since 1985.

In short, Minnesota's FAS costs were:

Fetal alcohol syndrome costs
= US costs
x Minnesota population/US population
x Inflator for 1985 to 1989 cost increase

Findings

The costs of FAS in Minnesota were estimated to be $44.8 million, representing about 3% of total alcohol-related costs in the state (Table 3.16). This translates to a cost of about $10 for every person in Minnesota. At the national level, over four-fifths of the costs were for residential care and support of adults with FAS, with the remaining one-fifth expended on care for individuals under 21 years. The proportion may be similar in Minnesota, but no actual state cost breakdowns are available.

For more information about fetal alcohol syndrome and fetal alcohol effects, see the section entitled "Alcohol consumption during pregnancy" in chapter 4.

Issues and limitations

Although reasonably good cost data exist for treatment of FAS conditions, reliable data on the incidence of FAS are still unavailable (Abel, 1990). In this report, the cost for Minnesota was based on a national estimate of 1.9 FAS cases per 1,000 live births. A more recent estimate placed the incidence at 0.33 per 1,000, but this may be low (Day, 1992). In addition, drinking levels among women of childbearing age are higher in Minnesota than in most other states, potentially raising the risk for FAS (Centers for Disease Control and Prevention, 1994).

To arrive at a more accurate estimate of FAS costs, Minnesota-specific cost data on treatment, education, and residential care, as well as state-specific incidence data, are needed.

For additional information on the data and methods, issues, and limitations regarding fetal alcohol syndrome costs, please refer to the appendix to this chapter.

Table 3.16 - Fetal alcohol syndrome costs, Minnesota, 1991

Minnesota 1991 cost

= US 1985 cost
x Minnesota population/US population
x Inflator to update costs

Estimated Minnesota 1991 FAS cost:	**$44.8 million**
Per-person Minnesota FAS cost in 1991:	**$10**

Sources: ARDI software (Shultz et al., 1989), 1990 Minnesota population data (US Dept. of Commerce, 1991) and 1985 national cost figures inflated to 1989 values.

Non-Health Sector Costs

Summary points

- Non-health sector costs cover a broad range of areas, including the non-medical costs of alcohol-related crime, motor vehicle crashes, fire destruction, and social welfare administration.
- Minnesota's non-health sector costs totaled over $228 million in 1991, for a cost of about $52 for every Minnesotan.
- Crime-related direct and indirect costs accounted for 70% of all non-health sector costs.
- Motor vehicle crashes were the second highest cost category, at one-fourth of all non-health sector costs.
- The costs of pain and suffering resulting from personal violence and property destruction cannot be adequately measured.

Definition

Non-health sector costs are all alcohol-related costs occurring outside the health sector. These cover a broad range of areas. Direct costs include public and private expenditures for crime, property destruction due to crime, motor vehicle crashes (except medical costs), fire destruction, and social welfare program administration. Indirect costs include the value of lost work productivity of crime victims and incarcerated criminals due to alcohol-related offenses (Rice, Kelman, Miller, & Dunmeyer, 1990). Minnesota's non-health sector costs were estimated at $228.1 million in 1991.

Data and methods

The eight non-health sector cost components are:

(1) public criminal justice system

(2) private legal defense

(3) crime-related property destruction

(4) motor vehicle crashes (non-medical costs)

(5) fire destruction

(6) social welfare administration

(7) lost work days for victims of crime

(8) lost work days for incarcerated criminals

National non-health sector costs were applied to the Minnesota population using the following formula:

Alcohol-related non-health sector costs

= (US costs/US population)
x Minnesota population
x Inflator for 1985 to 1989 cost increase (for indirect costs only)
(Adapted from Shultz et al., 1991)

The combined costs for all components then yielded the estimated total non-health sector costs.

Findings

Alcohol-related 1991 non-health sector costs in Minnesota totaled $228.1 million (Table 3.17), or 13% of all the costs of alcohol use. This translates to a cost of $52 for every Minnesotan in 1991. Although non-health sector costs are incurred due to the alcohol consumption of individuals, many of these costs are paid by society through publicly funded activities and programs (e.g., alcohol-related costs of law enforcement, social welfare administration).

Crime-related direct and indirect costs accounted for 70% of non-health sector costs (Table 3.18). Motor vehicle crashes created the next largest set of costs, at nearly one-fourth of the total. These include legal/court costs, insurance administration, and vehicle damage for crash fatalities, injuries, and property damage. Fire destruction and social welfare administration comprised the remainder of non-health sector costs.

For more information on these topics, including additional Minnesota data, see chapter 4.

Table 3.17 – Alcohol-related non-health sector costs, Minnesota, 1991 (in millions of dollars[1])

Cost	Both genders	(%)
DIRECT COSTS[2]		
Crime[3]	$ 91.9	(40.3%)
Motor vehicle crashes	55.9	(24.5)
Fire destruction	9.9	(4.3)
Social welfare administration	1.9	(0.8)
Subtotal direct costs	159.6	(70.0)
INDIRECT COSTS[4]		
Victims of crime	10.1	(4.4)
Incarceration	58.4	(25.6)
Subtotal indirect costs	68.5	(30.0)
TOTAL	$228.1	
Total cost, per person (in actual dollars, not millions) : $52		

1 Numbers may not total exactly due to rounding.
2 Direct costs are the actual dollar value of goods and services associated with alcohol abuse, e.g., property losses due to alcohol-related crime.
3 Includes costs of the public criminal justice system, private legal defense, and crime-related property destruction.
4 Indirect costs are the value of lost economic productivity related to alcohol abuse, e.g., the value of lost work time of crime victims and criminals due to alcohol-related crimes.

Sources: This table was generated using ARDI software (Shultz et al., 1989) and the 1990 Minnesota population (US Department of Commerce, 1991).

Issues and limitations

In addition to the general issues listed in the introduction to this chapter, three areas are of special concern: (1) the need to utilize more Minnesota data sources; (2) the relationship of alcohol to crimes and the assignment of an alcohol-attributable percentage to various crimes; and (3) the relative underdevelopment of non-health sector cost estimation techniques compared to other cost categories.

For additional information on the data and methods, issues, and limitations regarding non-health sector costs, please refer to the appendix to this chapter.

Table 3.18 – Crime-related direct and indirect non-health costs, Minnesota, 1991 (in millions of dollars)

DIRECT COSTS:	
Criminal justice system	
- police protection	
- legal and judicial services	
- federal (Minnesota's share), state, and local corrections	
Private legal defense	
Criminal property destruction	
Subtotal direct costs:	$91.9
INDIRECT COSTS:	
Value of lost work days for victims of crime	$10.1
Value of lost work days for incarcerated criminals	$58.4
Subtotal indirect costs:	$68.5
TOTAL	$160.4

Sources: Rice et al. (1990), Shultz et al. (1989), ARDI calculations

Implications for public health promotion and protection

Alcohol-related economic costs affect society at all levels: individual, family, community, state, and nation. These costs may be health-related, such as hospital costs or lost productivity due to alcohol-associated disease and injury; or they may be non-health costs, such as the alcohol-related costs of law enforcement.

Economic costs are an indicator of the seriousness of public health problems associated with alcohol consumption. Reductions in economic costs can serve as a measure of the effectiveness of efforts to address this issue. However, it is important to recognize that in addition to economic costs, there are also other compelling reasons to take action to prevent or diminish the harmful effects of alcohol use. These include many aspects that are not readily quantified, such as the emotional pain suffered by individuals and families affected by alcohol-related problems, and resulting tensions in the larger society.

Alcohol plays a significant role in the occurrence of many health and social problems, such as chronic diseases, poor pregnancy outcomes, injuries, and interpersonal violence. At the same time, resources to address these problems are limited. Prevention of alcohol-related problems is complicated and challenged by varied patterns of alcohol use, inconsistent and unenforced public policy, and permissive social norms. Community-based health promotion is an important and promising strategy to meet this challenge, reduce subsequent costs, and ultimately free resources to address other pressing needs.

Organizations can employ many public health strategies to reduce alcohol-related costs. These include: (1) educational efforts to create changes in the social environment; (2) development of public policies to encourage responsible choices about alcohol; (3) professional education and training; (4) systematic screening and referral to chemical dependency treatment programs; (5) sound evaluation of the effectiveness of programs and policies; and (6) ongoing studies to understand the scope of the problem and trends over time.

A review of this chapter points to some specific areas where public health actions may identify and reduce alcohol-related costs:

Direct health care: (1) Training health care providers to better recognize and record alcohol involvement in medical diagnoses will lead to a better understanding of where alcohol-related direct health care costs are the greatest.

(2) From a cost standpoint, focusing efforts such as education and alcohol treatment on young to middle-aged men will potentially provide the most savings at the present time. However, it is important to remember that some costs associated with women's alcohol consumption are measured in other categories, such as fetal alcohol syndrome.

Indirect mortality: (1) Injury is the largest cost category. Among injuries, motor vehicle crashes are the single most significant contributor to indirect mortality costs. Efforts to reduce injury potential, especially drinking and driving (e.g., stiffer penalties for DWI offenses) are public health activities which may decrease costs in this area. (2) The highest mortality costs at the present time are associated with young males. Media campaigns targeting the general public, as well as screening programs focusing specifically on this group, may be most effective in reducing indirect mortality costs.

Indirect morbidity: (1) Morbidity costs are highest for non-institutionalized males between 35 and 54 years. Employee assistance and treatment programs focusing on this group as well as on the workforce in general may reduce costs. However, it is important to note that costs may exaggerate the relative severity of alcohol-related health problems for this group, since the earning level of men in this group is greater than that of women. (2) Because most alcohol-related costs stem from lost productivity (indirect mortality and morbidity), employer-based alcohol treatment programs may be particularly useful in reducing costs (see Holder & Cunningham, 1992). Worksite health promotion efforts and responsible hosting policies may provide other ways to reduce alcohol-related productivity losses.

Fetal alcohol syndrome: (1) The greatest proportion of fetal alcohol syndrome (FAS) costs are for residential care and support of adults with FAS. Although some assistance is currently available for children with FAS through education, health, and social systems, persons with alcohol-related birth defects such as FAS and fetal alcohol effects (FAE) have additional needs throughout their lifetime. (2) The extent and costs of fetal alcohol exposure need further clarification. Two areas should be noted in particular—the need for: (a) better estimates of the incidence and prevalence of fetal alcohol syndrome, and (b) a commonly agreed-upon definition of fetal alcohol effects. (3) Reducing the occurrence of FAS and FAE will reduce their associated costs. Prevention strategies include messages from the media and health care providers encouraging women not to drink while pregnant or trying to conceive, screening pregnant women for chemical use, and linkage of chemical treatment to family planning and pregnancy programs.

Non-health sector: (1) Crime-related costs comprise the highest proportion of non-health sector costs. Efforts to clarify the relationship between alcohol use and violence will inform activities designed to reduce alcohol-related crime. (2) The next highest category of non-health costs is motor vehicle crashes. Policies and programs to reduce drinking and driving will lower non-health sector costs, as well as health-related costs.

Although identification of particular high-risk groups or activities is one focus for action, efforts to change norms to more responsible alcohol use throughout the general population can affect a broad range of costs.

Both approaches are useful, and all three levels of prevention are necessary to reduce costs: (1) preventing the occurrence of alcohol-related problems in the first place; (2) identifying individuals who are just beginning to exhibit alcohol-related negative consequences and intervening before the problem worsens; and (3) reducing or eliminating alcohol-related problems once they are underway.

Chapter 3 • Appendix

Supplementary Information on Economic Cost Calculations

A. Introduction

Previous national cost-of-alcohol studies

Current efforts to quantify the cost of alcohol use are based on cost-of-illness (COI) estimates that were first developed in the late 1950s (Rice, 1966). A pioneer in this field, Rice was among the first to consider alcohol use costs specifically, and to establish the methods for systematic COI calculations. Subsequent national and state-level studies have broadened the study of alcohol-related costs and refined their measurement (Table 3.19).

Three developments in the 1970s led to Berry and Boland's comprehensive 1977 study of the direct and indirect costs of alcohol consumption: (1) a growing understanding of alcoholism as a disease rather than as a moral failure, (2) the formation of the National Institute on Alcohol Abuse and Alcoholism (NIAAA) in 1970, and (3) increasing use of benefit/cost analysis as a tool for policymaking (Berry & Boland, 1977). Hodgson and Meiners (1979) coordinated efforts with a Public Health Service Task Force on Cost of Illness Studies to standardize COI guidelines (e.g., specifying methods and cost categories).

In the early 1980s, the Research Triangle Institute (RTI) conducted two major studies on alcohol, drug abuse, and mental illness (Cruze, Harwood, Kristiansen, Collins, & Jones, 1981; Harwood et al., 1984). Harwood et al. expanded the methods with respect to productivity losses, demographics, and fetal alcohol syndrome.

The most recent estimates of the economic cost of alcohol come from the work of Rice and associates (Rice et al., 1990; Rice et al., 1991b; Rice, 1993). These studies provided cost estimates for alcohol and drug abuse and mental illness for 1985, 1988, and 1990 using data and methods selected to correct some inaccuracies evident in the RTI studies.

Although the Rice studies still share many similarities to the RTI studies, use of some new data and methods resulted in cost estimates for 1985 that were actually 40% lower than RTI estimates for 1983 and 21% lower than RTI estimates for 1980. Collectively, all of these studies laid the essential groundwork for the estimates presented here.

For more information about previous alcohol cost studies, see the reviews by Parker et al. (1987) and Shultz et al. (1989). Jarvinen (1988) provides a comprehensive review of cost-of-illness literature since 1980, with special emphasis on alcohol use and drug abuse and mental illness.

Table 3.19 – Selected Cost Of Illness (COI) studies addressing alcohol use[1]

Study	Purpose	Innovation(s)	Estimated cost
Rice (1966)	Examine economic costs of major diseases entities in 1963	Formalized procedures for systematic COI calculations and included some costs of alcohol-related diseases	Alcohol-related diseases included in mental disorder costs
*Berry and Boland (1977)	Calculate economic costs of alcohol abuse for 1971	First comprehensive study of economic costs of alcohol abuse	$31.4 billion (1971 dollars)
Hodgson and Meiners (1979)	Provide guidelines for COI studies based on recommendations of Public Health Service Task Force on Cost of Illness Studies	Standardized the COI study guidelines, providing methodological framework for future studies	No estimate
*Cruze, Harwood, Kristiansen, Collins, and Jones (1981): first Research Triangle (RTI) Study	Calculate economic costs of alcohol and drug abuse and mental illness (ADM) for 1977	One of the first studies to utilize the Public Health Service Guidelines for Cost-of-Illness Studies, and the first study to apply common methodology and categories to all three ADM disorders	$49.4 billion (1977 dollars)
Schifrin (1983)	Review Berry et al 1975 cost estimate using methods similar to those of Berry and Boland	Corrected for some omissions in Berry and Boland estimation	$73 billion (1975 dollars)
*Harwood, Napolitano, Kristiansen, and (Collins (1984): second Research Triangle Institute (RTI) study	Assess the availability of data for various cost components and update 1977 ADM cost estimates from the 1981 Cruze et al RTI study for 1980 data. Provide estimates for 1981,1982, and 1983 by adjusting 1980 costs.	Productivity loss estimation improved, fetal alcohol syndrome costs added, improved data collection and analysis.	$89.5 billion (1980 dollars) $116.7 billion (1983 dollars)
Parker, Shultz, Gertz, Jensen, Neider, and Moen (1985)	Calculate cost of alcohol abuse *in Minnesota* for 1983	Comprehensive state study following PHS Task Force COI Guidelines and RTI methodology	$0.68 billion to $1.95 billion (1983 dollars)
*Rice, Kelman, Miller, and Dunmeyer (1990)	Calculate the cost of alcohol and drug abuse and mental illness in 1985, to update 1980 estimates made by RTI, using improved data and methodology	New data sources and methodologies for direct health care costs and morbidity, replacing ones which may have led to overstatement of costs in past studies	$70.3 billion (1985 dollars)
Rice, Kelman, and Miller (1991b)	Update the 1985 data for 1988 (more limited data than in the larger study using 1985 data)		$85.8 billion (1988 dollars)
*Manning, Keeler, Newhouse, Sloss, and Wasserman (1991)	Calculate the external costs of three poor health habits: smoking, heavy drinking (2+ reported drinks/day), and not exercising		Lifetime external costs of excess drinking are $42,000 per heavy drinker (5% discount rate).
Rice (1993)	Update 1985 cost data for 1990 (by multiplying the 1985 cost estimates by the percent changes in socio-economic indexes from 1985 to 1990)		$98.6 billion (1990 dollars)

[1] All studies except Parker et al. established costs for the US population. The Parker et al. study established costs for Minnesota.

* Major national study of alcohol use costs. All of these major studies use a six percent discount rate for indirect mortality costs.

Sources: All studies described above, and Cook (1984), Parker et al. (1985), Shultz et al. (1991)

Previous state studies

A number of state-level studies of the extent and cost of alcohol use have been done using cost-of-illness methods. As mentioned previously, Parker et al. issued a report on 1983 alcohol-related costs in Minnesota (1985). Sacks and Sikes (1987) estimated costs for the state of Georgia. Wisconsin and California conducted studies using Alcohol-Related Disease Impact (ARDI) software, also used in this study. The Wisconsin Department of Health and Social Services estimated alcohol-related costs in 1988 to total $1.47 billion (Centers for Disease Control, 1990). The California Department of Health Services used ARDI software to determine alcohol-related mortality in California from 1980 to 1989 (Sutocky, Shultz, & Kizer, 1993).

Issues involved in measuring the cost of alcohol use

Individual costs and social costs

When alcohol cost studies are used for policymaking purposes, it is important to distinguish between the costs that fall upon the individual alcohol user ("internal" costs, such as the proportion of alcohol treatment paid for by the individual), and the involuntary costs imposed on society ("social" or "external" costs, such as the loss of life of a pedestrian hit by a drunk driver).[6]

Economists and policymakers are primarily concerned with external costs when addressing alcohol use (Cook, 1984; Manning, Keeler, Newhouse, Sloss, & Wasserman, 1991). Internal costs are viewed by economists as being incurred as the result of an individual's free choice, and as such, are paid for by the individual and are not a primary concern for policymaking.

This perspective differs considerably from a public health perspective. Public health generally focuses on problems based on their health impact on a population, more than on whom the cost burden falls.

Although the costs in this study are not categorized as external or internal, some items can be clearly identified as external costs. An example of an external cost is the expenditure for social welfare administration for alcohol-related temporary disability. This is an external cost because it is borne by taxpayers, not by the individual.

There are a number of additional critical conceptual and estimation issues involved in the measurement and interpretation of the costs of alcohol use. These issues are discussed in the Rice et al. (1990) and Shultz et al. (1989) and are summarized briefly here.

Conceptual issues

Human capital valuation of life: There are two commonly used approaches to placing an economic value on human life—the human capital approach and the willingness-to-pay approach. The human capital approach, which values an individual's life by his or her production potential in the labor market, is usually used for cost-of-illness studies and was chosen to calculate the indirect mortality figures in this study. Although it is comparatively easy to use, this approach must be used with caution since it equates earnings with productivity and undervalues the worth of persons whose wages reflect labor market wage discrimination.[7]

On the other hand, the willingness-to-pay approach measures the amount that all affected persons would be willing to pay for changes to reduce the probability of death from a particular disease (Schelling, 1968). This method is not widely accepted in COI studies.

Prevalence and incidence approaches: Prevalence studies such as this one provide an estimate of the disease costs incurred over a period of time, usually a year, regardless of the time of disease onset. For a given year, therefore, prevalence costs measure costs for that year alone, for all individuals with a disease regardless of date of onset. In contrast, incidence costs measure lifetime costs of a disease, but only for the individuals who were diagnosed in the given year of study.

Estimation issues

Each of the following issues must be addressed in any effort to estimate the cost of alcohol use. Where some items are difficult or impossible to quantify, it is important to recognize their omission from cost calculations. Decisions about how to resolve the issues listed below will influence subsequent cost estimates.

Psychosocial costs: Quality of life indicators are difficult to quantify. Psychosocial costs, such as the suffering of an individual with alcohol-related problems or the family of the individual, are currently not included in economic cost estimates.

Reduced productivity: Society loses some production from members of the labor force who are impaired due to alcohol use. Lost productivity is difficult to estimate because data are not collected on what is not produced (Rice et al., 1990). Reduced productivity is commonly assessed by taking the difference in earnings between groups based on alcohol consumption patterns and adjusting for relevant demographic factors.

The value of household labor: Household labor is evaluated as the estimated market value of the labor of homemakers, who are not officially in the labor force. This value has been measured in various ways. This study uses a method that measures average time inputs for household tasks and assigns the prevailing wage rate for similar tasks performed in the work force (Peskin, 1984).

Earnings: Earnings are used as a measure of the productivity of individuals and groups; their use may under- or overestimate the productivity losses associated with alcohol-related problems. Also, the use of average earnings for people suffering from diseases that disproportionately affect certain socioeconomic groups may lead to estimation errors.

Non-market use of resources: Non-market resources are the services provided by relatives, friends, and volunteers who receive no monetary compensation for their care of individuals with alcohol-related problems. Few studies estimate the value of such services.

Discount rate: Employed in the calculation of indirect mortality, this is the percentage used to reduce the arithmetic sum of future earnings to its present dollar value. Several rates are usually used in order to yield various cost estimates under different economic assumptions. This study uses a 4% discount rate, as did the Parker et al. report (1985) on Minnesota's alcohol-related costs in 1983.

Consumption of goods and services: In some estimates of morbidity and mortality, the consumption of goods and services by an individual has been subtracted from the individual's output (productivity). However, in most current studies, including this one, consumption is not subtracted from output (measured by earnings).

Costs versus charges: Direct cost estimates are based on either the cost of a good or service, or the amount

actually charged for a good or service. Largely for convenience, charge data are usually used in COI studies.

Transfer payments: These are payments which are shifted from one segment of society to another (e.g., disability payments). Transfer payments are not considered in the costs of morbidity and mortality, because they do not represent actual losses or gains to society's resources, but rather a reallocation of them.

Non-health related costs: These are costs associated with alcohol use in addition to direct health care, indirect mortality, and indirect morbidity costs. Non-health related costs include direct and indirect costs for such items as crime, motor vehicle crashes, fire destruction, and social welfare administration. This is the newest cost category to be included in alcohol-related cost-of-illness studies. Non-health related costs have been estimated since the adoption of the Public Health Service Guidelines for Cost of Illness Studies (Hodgson & Meiners, 1979).

Limitations of cost estimation

Several authors have addressed the limitations of cost-of-illness studies in general (Cook, 1984; Heien & Pittman, 1989; Hodgson, 1983; Parker et al., 1987). Gordis (USDHHS, 1991) notes two major problems important to studies of the cost of alcohol use in particular:

(1) It is often hard to establish alcohol use as a cause of the problem in question, and not just an associated factor.

(2) Many alcohol use costs cannot be measured directly, especially the costs of lost productivity due to illness, injury, or death.

Other limitations include the following:

(3) Cost calculations may be complicated by "comorbidity" (concurrent diagnoses), in which alcohol and drug abuse and mental illness (ADM) disorders play a secondary role to other diagnoses, and by "overlap," in which ADM disorders occur together (Rice & Kelman, 1989). The Rice et al. 1990 study attempted to deal with this issue (see "Direct costs" section).

(4) Cost calculations are based on alcohol-attributable fractions, which are only "best estimates" of the relationship of alcohol to morbidity, mortality, and social problems such as crime.

(5) Little attention has been paid to the issue of possible savings to society due to premature death of chronic alcohol users. As Cook (1984) notes, chronic heavy users may incur high medical and disability costs, much of which is paid for by third parties through social welfare programs and private insurance. Whether such social savings exist is a question that remains to be thoroughly investigated. Research of these possible social cost savings would not minimize the tragedy of premature loss of human life due to alcohol-related problems. Rather, it would be an attempt to make cost studies more accurate.

(6) To date, it appears that no economic estimates have been made to evaluate the possible beneficial effects of alcohol consumption, such as the reduced risk of cardiovascular disease associated with moderate drinking. Although cost studies have focused on the costs of alcohol-related problems, inclusion of economic *benefits* of moderate use have not traditionally been reflected in cost figures.

(7) Cost of illness studies have been used to indicate the magnitude of the economic burden of illness as well as to assess social preferences regarding public policy (Hodgson, 1983). Economists disagree about the use of alcohol cost studies as a basis for policymaking. While Heien and Pittman (1989) and Cohodes (1982) state that alcohol cost estimates are inaccurate and inappropriate for policymaking, others believe that the estimates can be relevant to policy if their limitations are understood and they are not used as the sole basis for making policy decisions (USDHHS, 1991). Cook (1984, p. 65) reports that most economists who have studied alcohol-related problems believe that "the most appropriate use of economic cost estimates is in the context of evaluating a specific, well-defined government action or program, rather than as a device for indicating the overall impact of alcohol abuse on society."

Despite these limitations, this report uses the best models and methods available to provide an estimate of the magnitude of alcohol use in Minnesota and the relative importance of various alcohol-related diseases, injuries, and costs which place a burden on the population of Minnesota.

Comparability of cost estimates in this study and the 1985 Minnesota report

Parker et al. (1985) estimated the total cost of alcohol abuse in Minnesota in 1983 to range from $0.68 billion to $1.95 billion (1983 dollars). This study estimated the total cost for 1991 to be about $1.74 billion (1989 dollars).[8] Although the previous and current studies used similar cost categories, it is difficult to compare these two sets of estimates for several reasons, described below.

The 1985 Minnesota study used guidelines set forth in calculations by the Research Triangle Institute (Cruze et al., 1981; Harwood et al., 1984) and the US Public Health Service (National Center for Health Statistics, 1981). Parker et al. obtained almost all the data for their cost calculations directly from Minnesota sources such as state agencies and health providers, whereas the current study uses a combination of state and national data (see "Data and methods of calculation" below).

The ARDI software used in the current calculations was not available at the time of Parker and colleagues' 1985 study. Some of the methods developed for the Parker et al. study were used in the creation of ARDI by Shultz, Parker, and Rice, particularly the selection of diagnoses and alcohol-attributable fractions to include in calculations. Additionally, ARDI software incorporates new data sources and methods used in the national cost study by Rice et al. (1990), which was designed to improve on the Research Triangle Institute data and methods.

Because the national cost data used by ARDI software are for years prior to 1991 (the year of this study), adjustments were made using appropriate cost inflators. Likewise, many of the costs for the Parker et al. study (1985) were 1980 estimates, inflated to 1983 values. Any comparison of the two studies depends in part on the assumption that accurate inflators have been used to adjust values properly.

In addition to the data and methodological differences described above and in the following sections of this chapter, comparison of the two Minnesota studies is complicated for these reasons:

- Some alcohol-related disease categories have been added since the 1985 Parker et al. study (see chapter 2).
- Some of the alcohol-attributable fractions have changed, due to new information.
- Alcohol-related child abuse costs were estimated in the Parker et al. study, but were not estimated in the current study. This hard-to-estimate cost category was not incorporated into the ARDI software used to calculate the current estimates.[9]

Each of the differences between the data sources and methods of the two Minnesota studies could affect the direction (lower or higher cost) and magnitude (major or minor effect) of cost estimates. For example, the use of hospital discharge records for direct health care cost calculations in the current study led to a lower cost estimate than would likely have been obtained using the methods for the 1983 cost calculations (see Direct costs section for details).

Also, the addition of new alcohol-related disease categories to the 1991 estimate increased the cost estimate, as did the higher values for alcohol-attributable fractions (AAFs) of some diseases and injuries. On the other hand, the AAFs for some diseases and injuries were lower in 1991 compared to 1983. This, along with the omission by ARDI software of an estimated alcohol-related cost of child abuse, would lead to lower 1991 costs than would otherwise be obtained.

As a consequence of the differences between the 1985 study and this study, the cost figures are not comparable and should not be used to estimate changes in costs over the time period under consideration.

For more information on the development of ARDI, see the Introduction to this report. More information on the comparability of the current ARDI-based estimates to the 1985 Parker et al. study can be found within the separate cost category sections.

B. Direct Health Care Costs

Definition

Alcohol-related direct health care costs are the costs of detection, treatment, and rehabilitation of people with alcohol-related diseases and injuries.

Direct health care costs fall within two main groups: treatment costs by providers, and associated support costs. Treatment costs are classified by the type of provider offering care. "Treatment" refers both to medical care provided for alcohol-related diseases and injuries, as well as chemical dependency treatment for alcohol use. The general descriptor "treatment costs" includes detection, treatment, and rehabilitation. "Support costs" are the costs of research, training, administration, and private health insurance associated with detection, treatment, and rehabilitation.

The Alcohol-Related Disease Impact (ARDI) software (Shultz et al., 1989) used to generate the figures in this report, as well as the study by Rice et al. (1990) on which it is based, do not specifically address prevention costs. However, some of the treatment activities for which costs were calculated may also include prevention efforts. This is especially true for efforts to curtail or prevent further alcohol use among individuals in treatment, or to prevent relapse of former alcoholics who have undergone treatment.

The six treatment cost classes are: hospitals, specialty institutions such as freestanding (non-hospital-based) chemical dependency treatment centers, office-based physicians, nursing homes, other professional services, and federal providers.

These **treatment costs** are described below. The definitions are based on the study by Rice et al. (1990) and definitions used by the Health Care Financing Administration ("Revisions to the National," 1990).

(1) *Hospitals* = costs for hospital stays in which the discharge listed alcohol abuse as a primary or secondary (second-to-fifth-listed) diagnosis. Primary diagnoses include conditions that are 100% alcohol-attributable, such as alcohol poisoning. Secondary diagnoses are those diagnoses that indicate some alcohol involvement (Rice and Kelman, 1989). An example is a patient who is treated for an injury, but who requires an extra day of hospitalization due to additional treatment needs arising from a history of excessive alcohol consumption by the patient. For secondary diagnoses, costs are counted for alcohol-related extra days of care beyond the average hospital stay (US Department of Health and Human Services [USDHHS], 1991).

(2) *Specialty institutions* = alcohol-related costs for the care of people with alcohol problems in institutions such as freestanding alcohol, drug and mental health care organizations.

(3) *Office-based physicians* = costs of visits to office-based physicians, including psychiatrists, for alcohol-related diagnoses. These costs also include visits by office-based physicians to patients hospitalized with alcohol-related diagnoses.

(4) *Nursing homes* = costs for nursing home residents with a primary or secondary alcohol-related diagnosis. These costs are measured as the annual expenditures for residents who are in nursing homes due to alcohol disorders.

(5) *Other professionals and home health care* = costs of professional services provided to individuals with alcohol-related problems by office-based professionals such as psychologists and social workers. Home health care costs are also included. The costs of services by hospital and nursing home professional staff are not included here, but are under the costs of care in those settings.

(6) *Federal providers* = costs for care provided to people with alcohol-related problems by the Veterans Administration; the Army, Navy, and Air Force;[10] and the Indian Health Service.

Support costs include the following:

(7) *Federal expenditures for medical and health services research* = alcohol-related research expenditures by the Substance Abuse and Mental Health Services Administration (SAMHSA)[11] and the Veterans Administration (VA). The SAMHSA expenditures are the alcohol-related research items designated in its budget. The VA alcohol-related research expenditures are a proportion of total VA research expen-

ditures, based on the percentage of total VA hospital costs that are represented by alcohol-related concerns.

(8) *Specialized training for physicians and nurses* = costs of training physicians and nurses to treat alcohol problems. These costs are a proportion of the private sector funds spent for undergraduate and graduate medical education and baccalaureate degree nursing programs, and public sector training funds from SAMHSA and the VA. The proportion of private funds for physicians' training is based on the number of alcohol-related visits to office-based physicians as a percentage of total visits. The proportion of private funds for nurses' training is based on the costs of alcohol-related inpatient and ambulatory care as a percentage of the total cost of these services. The proportions of SAMHSA and VA training are obtained in the same way as the research expenditures described in (7).

(9) *Program administration and net costs of private health insurance* = alcohol-related costs for public and philanthropic health program administration and the net costs of private health insurance.

Data and methods

Hospital stays, office-based physicians, nursing homes, and other professional services

Health Care Financing Administration (HCFA) 1989 Minnesota-specific data were used for the costs of hospital stays, office-based physicians, nursing homes, and other professional services (HCFA, 1992). Alcohol-Related Disease Impact software (ARDI) was then used to calculate the proportion of these Minnesota costs that are alcohol-related, based on alcohol-related proportions of national costs estimated by Rice et al. (1990).

The Rice et al. study primarily utilized the following sources to determine alcohol-related proportions: (1) Hospital costs—National Hospital Discharge Survey data. (2) Office-based physicians—National Ambulatory Care Survey. (3) Nursing homes—National Nursing Home Survey. (4) Other professional services—communications from the American Psychological Association and the American Council of Social Workers. A complete discussion of data sources, methods, and references is available in the Rice et al. report. For the four items listed above, only the nationally-derived alcohol-related proportions (not national costs) were used in the ARDI calculations for Minnesota, since state-specific cost figures were available.

In summary, alcohol-related direct health care costs for these four sources of treatment were estimated as follows:

Direct health care costs
(for hospitals, office-based physicians, nursing homes, and other professional services)
= Total 1989 state cost for each component
x National estimate of the alcohol-related proportion of each cost
(Adapted from Shultz et al., 1991)

Specialty institutions, federal providers, and support

For the remaining three direct health care cost components—specialty institutions, federal providers, and support costs—Minnesota-specific HCFA cost data were not available, so both the national cost data as well as national alcohol-related proportions were used.[12]

The 1985 alcohol-related national costs for specialty institutions, federal providers, and support were estimated by Rice et al. (1990). The costs for these three components were employed

in ARDI software and inflated to 1989 levels, using the 1.44 ratio of 1989 to 1985 national personal health care expenditures (Lazenby & Letsch, 1990). Costs were inflated to 1989 levels to be consistent with the Minnesota-specific data described in the previous paragraphs. A proportion of the alcohol-related national costs for these three items was then attributed to the state population of Minnesota. These costs were then distributed across the population by age and gender.

The costs for these three treatment sources were therefore calculated for each component source, by five-year age and gender stratum, as follows:

Direct health care costs
(for specialty institutions, federal providers, and support)
= (Total 1985 US alcohol-related direct health care cost for each component/ US population)
x Minnesota population
x Inflator for 1989:1985 costs
(Adapted from Shultz et al., 1991)

Specialty institution costs in the Rice study were based on (1) National Institute of Mental Health data, which provides numbers of alcohol-related discharges; and (2) the National Drug and Alcohol Abuse Treatment Utilization Survey, from the National Institute on Alcohol Abuse and Alcoholism.

The costs for federal providers were based on estimates by Harwood, Napolitano, Kristiansen, and Collins (1984), inflated to 1985 values for the Rice study. The Harwood study used data from the Veterans Administration, the Department of Defense, and the Indian Health Service.

Support costs were obtained from various sources, including the budget of the United States, journal reports of physician and health professional training costs, and figures from the Health Care Financing Administration (Rice et al., 1990; Shultz et al., 1989).

The data sources and inflators for direct health care components are summarized in Table 3.4 (see Introduction to this chapter).

It should be noted that state-level data on the costs of chemical dependency treatment are available through the Minnesota Department of Human Services (DHS, 1993). Due to software limitations, these data were not used in the ARDI software cost calculations for this report, but are presented below for comparative purposes.

The DHS reported that $49.6 million of public funds were expended for chemical dependency treatment in Minnesota in the 1991 calendar year. Public funds covered about half of all clients treated, so this figure could be doubled to give an approximate total for public and private treatment costs. Of the public expenditures, 61.5% was for alcohol abuse or alcohol dependence only, 6.8% was expended for drug abuse or dependence only, and 31.7% was for both alcohol and drug abuse or dependence.

Primary treatment in freestanding and regional treatment centers was the most common, at 45.3% of public expenditures. Hospital-based treatment accounted for 19.8%, and treatment in halfway houses totaled 18.3%. Non-hospital-based extended care accounted for 16.6% of the total.

For a description of the programs and budgets of all state agencies with drug or alcohol-related activities as of November 1992, see the 1993 biennial report of the Minnesota Department of Human Services Chemical Dependency Division (1994).

Issues and limitations

As noted earlier, this study builds on several earlier cost-of-illness studies, but the 1991 Minnesota direct health care costs reported here are clearly estimates for several reasons. Perhaps most important is that they use a variety of state-specific and national cost figures, and apply nationally-derived alcohol-related proportions to these cost figures. The advantages of using national data are that it is time- and labor-efficient, and that some of the data do not exist at the state level (Shultz et al., 1989). However, when reliable and available, state-level data presumably provide more precise state cost estimates.

Another issue in the ARDI direct health care cost estimates of this study is the range of dates used for the various demographic and cost figures. Although 1991 is the designated year for all estimates in this report, only the state mortality figures are for 1991. The data used in the calculation of direct health care costs come from 1990 Minnesota population figures, 1989 Minnesota cost figures, and 1985 national costs inflated to 1989 levels. These were the most recent cost data available at the time of the calculations.

Other limitations include the following:

(1) Hospital discharge records may not be a valid indicator of the proportion of hospital costs that are alcohol-related (USDHHS, 1991, p. 2):

> *"[The use of hospital discharge records] may underestimate treatment costs because alcohol involvement often is undiagnosed or unreported in hospital discharge records (Moore et al., 1989), and because medical conditions that researchers use as indicators of alcohol abuse in an individual (e.g., alcoholic cirrhosis of the liver) represent only a portion of those conditions that might be caused by alcohol abuse. An example of relevant information often not reflected in hospital discharge records is the role of alcohol in the occurrence of many injuries."*

Despite these concerns, hospital discharge records may provide more comprehensive documentation than the previous method, in which alcohol-related cost estimates were based on the proportions of diseases that were deemed to be alcohol-related (Rice, Kelman, & Miller, 1991a).

(2) The costs incurred by family members and friends are not included in direct cost figures. For example, the costs of transporting patients to and from health providers is not tallied into direct health costs (Hodgson, 1983).

(3) The total estimated direct health care cost in this study equals $178.6 million. This figure is less than the estimated direct health care cost of $211 million for Minnesota in 1983 (Parker et al., 1985). There are a number of possible explanations for this. The most likely reason is that the data sources and methods have changed significantly since the previous study was done.

The previous study used almost all Minnesota-specific figures, but the current study uses a combination of Minnesota and national data. A few categories, such as dental costs, were included in the previous study but are not in the current one, due to the fact that they are not included in the data available in ARDI software.

The methods also differs between the two studies. The previous Minnesota study was based on the Research Triangle Institute (RTI) methods (Harwood et al., 1984) The current

study used the methods developed by Rice et al., which calculates national direct health costs for 1985 to be only two-thirds the value of the 1983 costs calculated by the RTI study (Rice et al., 1990). Much of this decrease was due to the use of hospital discharge data, described above. Likewise, the apparent decrease in Minnesota's 1991 costs may reflect this change in methods.

(4) Prevention costs are not explicitly addressed in the calculation of direct health care costs. It would be useful to have better delineation and estimates of alcohol-related prevention costs, in order to determine their proportion of total costs and their relationship to other cost components.

Drug and alcohol-related prevention efforts of Minnesota state agencies are described in the Minnesota Department of Human Services Chemical Dependency Division biennial report (DHS, 1994).

C. Indirect Mortality Costs

Data and methods

For each alcohol-related diagnosis, 1991 Minnesota mortality data were entered into ARDI software for men and women by five-year age groups (Minnesota Center for Health Statistics, 1992). An alcohol-attributable fraction for each diagnosis was multiplied by the number of deaths in each age- and gender-specific diagnostic group (see chapter 2).

The resulting number of alcohol-related deaths in each of these groups was then multiplied by the expected future earnings for the years these individuals would have worked.[13] The lost earnings were then totaled across all age and gender groups for all diagnoses, to yield an overall estimate of the lost productivity in 1991 due to alcohol-related deaths.

In other words, for each five-year age and gender group in each diagnosis:

Alcohol-related indirect mortality costs
= Minnesota deaths
x AAF x PVFE x Inflator,
where AAF
= alcohol-attributable fraction of deaths,
and PVFE
= present value of future earnings
(Adapted from Shultz et al., 1991)

Expected future earnings figures were from calculations by Rice, Kelman, Miller, Dunmeyer (1990). Rice et al. accounted for differing life expectancies for each five-year age and gender group, as well as variable earnings and labor force participation rates throughout life stages. These estimated future annual earnings were calculated to life expectancy, assuming a 1% annual increase in productivity and an average rate of inflation.

The discount rate and the present value of future earnings

Because this study is concerned with estimating the costs of alcohol use in the year 1991, the projected value of lost earnings in the years after 1991 (for a person who died in 1991) should be converted to its value in 1991 dollars. This process of converting the value of future earnings to its current value is known as "discounting." It is necessary to discount future earnings to their "present value" because the value of money generally increases over time. For example, $100 invested at 4% interest in 1991 would be worth $104 in 1992. Therefore, the value of *future* earnings for a person in each age and gender diagnostic subgroup was discounted to its *present* value. These

discounted earnings were then summed together to obtain the overall indirect mortality cost for 1991.

Future earnings in this study were actually discounted to 1989 dollars instead of 1991 dollars. This enabled more direct comparison to other cost categories (e.g., direct health care), which used 1989 cost data.[14] Because the mortality data were for 1991, the cost estimates are presented here as the costs for 1991. However, the true cost figure for 1991 might have been somewhat different since economic data for 1989 rather than 1991 were used here.

A 4% discount rate was used here, as in the previous Minnesota cost study (Parker et al., 1985). The higher the discount rate, the lower the present value will be. A lower present value means a more conservative estimate of the indirect mortality costs. The present value of lifetime earnings calculated at a 4% discount rate is presented in Table 3.20. If a 6% rate had been used, the total indirect mortality cost for 1991 would have been $311.2 million, instead of $393.3 million at a 4% rate.

Issues and limitations

The following points address some of the major issues and limitations of indirect mortality cost estimates.

1. *Use of human capital method to measure the cost of a premature death due to alcohol use.* Cost of illness studies such as this one require the use of some measure of the cost of a life lost. Although attempting to put a value on human life is admittedly crude and controversial, it is viewed as a necessary part of cost estimates. The "human capital" approach is the most commonly accepted way to measure the cost of a premature death. The human capital method puts a value on the lost productivity of a person by estimating the person's future earnings lost due to his or her premature death.

Although it is easier to use than other methods, the human capital approach has some major limitations, including the following: (a) it equates earnings with productivity, when in fact these may not be equivalent;

Table 3.20 – Present value of future lifetime earnings by age and gender, discounted at 4%, Minnesota, 1989[1]

Age category	Males	Females
0-4	509,108	412,595
5-9	581,794	471,285
10-14	674,343	546,064
15-19	772,325	618,398
20-24	835,162	647,899
25-29	839,658	624,981
30-34	803,746	575,452
35-39	731,918	509,485
40-44	628,338	435,182
45-49	504,506	357,592
50-54	371,255	279,353
55-59	239,365	202,889
60-64	121,946	131,413
65-69	48,024	75,428
70-74	21,477	40,984
75-79	10,509	21,109
80-84	5,262	10,264
85+	1,615	2,588

[1] These 1989 values are based on 1985 figures from ARDI software. The 1985 figures were inflated to 1989 levels using a factor of 1.12, the ratio of 1989 to 1985 earnings (US Department of Labor, 1992). Levels for 1989 were used in order to be consistent with Minnesota direct health cost figures, the majority of which were for 1989. The application of these 1989 values to the 1991 mortality data used in this report may lead to a different estimate than would have been projected using 1991 present values of future lifetime earnings.

Sources: Rice et al. (1990) and ARDI software (Shultz et al., 1989)

(b) it undervalues the worth of groups of people who may be experiencing wage discrimination; and (c) it undervalues the contributions of retired people and people not receiving wages or salaries for their work (e.g., homemakers and volunteers). ARDI software includes a monetary value for the work of homemakers.

In addition to the above considerations, it is important to note that the use of lost earnings as a measure of the cost of a death leads to a much higher value resulting from the death of a younger person than a middle-aged or older person.[15] The human capital approach is only one way to measure the cost of the loss of a life—other measures might weight costs differently with regard to the age of the person.

2. *Choice of a discount rate*. The choice of a discount rate depends on assumptions about changes in the value of money over time. It might be more useful to present a range of indirect mortality cost figures using various discount rates. Most national studies have used a 6% rate (see Introduction, chapter 3). This study used a 4% rate (see discussion in "Data and methods" in this appendix).

3. *Application of a single alcohol-attributable fraction to all age and gender categories*. For most of the alcohol-related diagnoses, the alcohol-attributable fraction (AAF) is neither age- nor gender-specific. Applying a single AAF for deaths at all ages tends to underestimate alcohol-related indirect mortality costs (Shultz et al., 1989).

4. *Variation in alcohol-related consumption and mortality across occupations*. Alcohol consumption and alcohol-related deaths vary by occupational group. Parker and Harford (1992) found that percentages of drinkers were generally higher among workers in white-collar occupations than in blue-collar occupations, but that drinkers in blue-collar occupations tended to drink more alcohol than those in white-collar work.

Brooks and Harford (1992) found that alcohol-related mortality differs significantly by occupational group for various causes of death, but that the highest alcohol-related mortality generally occurs among blue-collar workers. (See chapter 1 for more information on occupational drinking patterns in Minnesota.)

The ARDI software used in this study calculates earnings losses using average earnings for age and gender groups, so if the deaths in any group occur disproportionately among people with higher- or lower-than average earnings, those estimates would be under- or overestimated.

D. Indirect Morbidity Costs

Data and methods

Indirect morbidity costs were calculated for both non-institutionalized and institutionalized people. Institutionalized individuals include residents of nursing homes and state and county mental hospitals (Rice et al., 1990).

Data sources included the 1990 Census (US Department of Commerce, 1991) for Minnesota population figures; and Rice et al. (1990) for alcohol-related income loss percentages and average income levels. The 1985 income levels in the Rice study were adjusted to 1989 levels by using an earnings inflator of 1.12. This inflator represents the ratio of 1989 to 1985 average earnings in the United States (US Department of Labor, 1992).

Because this is a study of 1991 costs, the use of 1990 Census data and 1989 cost figures likely led to a different estimate of costs than would have been obtained if all 1991 data had been available. (For data sources and adjustments used, see Table 3.4.)

To determine indirect morbidity costs for *non-institutionalized* people, ARDI software multiplied the following four factors for Minnesotans by age and gender group (e.g., 18-24 year-old females, etc.): (1) the total population in the group, (2) the estimated percentage of that group who abuse alcohol, (3) the average income for a person in that group, and (4) the estimated percentage of income that is lost by each individual in the group as a result of his or her alcohol abuse. The four-factor products for each age and gender group were then summed to yield the total indirect morbidity costs for Minnesota.

Expressed as a formula, these costs were calculated for each age and gender stratum as follows:

Alcohol-related indirect morbidity costs for non-institutionalized people

= Minnesota non-institutionalized population
x Prevalence of alcohol abuse or dependence
x Average 1985 income
x Alcohol-related percentage of income lost
x Inflator 1989:1985

(Adapted from Shultz et al., 1991)

The process of estimating the percentage of income lost by a person who is dependent on or abusing alcohol is explained in the following text box.

Estimating the percentage of income lost through alcohol abuse.

The estimation of the percentage of income lost for a person who abused alcohol is developed from information about the past timing and duration of the disorder and an estimation of the person's likely income, had he or she not abused alcohol...Briefly, a timing model (which yields a present value of lost income based on one's past drinking history) was developed to estimate the rate of earnings impairment (percentage of income loss), and this rate was applied to average incomes by age and gender. For persons not employed outside the home, a value for household work was calculated, and the rate of impairment was applied to that value. The maximum likelihood estimation measures the maximum lifetime effect of alcohol abuse based on a person's current income, taking into account the timing and duration of the disorder. (Rice, Kelman, & Miller, 1991a, p. 309)

Data for the Rice et al. (1990) income impairment estimates were drawn from Epidemiologic Catchment Area surveys by the National Institute of Mental Health. This estimation procedure considered the effects of race, age, marital status, children, lifetime illness, alcohol use, drug use, and psychiatric disorders. For a detailed description of the estimation procedure, see appendices A and B of the 1990 Rice et al. study (1990).

For *institutionalized* people, ARDI software multiplied the number of people in Minnesota who were institutionalized due to alcohol abuse or dependence by the labor force participation rate for each age and gender group. This yielded the number of people in the group would have been working if they weren't institutionalized. The product was then multiplied by the

average earnings and wage supplements (e.g., benefits) for the group. All age and gender group totals were then summed to obtain the overall indirect morbidity costs for institutionalized people (Rice et al., 1991a).

Expressed as a formula, these costs were calculated for each age and gender stratum as follows:

Alcohol-related indirect morbidity costs for institutionalized people
= Minnesota population institutionalized related to alcohol abuse or dependence
x Labor force participation rate
x Average 1985 earnings and wage supplements
x Inflator 1989:1985

Issues and limitations

As Rice et al. (1990) note, "The obvious measurement problem with morbidity costs (as with mortality costs) is that data are not collected on what is not produced" (p. 231). This is in contrast to direct costs, which measure the value of goods and services that *are* produced. As with indirect mortality costs, indirect morbidity costs can only be inferred (Rice et al., 1990). This process of inference is based on the human capital method, whose shortcomings have been discussed previously in this chapter.

Although productivity losses are difficult to measure, researchers have attempted to address this issue by evaluating the impact of alcohol consumption on various aspects of the six classes of losses listed in the Definition section above (e.g., absenteeism). Parker et al. (1985) reviewed literature on the extent and/or costs of alcohol-related absenteeism, work injuries, and reduced productivity on the job. Rice et al. (1990) provided a more current review of the literature pertaining to all six classes of losses.

Some recent studies addressing alcohol and the workplace are briefly described in Table 3.21. Many of the findings confirm the work of older studies. However, as Mullahy and Sindelar (1992) note, studies must be interpreted and compared with caution for several reasons:

- Determination of cause is difficult to ascertain. Does excessive alcohol consumption reduce productivity, or is it a symptom of reduced productivity? As Rice et al. (1990) suggest, an alcohol disorder may be only one of a constellation of personal, familial, or social factors associated with poor economic outcomes.
- Different data sets operationalize alcohol consumption in a variety of ways, including: consumption at any level, moderate consumption, alcohol abuse, alcohol dependence, heavy drinking, problem drinking, and alcoholism.

Table 3.21 – Selected recent studies addressing alcohol and the workforce

Study	Alcohol focus	Data set	Main finding(s)
Berger & Leigh (1988)	Consumption	Employed workers	Workers who use alcohol tend to have higher wages than those who do not.
Heien & Pittman (1989)	Abuse	None — study is a critical review of methods and assumptions used in estimating economic costs, especially productivity losses.	Costs of alcohol abuse are overstated due to attribution of causality to alcohol abuse and improper methodology with regard to productivity impairment measures.
Mullahy & Sindelar (1989)	Alcoholism	General population[1] (Epidemiological Catchment Area survey)	Early onset of alcoholism has a strong effect on lifetime earnings, due to lower educational achievement leading to reduced earnings and occupational status.
Cook (1991)	Consumption	Employed workers	Workers who use alcohol tend to have higher wages than those who do not.
Fielding, Knight, Goetzel, & Laouri (1991)	Heavy or problem drinking	Employed workers (seven worksites)	Younger employees are more likely to report binge drinking, and older employees are more likely to report chronic drinking.
Gleason, Veum, & Pergamit (1991)	Consumption	General population aged 19-27 years (National Longitudinal Survey of Youth)	Alcohol use at the workplace is more common among men than women, and among blue-collar compared to white-collar workers. Nine percent reported that alcohol had "ever interfered with work on a job."
Manning, Keeler, Newhouse, Sloss, & Wasserman (1991)	Heavy drinking	General population (Health Insurance Experiment and National Health Interview Survey)	Absenteeism increases significantly due to heavy drinking, perhaps up to 40 percent.
Parker & Harford (1992)	Alcohol use and alcohol dependence	Employed workers (National Health Interview Survey respondents who were employed within two weeks prior to the survey)	Percentages of drinkers are higher among white-collar occupations than blue-collar occupations, but drinkers in blue-collar occupations consume more alcohol than drinkers in white-collar occupations.
Shore (1992)	Consumption (all levels examined)	Employed women (literature review)	Over the past few decades, alcohol consumption (but not heavy or problem drinking) has increased among employed women.
Blum, Roman, & Martin (1993)	Consumption (all levels examined)	Employed males	Heavy drinkers may be absent or late to work less frequently than their lighter-drinking counterparts, but some aspects of their performance on the job tend to be worse.

[1] General population includes employed and unemployed workers, and people not in labor force

- The data sample may consist of employed workers only, or it may include the general population. If the sample includes workers only, it implicitly excludes unemployed people and those not in the labor market (homemakers, retired persons).

In general, the literature finds that heavy, abusive, and dependent drinking leads to decreased personal and household income (Mullahy & Sindelar, 1992). However, two studies found that workers who use alcohol tend to earn higher wages than those who do not (Berger & Leigh, 1988, Cook, 1991). Mullahy and Sindelar suggest that these apparently contradictory findings may be explained in part by distinguishing between alcohol consumption in general and alcoholism. Moderate drinking may be associated with increased wages at least at certain ages, but abusive drinking may have a detrimental effect on earnings.

Mullahy and Sindelar advocate a distinction between earnings (wages or salaries) and income (earnings plus transfer payments and property income) and suggest that researchers consider how earnings and income vary over the lifetime of a person who consumes alcohol. For example, an individual who becomes alcoholic at an early age may forego college, enter the labor force, and initially have higher wages than someone who pursues post-secondary education at the same age. However, this second person's earnings may surpass the first person's earnings within several years after college graduation.

Several other problems inherent in estimating indirect morbidity costs should be noted:

(1) Many individuals with alcohol-related disorders also abuse drugs or have mental disorders. Therefore, it is difficult to determine what portion of income loss is due to alcohol alone. Rice et al. (1990) made an effort to separate these effects in their estimates of alcohol-related income losses.

(2) The costs of lost productivity for family members and friends who care for individuals with alcohol-related problems are not measured (Hodgson, 1983). The Employee Assistance Society of North America estimated that non-alcoholic members of alcoholics' families use ten times as much sick leave as members of families in which alcoholism is not present ("Alcohol & Drugs," 1986).

(3) Personal income, not personal earnings, is the denominator for the measure of the percentage of decreased income due to alcohol abuse or dependence. Personal income includes unearned income such as "transfer payments" (e.g., disability benefits). As a result, the alcohol-related costs may be understated (Rice, Kelman, & Miller, 1991b).

(4) Some productivity losses, such as declines in product quality and workplace process disruptions, cannot be captured by the lost-income methods (US Department of Health and Human Services, 1991).

Finally, it should be noted that Minnesota indirect morbidity cost estimates presented in this study are based on the cost data and methods of Rice et al. (1990), whose revisions of previous Research Triangle Institute (RTI) work (Harwood, Napolitano, Kristiansen, & Collins, 1984) resulted in major cost estimate changes. The Rice study estimated indirect morbidity costs at less than two-

fifths of the total costs, whereas in the earlier RTI study indirect morbidity accounted for three-fifths of total costs. The Parker et al. (1985) study was based on Berry and Boland (1977) and RTI methods and estimated 1983 costs in Minnesota to be 51-65% of the total.[16] The current study estimated these costs at 51% of the total.

E. Fetal Alcohol Syndrome Costs

Data and methods

The costs of FAS in Minnesota were estimated as Minnesota's proportion of the national costs of FAS (Abel & Sokol, 1987; Rice, Kelman, Miller, & Dunmeyer, 1990). Abel and Sokol based their national estimate on their own data and data from several previous studies, most notably a report by the Institute of Medicine (1985) on low birthweight infants. To arrive at a cost for residential care for individuals with mental retardation due to FAS, Abel and Sokol reviewed previous "retrospective" and "prospective" studies[17] and averaged the estimates from these two approaches.

Table 3.22 gives a breakdown of estimated national FAS costs by component for 1985. These national costs totaled over $1.6 billion. A percentage of this amount, reflecting Minnesota's proportion of the 1990 US population, was estimated to be Minnesota's expenditure for FAS.

The Minnesota costs were inflated from 1985 figures to their 1989 levels for consistency with other 1989 cost data used in this report. The 1985 figures were multiplied by 1.44, which represents the ratio of 1989 to 1985 personal health care expenditures (Health Care Financing Administration, 1992). Because this is a study of 1991 costs, the use of 1990 Census data and 1989 cost figures likely led to a different estimate of costs than would have been obtained if all 1991 data had been available. (For data sources and adjustments used, see Table 3.4.)

Table 3.22 - US cost of fetal alcohol syndrome, 1985

Category	Amount (millions)	Percent distribution
Growth retardation (intensive care costs)	118	7.3
Growth retardation at birth	91	5.6
Rehospitalization of low birthweight infants	26	1.6
Single year morbidity	1	0.06
Abnormalities requiring surgical correction	17	1.1
Cleft palate	15	0.9
Heart defects	2	0.1
Auditory defects	0.2	0.01
Full-time residential care (for severely retarded)	110	6.8
Semi-independent supervised care (for moderately retarded)	76	4.7
Residential care for adults over age 21	1,287	79.9
Research	3	0.2
TOTAL	$1,611	100.0

Sources: Adapted from Rice et al., 1990; Abel and Sokol, 1987, Tables 4, 5 and 6.

In short, Minnesota's FAS costs were estimated as:

Fetal alcohol syndrome costs
= (US costs/US population)
x Minnesota population
x Inflator 1989:1985

Issues and limitations

Abel (1990) has noted that while reasonably good cost data exist for treatment of FAS conditions, reliable data on the incidence of FAS are still unavailable. The costs reported in this study were based on Abel and Sokol's (1987) FAS-related cost estimate for 1985, adapted by Rice et al. (1990) and used by Alcohol-Related Disease Impact (ARDI) software to generate the Minnesota cost figures. Abel and Sokol have since published a new cost estimate which is considerably lower than their previous estimate, due to their revised estimate of FAS incidence (Abel & Sokol, 1991). Their 1987 incidence estimate was 1.9 FAS cases per 1,000 live births, later revised downward to 0.33 cases per 1,000 live births.

It is possible that the use of a national estimate of FAS incidence in this ARDI cost calculation *may* underestimate Minnesota incidence. Self-reported data collected from 47 states and the District of Columbia in 1991 through the Centers for Disease Control and Prevention show that among women of childbearing age, Minnesota has the fourth highest prevalence of frequent drinking,[18] at 18.2% (Centers for Disease Control and Prevention, 1994). Because the exact relationship of drinking patterns to fetal damage is not known, one cannot conclude with certainty that Minnesota's FAS incidence is higher than the national incidence, but there could be a greater possibility of adverse outcomes given the higher prevalence of frequent drinking in Minnesota.

Although FAS incidence may be lower than was assumed for the calculations of this report, it is important to note that the FAS costs presented in this report do not include the costs of fetal alcohol effects (FAE)[19] or other less identifiable consequences of alcohol use during pregnancy. The incidence of these problems and their associated costs are extremely difficult to estimate. FAE is believed to be much more common than FAS. One of the more conservative estimates suggests an FAE incidence three times the incidence of FAS (Abel, 1984).

As with other cost estimates in this report, FAS estimates used national cost data prorated to the Minnesota population. In addition, this section applied national FAS incidence and prevalence figures to the Minnesota population. It was necessary to use national data because minimal Minnesota data have been available to date. The Parker et al. study (1985) also employed non-Minnesota incidence data but used Minnesota cost data. Their estimated $42.4 million cost for 1983 accounted for 2-3% of total alcohol-related costs,[20] which is similar to the $44.8 million, or 2.6% of total costs, reported for 1991 in this study.

Although some useful treatment cost data exist, there are several important costs which have not been included in this estimate, due to a lack of accurate estimates in the research literature on FAS and FAE. One of the most important items is the cost of lost productivity, which constitutes a major portion of estimated alcohol abuse costs in the general population. This figure is still unavailable for FAS and FAE. Likewise, no estimate has yet been made for FAS- and FAE-related criminal justice costs. Medical costs beyond neonatal intensive care and surgery were not included. Some educational and social service costs may not have been included in the costs of residential care. Finally, no estimates were made of mental and emotional pain and suffering due to FAS and FAE.

F. Non-Health Sector Costs

Data and methods

To obtain an estimate of alcohol-related non-health sector costs for Minnesota, Alcohol-Related Disease Impact (ARDI) software was used to apply per capita national costs to the 1990 Minnesota population. National costs were estimated by using 1985 data from the Bureau of Justice Statistics (Rice et al., 1990). *Direct* costs (value of goods and services produced) were not adjusted due to the lack of an accurate inflator. *Indirect* costs (value of lost productivity) were adjusted to 1989 levels using an earnings inflator of 1.12, which represents the ratio of 1989 to 1985 earnings in the United States (US Department of Labor, 1992). Therefore, these estimates probably underestimate the true cost increases due to inflation.

In general, the cost for each non-health sector cost component was estimated as follows:

Alcohol-related non-health sector costs
= (US costs/US population)
x Minnesota population
x Inflator 1989:1985
[for indirect costs only]
(Adapted from Shultz et al., 1991)

The combined costs for all components yielded the total non-health sector cost estimate. Each component of non-health sector costs is described in the following pages.

Because this is a study of 1991 costs, the use of 1990 Census data and 1985 and 1989 cost figures likely led to a different estimate of costs than would have been obtained if all 1991 data had been available. (For data sources and adjustments used, see Table 3.4.)

Non-health cost components

The eight non-health cost components are listed in the accompanying text box.

Non-health sector cost components

1. **Public criminal justice system**
   a. Police protection
   b. Legal and judicial services
   c. Federal and state corrections
   d. Local corrections
2. **Private legal defense**
3. **Crime-related property destruction**
4. **Motor vehicle crashes**
   a. Legal and judicial costs
   b. Insurance administration
   c. Vehicle damage
5. **Fire destruction**
6. **Social welfare administration**
   a. Old age, survivors, and disability insurance
   b. Unemployment insurance
   c. Railroad temporary disability insurance
   d. State temporary disability insurance
   e. Workers compensation
   f. Public assistance
   g. Supplemental security income
   h. Food stamps
   i. Veterans pensions and rehabilitation
   j. Vocational rehabilitation
7. **Lost work days for victims of crime**
8. **Lost work days for incarcerated criminals**

Source: Rice et al., 1990

The following text describing these components is adapted from Rice et al. (1990), with additional information from Shultz, Parker, and Rice (1989). National costs estimated by Rice et al. for 1985 are described in each case. These costs were then apportioned to the Minnesota population (and inflated to 1989 levels for indirect costs).

For criminal justice components, offense-specific costs were determined by multiplying the offenses in each category by a factor that represents the

proportion of offenses considered to be due to the effect of alcohol (Rice et al., 1990). The offenses and their estimated alcohol-attributable percents are listed in Table 3.23.[21]

The 1985 national costs were estimated as follows:

(1) ***Public criminal justice system.*** This includes four major items:

- police protection,
- legal and judicial services,
- federal and state corrections, and
- local corrections.

Rice et al. estimated alcohol-attributable costs for each item using a crime-specific methods developed by Cruze, Harwood, Kristiansen, Collins, and Jones (1981) and Harwood, Napolitano, Kristiansen, and Collins (1984). Crime categories are from the Uniform Crime Reporting System of the US Department of Justice. The Department of Justice receives monthly data from law enforcement agencies nationwide, who report "actual known offenses." These are accounts of police time spent responding to and investigating crimes reported by victims, officers, and other sources.

Table 3.23 – Alcohol-attributable percentages of offenses

Part I offenses:	
Homicide	46.0%
Rape and aggravated assault	26.9
Robbery	3.9
Burglary	4.7
Larceny	3.8
Auto theft	4.6
Part II offenses:	
Driving under the influence of alcohol	100.0%
Liquor law violations	100.0

Sources: Rice et al., 1990; Shultz et al., 1989

(1)(a) *Police protection costs* were computed on a per-offense basis, using *known offenses reported* for Part I categories and *known arrests* for Part II offenses.[22] See Table 3.23 for Part I and Part II offenses. The national cost per case was estimated in 1985 to be $28.76, half of the estimated combined cost of police protection and legal and judicial expenses.

(1)(b) *Legal and judicial costs* are the sum of court costs, legal services, and public defense expenses. Part I offense costs were calculated by multiplying the offense-specific percentage of offenses "cleared by arrest"[23] by the specific alcohol-related factor, by the total US public cost of judicial and legal services. Part II offenses were calculated on a per-arrest basis, multiplying the number of arrests by $28.76, the estimated cost per case.

(1)(c) *Federal and state corrections costs* are the costs of incarceration (e.g., costs of feeding and housing inmates) at the federal and state level. These costs were calculated separately from local corrections because serious offenders are usually sent to federal and state institutions for longer periods. Offense-specific federal and state alcohol-related crimes were calculated by multiplying the percentage of total federal and state inmates in each offense category by the alcohol-related percentage for that category. These figures were then multiplied by the total expenditures for federal and state corrections costs. The costs for each offense category were then added together for a total cost estimate.

(1)(d) *Local corrections costs* were calculated by multiplying the percentage of known arrests in each offense category by the alcohol-related percentage for that category, by the total expenditures for local corrections costs. These were then added together.

(2) ***Private legal defense costs*** were estimated using the US Census Bureau's total annual payroll for private legal services (cited in Rice et al., 1990), attributing to private defense the same proportion of alcohol-related costs as was reported for public legal costs (Cruze et al., 1981).

(3) ***Crime-related property destruction costs*** were estimated using the National Crime Survey Report (cited in Rice et al., 1990), which gives the value of damaged or destroyed property due to specific offenses. The alcohol-attributable percentages listed in Table 3.23 were then multiplied by the corresponding costs for each offense category and totaled.

(4) ***Motor vehicle crash costs*** include three types of non-medical costs: legal and judicial costs, insurance administration, and vehicle damage. Rice et al. (1990) used National Highway Traffic Safety Administration data reporting the number of fatalities, nonfatal injuries, and crashes involving property damage only (Blincoe, 1987). Cost data were obtained from Berry, Boland, Smart, and Kanak (1977), Faigin (1976), Cruze et al. (1981) and Blincoe (1987). Alcohol-attributable percents were drawn from Berry et al. (1977) and Cruze et al. (1981).

Alcohol-attributable percents of crashes were estimated at:

- 6% of all crash costs,
- 37% of fatal crash costs,
- 10% of severe/critical injury crash costs,
- 10% of minimum/moderate injury crash costs, and
- 3% of property damage crash costs.

(5) ***Fire destruction costs*** were based on a national estimate of property losses due to fire destruction published by the National Fire Protection Association (cited in Rice et al., 1990). Berry et al. (1977) determined that 6.1% of these losses could be attributed to alcohol use.

(6) ***Social welfare administration costs*** utilized expenditures and data for social welfare programs having large numbers of participants with alcohol problems, in conjunction with illness-specific alcohol-related percentages (cited in Cruze et al., 1981). The social welfare programs include Old Age, Survivors, and Disability Insurance; unemployment insurance; railroad temporary disability insurance, state temporary disability insurance, workers compensation, public assistance, supplemental security income, food stamps, veterans pensions and rehabilitation, and vocational rehabilitation.

(7) ***The value of lost work days for victims of crime (lost economic productivity)*** was calculated by applying offense-specific alcohol-related percentages (Cruze et al., 1981) to data from the National Crime Survey (cited in Rice et al., 1990). Data include the number of victims by type of crime, average work days lost, and the annual average earnings adjusted for wage supplements for women and men. The average earnings per day were applied to the number of work days lost by victims of alcohol-related crimes in each category.

(8) ***The value of lost work days for incarcerated criminals (lost economic productivity)*** was estimated using Department of Justice data (cited in Rice et al., 1990) and the methods of Cruze et al. (1981). The number of people incarcerated due to alcohol-related crimes was estimated, as well as the total years served by all prisoners by type of crime. Gender-specific average earnings were then multiplied by the estimated lost work days for each type of crime. Added together, these figures represent the total value of lost work days for incarcerated criminals.

Issues and limitations

In addition to the general issues listed in the Introduction to this chapter, three areas are of special concern: (1) the need to utilize more Minnesota data sources; (2) the relationship of alcohol use to crimes and assignment of an alcohol-attributable percentage to various crimes; and (3) the relative underdevelopment of non-health sector cost estimation techniques compared to other cost categories.

(1) State-specific data on the number of crimes, motor vehicle crashes, and fires, as well as social welfare administration costs, are available for Minnesota. For motor vehicle crashes (since 1988) and fire deaths (since August 1993), alcohol-attributable percentages are available for Minnesota. A limitation of Alcohol-Related Disease Impact (ARDI) software is that the only state-specific data it is able to use for the calculation of non-health care costs is state population data. All other data are from the Rice et al. national report (1990). Separate sections in chapter 4 present some state-specific data on these topics.

(2) The alcohol-attributable percentages assigned to crimes were first developed by Cruze et al. (1981). They developed estimates of the association of alcohol with violent and property crime, and the proportion of such offenses that could be considered caused by alcohol consumption. There are ongoing debates about whether and when alcohol causes crimes, or whether alcohol is simply present in perpetrators and/or victims of crimes.

Alcohol-related crime costs may be underestimated for the following reasons:

- The estimate does not include the value of years of work lost by homicide victims (this is measured in the category of lost productivity due to premature death—see "Indirect mortality" section).
- The lost economic production of crime victims and incarcerated criminals is estimated only by the value of days of work lost. It does not include possible lowered productivity on the job due to stress suffered by victims.
- Figures cannot adequately measure the cost of pain and suffering resulting from crimes.
- Some crimes (including alcohol-related crimes) go unreported.

(3) Estimation of non-health sector costs is not as well developed as is the case with health-related cost categories. Hodgson (1983) describes the problem with non-health sector estimates in cost-of-illness studies:

> *"The most progress has been made with respect to health sector direct costs and indirect economic costs of time lost from work and housekeeping by the victim of disease [i.e., the alcohol abuser]. Limitations of data and knowledge have hindered development of non-health sector direct costs and indirect costs incurred by others besides the victim [the alcohol abuser]" (p. 137, brackets added).*

For example, in the case of alcohol-related non-health sector costs, the value of care by family members and friends of crime victims is not included, nor are the pain and suffering by crime victims and their family and friends measured. Any decreased economic productivity by victims as a result of their stress is not measured, except the value of lost work time. The net effect of these problems is an underestimate of the magnitude of non-health sector costs.

Endnotes

1 Costs for hospitals, office-based physicians, nursing homes, and other professional services are from 1989 Minnesota Personal Health Care Expenditures (Health Care Financing Administration, 1992).

2 Direct non-health costs were kept at their 1985 levels because an accurate inflator was not identified. Using 1985 levels resulted in an underestimate of these costs.

3 Female deaths were higher for cardiovascular diseases (119 female deaths compared to 84 male deaths), respiratory diseases (42 vs. 35) and other diseases (excess blood alcohol and diabetes, 22 vs. 17). Deaths in the diagnostic categories for which male deaths predominate (injuries and violence) generally occur at younger ages.

4 Chapter 4 contains a section on alcohol consumption during pregnancy, which describes FAS in greater detail.

5 In this report, the terms "crime" and "offense" are used interchangeably. ("Offense" is the term used in many official crime reports.)

6 Internal and external costs may be direct or indirect costs. Likewise, they may be core or related costs. Examples: (1) An individual pays for alcoholism treatment with his or her own earnings (internal direct core cost), or a government agency pays a portion or all of the cost of treatment (external direct core cost). (2) An individual misses work due to an alcohol-related health problem and does not receive pay for lost work time (internal indirect core cost), or the individual goes to work but produces at a minimal level while receiving pay for a fully productive day's work (external indirect core cost).

7 Labor market wage discrimination results in the underpayment of individuals based on some judgment which does not reflect their productivity. For example, racial minorities have often experienced systemic labor market wage discrimination.

8 1989 dollars were used rather than 1991 dollars because Minnesota-specific direct health care costs for 1989 were available, and other ARDI-based 1985 costs were then inflated to 1989 levels for consistency. Only some non-health costs remained at 1985 levels since an accurate inflator was not identified.

9 Although alcohol-related child abuse costs were not estimated in this study, Minnesota Department of Human Services data on the proportion of abuse cases involving alcohol are included in the section of chapter 4 titled "Non-vehicle injury, violence, and property crime."

10 The Marine Corps was not included in the cost estimates from Rice et al. (1990).

11 The Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) was reorganized in 1992 and is now the Substance Abuse and Mental Health Services Administration (SAMHSA).

12 Alcohol-Related Disease Impact (ARDI) software documentation does not specify whether the costs of alcohol-related treatment in state, county, and private psychiatric hospitals are classified under "specialty institutions" or "hospitals" when state-specific data are entered by the user. If the user does not enter state-specific data, ARDI classifies psychiatric costs as part of "specialty institutions" costs. However, in this study, Health Care Financing Administration data for Minnesota were entered by the user. HCFA classifies psychiatric hospital costs under the HCFA "hospitals" category, not "specialty institutions." It is unclear how ARDI software addresses this shift in classification.

The treatment costs for psychiatric hospitals amounted to approximately 18% of all specialty institution costs in the Rice et al. (1990) study. These data comprise the national cost figures used in ARDI.

[13] These expected future earnings included the estimated monetary value of household work for those who did not work outside the home.

[14] Because ARDI software uses 1985 as the base year for the present value of future earnings (PVFE), the software discounted future earnings to 1985 values. An income inflator of 1.12 was then used to raise the PVFE figures to 1989 levels. This inflator is the ratio of 1989 to 1985 earnings (US Department of Labor, 1992).

[15] The present value of future lifetime earnings is lower for people under 20 years than for people in their 20s and 30s. This is because people will generally not begin fully paid regular jobs until about age 20, and because the future earnings to be discounted to their present value occur far in the future. For example, for a current five-year-old child, discounting the salary to be received when he or she is 22 years old back to its present value will make the present value considerably smaller in amount.

[16] The range of 51-65% is the result of four estimates made using different calculations of reduced productivity. These calculations depended on (1) the estimated alcohol-attributable percentage of productivity losses, and (2) inclusion or exclusion of the imputed value of household work. Regarding (1), Berry and Boland (1977) estimated that 14% of productivity losses were alcohol-related. The Research Triangle Institute (Harwood et al., 1984) estimated a 21% alcohol-related reduction. Using the 14% figure and excluding household work, $630 million was calculated as the low estimate of 1983 alcohol-related productivity losses in Minnesota. Using the 21% figure and including household work, $1.19 billion was the high estimate. The remaining two calculations fell in mid-range. Adding $72 million in estimated long-term employment losses to each of the above figures yielded the total indirect morbidity cost under the various assumptions. The percentage of the total costs under each assumption was then calculated, resulting in the 51-65% range.

[17] Retrospective studies are based on a determination of the incidence of FAS among mentally retarded people living in special facilities. Prospective studies determine the incidence of mental retardation among those already identified as having FAS.

[18] Frequent drinking is defined here as consuming 30 or more drinks in the month preceding the survey, or five or more drinks on at least one occasion during the preceding month.

[19] Fetal alcohol effects refers to the condition of an individual who meets some, but not all, of the criteria for a fetal alcohol syndrome diagnosis (Clarren & Smith, 1978).

[20] The 2-3% range depends on which level of indirect morbidity costs are included in the total 1983 costs. See footnote in section on indirect morbidity in this chapter.

[21] *Known offense* data were used for Part I offenses, and *known arrest* data were used for Part II offenses.

[22] National Uniform Crime Reports provide arrest data only for Part II offenses.

[23] "Cleared by arrest" means the process of arresting, charging, and turning the accused over to the courts for prosecution. More than one offense can be cleared by the arrest of a single individual. Additionally, multiple arrests can clear a single offense.

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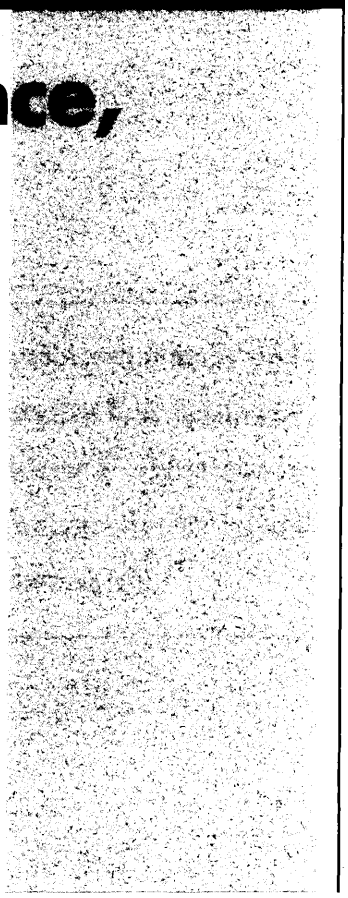
Chapter 4 • Section A

Non-Vehicle Injury, Violence, and Property

Summary points

- This section provides Minnesota data which supplements injury, violence, and property crime data used in the calculations of mortality and economic costs presented in chapters 2 and 3.
- Alcohol has a recognized association with violence and all types of injuries, especially the more severe and fatal ones.
- Drinking by both offender and victim often precedes homicides and assaults.
- Frequent drinking has been clearly associated with spouse or partner abuse. The relationship of alcohol to child abuse has not been as well defined.
- Among Minnesota fire victims from August 1, 1993 through July 2, 1994, 36% had a positive blood alcohol content. Among drownings and boating fatalities, about 50% of the deaths were alcohol-related.
- The Minnesota Sentencing Guidelines Commission found that over 30% of 1,390 offenders in a 1991 study were under the influence of alcohol at the time of the offense, and 6% were under the influence of both alcohol and illegal drugs. About 27% of the 1,390 offenders regularly abused alcohol, and another 26% regularly abused both alcohol and illegal drugs.
- Minnesota's state and local justice expenditures for 1991 were estimated to be slightly over $1 billion, of which an undetermined percentage was alcohol-related.
- Community-wide approaches to change alcohol consumption norms, as well as policies designed to minimize consumption of alcohol, are effective public health strategies to lower the occurrence of alcohol-related injuries and violence.

Non-Vehicle Injury, Violence, and Property Crime



Introduction

Focus of this section

This section addresses the nature, magnitude, cost and public health implications of alcohol-related non-vehicle injury, violence, and property crime. Particular attention is given to efforts to determine the role of alcohol in injury and violence, and to Minnesota data collected by state governmental agencies.

Definitions of injury, violence, and property crime

"Injury" in this section refers only to "unintentional"[1] injuries that are not related to driving a vehicle while under the influence of alcohol, e.g., most fires,[2] falls, and drownings. Alcohol-impaired driving is covered in another section of this chapter. The injuries covered in this section may be fatal or nonfatal.

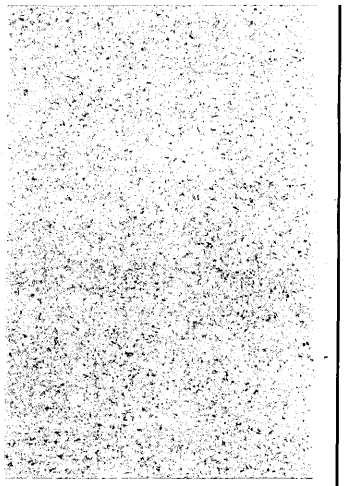
"Violence" refers to acts of personal violence such as suicide, homicide, robbery, arson, assault, rape, and abuse. Fatal or nonfatal injuries resulting from violent acts are sometimes referred to as "intentional" injuries, but in this section they will be included under the terms "violence," "violent crime," or "violent acts."

"Property crime" includes burglary, theft/larceny, and motor vehicle theft.

"Injury" in this section refers only to unintentional injuries that are not related to driving a vehicle while under the influence of alcohol, e.g., most fires, falls, and drownings. "Violence" refers to acts of personal violence such as suicide, homicide, robbery, arson, assault, rape, and abuse.

Minnesota injury, violence, and property crime data from state agencies

Injury, violence, and property crime data from Minnesota governmental agencies are presented in the following segments on magnitude and cost implications. In the non-health costs section of chapter 3, Alcohol-Related Disease Impact (ARDI) software (Shultz, Parker, & Rice, 1989) was used to calculate Minnesota's direct and indirect costs due to alcohol-related injury, violence, and property crime. These calculations were based on a combination of national and Minnesota data. National data included cost figures as well as alcohol-attributable fractions



for each type of fatal injury, violent crime, and property crime. The national figures were then applied to Minnesota-specific population and mortality data.

This section provides *additional* Minnesota data on the magnitude and associated costs of injury, violence, and property crime. Minnesota data are presented here if the reader wishes to use them to supplement or adjust the ARDI estimates of the magnitude and costs of alcohol-related injury, violence, and property crime using the additional Minnesota-specific data.[3]

This section provides additional Minnesota data on the magnitude and associated costs of injury, violence, and property crime. These data supplement state and national data used in the mortality and economic cost calculations presented in chapters 2 and 3.

The alcohol-attributable fractions (AAFs) used in ARDI software for each type of injury, violence, or property crime are based on national data. These AAFs are available as a complete set in ARDI software (see chapter 2 for AAFs of injuries, suicide, and homicide, and chapter 3, Non-health costs section, for AAFs of criminal offenses).

The relationship of alcohol to injury, violence, and property crime

Distinguishing between injuries and violence

Assessing the relationship of alcohol to injury, violence, and property crime is a difficult endeavor, plagued by definitional and measurement problems. Alcohol involvement aside, it is sometimes difficult to determine whether a death or nonfatal trauma is due to unintentional injury or to an intentional violent act. Baker and associates describe the problem this way (Baker, O'Neill, Ginsburg, & Li, 1992, p. 17):

Assessing the relationship of alcohol to injury, violence, and property crime is a difficult endeavor, plagued by definitional and measurement problems.

> "Unlike diseases, injuries [including personal violence] are often classified on the basis of the behaviors and events that preceded them and the imputed intent of the people involved. The commonly used major subdivisions of injury deaths are homicide, suicide, and unintentional.... Although the events leading to intentional and unintentional injuries may differ widely, the mechanisms of injury and the injuries themselves are typically similar." (brackets added)

For this reason, classification often requires knowledge of intent, which may not be readily apparent. As a result, for example, a homicide resulting from an act of violence may be mistakenly reported as a fatal unintentional injury. A homicide may be reported as a suicide, or a suicide as a fatal unintentional injury.

Defining the role of alcohol with respect to injury, violence, and property crime

A primary issue in addressing the role of alcohol in injury, violence, and property crime is determining whether alcohol is only associated with such events, or whether alcohol has a causal role. Many studies have shown an association of alcohol to injury and violence, but proving causation has been difficult. Evidence for causality includes a clear dose-response relationship of drinking (especially binge drinking) to fatal injuries[4] (Anda, Williamson, & Remington, 1988). Physiological effects of alcohol use, such as impaired cognition, could possibly be used to argue for a causal role of alcohol in injury, violence, and property crime. Patterns showing more injuries and violence on weekends implicate alcohol since these are the times at which alcohol is used most (Baker et al., 1992; Smith et al., 1989), but this alone does not show causation.

Some factors that complicate an understanding of the role of alcohol include: (1) People in different cultures or countries respond very differently to alcohol use. Even within one culture, people may respond differently to alcohol depending on the situation (Giesbrecht et al., 1989; Collins, 1988). (2) There may be other contributing or associated factors involved in an injury or violent casualty, such as drug use or mental illness, which are often present in combination with alcohol use (Cohen, Baer, & Satterwhite, 1991).

A primary issue in addressing the role of alcohol in injury, violence, and property crime is determining whether alcohol is only associated with such events, or whether alcohol has a causal role.

Measuring the involvement of alcohol in injury, violence, and property crime

While extensive documentation exists for alcohol-related motor vehicle crashes, injuries, and their costs,[5] relatively little data are available to study the magnitude and cost of other types of alcohol-related injury, violence, or property crime. In general, it is difficult to establish surveillance systems suitable for monitoring alcohol-related health problems, due in part to lack of uniform reporting capability (Smith et al., 1989).

While extensive documentation exists for alcohol-related motor vehicle crashes, injuries, and their costs, relatively little data are available to study the magnitude and cost of other types of alcohol-related injury, violence, or property crime.

Some of the major problems inherent in measuring the involvement of alcohol in injuries and violence include:

(1) Study populations differ widely. These populations include emergency room cases, autopsies, insurance cases, court cases, prison inmates, and victims' reports on offenders.

(2) Measures of alcohol use may be subjective or not comparable. While some measures are more objective, such as blood alcohol content, many studies depend on observations of

behavior by professionals such as emergency room personnel or reports by injured persons or offenders. Some studies consider the use of alcohol at the time of the incident or shortly thereafter, while other studies assess the history of alcoholism and other chronic use of alcohol preceding the incident.

(3) Because the findings of many studies are based on small numbers of cases, it is difficult to characterize alcohol's involvement in injuries and violence among the general population (Smith & Kraus, 1988). In addition, many studies use only descriptive statistics without a comparison population, lacking the rigor of a case-control or prospective study and making conclusions about alcohol's involvement less sound (Howland & Hingson, 1988).

In the United States, alcohol has been implicated in the four major leading causes of injury death: motor vehicle crashes, fires, falls, and drownings.

(4) Tests for alcohol's involvement may be inconsistently applied. The "degree of ascertainment" (percentage of cases actually tested for alcohol) can vary greatly across studies (Howland & Hingson, 1988). For example, emergency room personnel often rely on the smell of alcohol on a patient's breath when deciding whom to test for alcohol use, because conducting other tests may not be possible or feasible when a patient is seriously injured (Roizen, 1989). A study by Smith et al. (1989) found that alcohol tests were more frequently conducted for homicides and suicides than for deaths from unintentional injuries or natural causes.

Where blood alcohol content (BAC) is measured, the timing of the test is critical. Since alcohol is metabolized over time, BAC measurement for an injury which is untreated until many hours after it occurs may not indicate any alcohol involvement (Center for Injury Prevention, 1991).

(5) The injured person may not have been drinking, but drinking by another person(s) may have caused the injury, either through unintentional actions or violence. For example, Bijur and colleagues (Bijur, Kurzon, Overpeck, & Scheidt, 1992) report that children of parents who are problem drinkers are at an elevated risk of injury.

(6) Underestimates of the extent of alcohol's involvement in injuries and violence are due in part to the fact that data on alcohol use and nonfatal injuries are difficult to obtain (Smith & Kraus, 1988).

(7) Denial and shame about alcohol use may exist, especially when alcohol consumption accompanies an injury or violent event.

Alcohol and injury

In the United States, alcohol has been implicated in the four major leading causes of injury death: motor vehicle crashes, fires, falls, and drownings (Hingson & Howland, 1993; US Department of Health and Human Services [USDHHS], 1990a). While most public attention focuses on alcohol and motor vehicle injuries, alcohol may be substantially involved in other types of injuries. Smith and Kraus (1988) reviewed studies on non-vehicle injuries and alcohol since 1960 and found that alcohol has a recognized association with all types of injuries, especially

more severe and fatal ones, and that increased doses of alcohol lead to more severe injuries. They also note that a number of non-vehicle injury studies have shown blood alcohol content levels to be similar to those in motor vehicle studies.

Despite the methodological shortcomings of many studies, the best studies tend to confirm the hypothesis of an association between alcohol and non-vehicle injuries, especially fires and falls (Howland & Hingson, 1988; Smith & Kraus, 1988). Haberman (1987) found that a history of alcohol problems or alcohol consumption immediately preceding a fatality occurred more often in deaths by falls and fires than in traffic deaths.

A recent review of the literature on alcohol and injury from 1947-1986 (Hingson & Howland, 1993) found that across all the studies, the proportion of persons who had been drinking prior to fatal and non-fatal falls ranged from 18-53% and 21-77% respectively. Among individuals who drowned, 27-47% had positive blood alcohol concentrations. Among fire fatalities, alcohol was involved in 9-86% of deaths (12-61% among the five most recent studies). The wide ranges of values reflect variations in study methods, time periods, and populations. In an earlier analysis of the same studies, the median percentages of victims exposed to alcohol prior to injury were reported: falls (fatal and non-fatal), 39%; drownings, 38%; and fires, 39% (Howland & Hingson, 1988).

Although fires, falls, and drownings have been the subjects of the most alcohol and non-vehicle injury research, there are many other types of injuries which can be alcohol-related, e.g., machinery injuries, electric current, suffocation, cuts, and alcohol poisoning. For reviews of the relationship between alcohol and non-vehicle injuries, see Baker et al. (1992), Cherpitel (1992), Hingson and Howland (1993), Parker et al. (1985), Roizen (1989), Smith and Kraus (1988), Stallones and Kraus (1993), and USDHHS (1990a).

Alcohol has a recognized association with all types of injuries, especially the more severe and fatal ones.

Alcohol, violence, and property crime

Many studies have established a strong positive association between alcohol and violence, but whether alcohol consumption actually *causes* violent behavior needs clarification. Cohen and associates (1991) reviewed over 200 publications on alcohol and violence and found that alcohol use preceded or accompanied one-third to two-thirds of all homicides and serious assaults studied. Bushman and Cooper (1990) analyzed 30 experimental studies on alcohol and aggression and concluded that alcohol does indeed cause aggressive behavior. Although the association between alcohol and violence has been well documented, and while studies such as Bushman and Cooper's suggest a causal role for alcohol, the exact nature of alcohol's relationship to violent behavior is still a matter of investigation and debate. Numerous social, psychological, and physiological explanations of the relationship exist. These are often organized into frameworks such as the following:

Many studies have established a strong positive association between alcohol and violence, but whether alcohol consumption actually causes violent behavior needs clarification.

(1) Cohen and associates (1991): *causal, common source, or complex interplay theories*. *Causal* theory states that alcohol has a disinhibiting effect, psychologically or physiologically, on a drinking person. According to this theory, alcohol-induced changes in thinking or feeling lead to a greater likelihood of violent action. Cohen et al. note that some researchers and practitioners have observed the converse; i.e., that an individual who experiences violence may turn to alcohol, perhaps to dull painful experiences. *Common source* theory posits that violent behavior results from multiple problems stemming from a common origin; e.g., a dysfunctional family in which alcohol abuse and child abuse coexist and jointly contribute to violent behavior. *Complex interplay* theory suggests that many factors leading to violent behavior are intertwined. An individual factor cannot be isolated, since any one factor may lead to another.

(2) Collins (1988): *pathological, cultural, deviance disavowal, and situational frameworks*. The *pathological* framework sees alcohol use, by itself or in combination with other factors, as causing violent behavior due to a pathological condition in the drinker (e.g., a psychological disorder). The *cultural* framework understands behaviors to adhere to culturally grounded rules and conventions around the use of alcohol. Within the *deviance disavowal* framework, responsibility or blame for behavior after drinking is deflected from the individual and ascribed to alcohol. The *situational* framework suggests that drinking norms and subsequent behavior vary depending on the drinking context.

(3) Cook and Moore (1992): *rational choice framework*. This framework moves toward personal responsibility of the drinker as a rational decision maker, and away from physiological or other explanations for drinking-related behaviors. Pernanen (1991) supports this idea by concluding that alcohol-related violence, like sober violence, can be understood in terms of normal human motivation.

Other important considerations include a determination of whether chronic or binge drinking is more associated with violent behavior, and the degree to which psychological disorders play a part in violent acts committed under the influence of alcohol (Martin, 1992). Collins and Schlenger (1988) found that drinking just prior to a crime was significantly associated with imprisonment for the offense, but that having symptoms of chronic heavy drinking was not. Martin cites research findings that alcoholics with psychopathological disorders frequently commit violent offenses.

Studies on alcohol and crime show that several factors may lead to *overestimates* of the apparent relationship of drinking to crime (USDHHS, 1990a): (1) Few studies control for age and gender, both of which are related to the incidence of crime and to drinking. (2) Intoxicated criminals are more likely to be apprehended or convicted. (3) Patterns of police activity may lead to greater apprehension of criminal activity among intoxicated people (e.g., police being near bars at closing time).

Some factors may lead to *underestimates* of the relationship of alcohol to crime. In addition to methodological problems mentioned earlier in this section, if the violent action was perpetrated under the influence of alcohol on a person not using alcohol, the presence of alcohol in the event might go unreported. For example, homicide data generally report the blood alcohol content of the victim only.

(However, some studies have collected data on drinking by the assailant—see self-reported data from US Department of Justice surveys.)

Finally, the relationship between alcohol and crime may be obscured by the limited use of appropriate control groups in studies (USDHHS, 1990a). This means, for instance, that while a criminal population may be studied for use of alcohol in association with criminal activities, the extent of alcohol consumption may be unknown for a similar population who have not committed crimes (a control group).

For a more detailed description of the many problems inherent in researching the relationship of alcohol to violence, see Martin (1992).

US Department of Justice surveys

The US Department of Justice collects reports of criminal offenders and crime victims regarding alcohol use by the offenders in the crimes in which they were involved. Among the findings of self-reported alcohol use at the time of the offense:

- In a 1991 survey of state prison inmates (Beck et al., 1993), approximately one-fourth of inmates convicted of homicide, sexual assault, or other assault reported having committed the offense under the influence of alcohol only. Adding those who reported committing the crime under the influence of both alcohol and drugs raised the proportion to about two-fifths. About one-third of inmates convicted of a robbery or a property offense reported being under the influence of alcohol at the time of the offense.
- The inmates who reported drinking at the time of their offense had consumed an average of the equivalent of three six-packs of beer before committing the offense. About half of inmates under the influence of alcohol at the time of the offense had been drinking for six hours or more before the offense.
- Another Justice Department survey, of correctional populations in the United States in 1989 (US Department of Justice, 1991), found that 41 percent of convicted inmates reported committing their current offense under the influence of alcohol. Female inmates in 1989 reported lower levels of alcohol use than males by all measures reported (Table 4A.1) (Snell, 1992).
- A survey of 1991 crime victims' perceptions of alcohol use by the offenders also showed high perceived levels of alcohol use or combined alcohol and drug use at the time of the offense (Table 4A.2) (US Department of Justice, 1992). It should be noted that a high percentage of crime victims responded "don't know" to perceived alcohol or drug use (last column of Table 4A.2).

Table 4A.1 – Alcohol use and treatment of local jail inmates in the United States, 1989

(n = 5,675)	(%) Percent of jail inmates	
	Female	Male
Who had ever been an alcoholic	13.2%	21.7%
Who had ever participated in an alcohol abuse treatment program	9.5	15.3
Who were under the influence of alcohol at the time of the current offense*	20.6	43.5
Who reported drinking for 5 or more hours before the current offense*	9.0	19.2
Who reported being drunk or very drunk at the time of the current offense*	8.4	20.8

* Based on convicted inmates only.

Source: Bureau of Justice Statistics Special Report, "Women in Jail 1989" (Snell, 1992).

Homicide and assault

An important consideration in the relationship of alcohol to violent crime is determining whether the offender, the victim, or both had consumed alcohol before the crime was committed.

Tables 4A.3 and 4A.4 present the results of studies of drinking prior to homicides and assaults. In another review, Murdoch, Pihl, & Ross (1990) found that in many studies, both offender and victim had been drinking before the crime. They reported the most likely scenario for alcohol-related homicide and assault as one in which "heavy drinking and a verbal argument precede the violent act and the victim is as likely as the offender to initiate the altercation" (p. 1065). In a US Department of Justice study of homicides involving 2,655 victims, 64.4% of defendants had been drinking alcohol at the time of the murder, and 47.4% of the victims had been drinking alcohol (Dawson & Langan, 1994). Although a strong correlation exists between alcohol and homicide and assault, it is difficult to ascribe a causal role to alcohol based on these studies, due to many methodological problems previously mentioned.

For an additional literature review on alcohol and homicide, see Parker et al. (1985).

Table 4A.2 – Percent distribution of victimizations by perceived alcohol or drug use by the offender, United States, 1991

(n = 41,700 housing units) Type of crime	Alcohol	Drugs	Both	Under the influence of one or the other, not sure which	Don't know
Rape	34.2%	3.8%*	3.1%*	2.9%*	39.5%
Robbery	9.8	9.7	4.6	1.9*	60.9
Assault	23.7	3.0	5.8	1.6	42.8
Aggravated	25.3	4.3	8.1	2.4	44.3
Simple	22.9	2.4	4.8	1.3	42.0
All	21.5	4.2	5.5	1.7	45.9

* Estimate is based on about 10 or fewer sample cases.

Source: Bureau of Justice Statistics, "Criminal Victimization in the United States, 1991" (US Department of Justice, 1992).

An important consideration in the relationship of alcohol to violent crime is determining whether the offender, the victim, or both had consumed alcohol before the crime was committed.

Table 4A.3 – Studies of drinking prior to homicides

Researcher	Location and date	Source of data	Sample size	Total alcohol involvement* (%)	Drinking by assailant (%)	Drinking by victim (%)
Verkko (1951)	Vyborg County, Finland (1920-1929)	Court records	543 cases	69	55	48
Wolfgang (1958)	Philadelphia (1948-1952)	Medical examiner and police reports	621 offenders 588 victims	64	55	53
Voss & Hepburn (1968)	Chicago	Police reports	429 offenders 395 victims	54	-	-
Virkkunen (1974)	Helsinki, Finland (1963-1968)	Medical examiner and police reports	114 offenders 116 victims	79	66	68
Goodman, Mercy, & Rosenberg (1985)	Los Angeles (1970-1979)	Medical examiner and police reports	3,551 victims	-	-	49
Lindquist (1986)	Northern Sweden (1970-1981)	-	64 offenders 71 victims	-	66	47
Welte & Abel (1989)	Erie County, New York (1972-1984)	Medical examiner reports	792 victims	-	-	42
Zahn (1991)	Philadelphia (1978)	Medical examiner and police reports	679 victims	60	52	53

* Drinking by either or both parties

Source: Martin, 1992

Table 4A.4 – Studies of drinking prior to assaults

Researcher	Location and date	Source of data	Sample size	Total alcohol involvement* (%)	Drinking by assailant (%)	Drinking by victim (%)
Pittman & Handy (1964)	St. Louis	Police reports	241 cases aggravated assault, 237 offenders	31	24	25
Tardif (1966)	Montreal, Canada (1964)	Police reports	124 offenders 140 victims	-	37	25
Gerson & Preston (1979)	Ontario, (1976-1977)	Police reports	774 spousal assault cases	49	-	-
			2,978 other assault cases	36	75	75
Pernanen (1991)	Thunder Bay Canada (1977-1978)	Police reports	749 cases	42	31	26

* Drinking by either or both parties.

Source: Martin, 1992.

Rape/sexual assault

As with homicide and assault, alcohol consumption by both offender and victim is often associated with sexual assault (Martin, 1992, Table 4A.5). Alcohol has been identified as a risk factor for sexual assault in various studies (Abbey, 1991; Koss & Dinero, 1989; & Muehlenhard & Linton, 1987). Abbey, Ross, and McDuffie (1993) found that across studies using various assessments of sexual assault and with different populations, about 50% of sexual assaults were associated with alcohol consumption by the perpetrator, the victim, or both.

Suicide

A recent review of studies on alcohol and suicide (USDHHS, 1990a), found that (1) 20-36% of suicide victims either had a history of alcohol abuse or were drinking shortly before their suicides; (2) alcohol use was associated with impulsive rather than premeditated suicides; and (3) alcohol and the use of firearms were often related among youthful suicides. Numerous studies cite both chronic and acute (binge) drinking as risk factors for suicide (see Cohen, Baer, & Satterwhite, 1991, for a review).

For additional literature reviews, see Baker et al. (1992), and Parker et al. (1985).

Family violence

Frequent drinking has been strongly and consistently associated with spouse abuse, although it is difficult to prove that alcohol played a causal role in the violent act, or whether it was just coincidental to the circumstances causing the abuse (USDHHS, 1990a). Alcohol-related violence rates vary depending on research designs, methods, and samples

Table 4A.5 – Studies of drinking prior to rape/sexual assaults

Researcher	Location and date	Source of data	Sample size	Total alcohol involvement* (%)	Drinking by assailant (%)	Drinking by victim (%)
Tardif (1966)	Montreal, Canada (1964)	Police reports	67 offenders 112 victims	-	31	16
Amir (1971)	Philadelphia	Police reports	1,292 offenders 646 victims	34	24	31
Wikstrom (1980)	Gavle, Sweden	Police reports	264 cases	28	-	-

* Drinking by either or both parties.

Source: Martin, 1992.

(Martin, 1992). In a review of studies, Murdoch, Pihl, & Ross (1990) concluded that there appears to be a relationship of marital violence to alcohol independent of other marital problems.

A number of studies have shown an association between alcohol and child abuse, but the evidence of a link is much weaker than is the case with spouse abuse. Although studies suffer from methodological and conceptual problems (USDHHS, 1990a), some have found that a substantial number of child abusers are long-term drinkers, and that abusive parents often drink before or during the abuse (Martin, 1992). Other studies have shown no clear association between alcoholism and physical abuse (Combs Orme & Rimmer, 1981; Pollock et al., 1990). Because little systematic or specific research has been conducted, it is difficult to draw any strong conclusions about the nature of the relationship between alcohol and child abuse (USDHHS, 1990a).

For extensive reviews on alcohol and family violence, see Leonard and Jacob (1988), and Miller (1990).

Frequent drinking has been strongly and consistently associated with spouse abuse. A number of studies have shown an association between alcohol and child abuse, but the evidence of a link is much weaker than is the case with spouse abuse.

Magnitude of alcohol-related injury, violence, and property crime

Injury and violence as public health problems

Regardless of whether they are associated with alcohol use, injury and violence are significant public health problems (Minnesota Department of Education, 1995; Minnesota Department of Health, 1993 & 1995). Injury (including motor vehicle-related injury) and violence cause the majority of deaths of children and young adults in the United States and in Minnesota (Baker et al., 1992; Minnesota Center for Health Statistics, 1992). As a consequence, injuries and violence lead to high direct expenditures and indirect costs (lost productivity) to society.

Death rates from injury and violence vary greatly with age, gender, and race (Baker et al., 1992).

Alcohol-related injury, violence, and property crime in Minnesota

Injury

As reported in chapter 2, a total of 1,456 deaths resulted from injury in Minnesota in 1991, including motor vehicle-related deaths (Minnesota Center for Health Statistics, 1992). Using research-based alcohol-attributable fractions by type of injury, Alcohol-Related Disease Impact software estimated that 457 of the total injury deaths were related to alcohol use (Shultz et al., 1989). The majority of alcohol-related injury deaths—247 (54%)—were estimated to be from motor vehicle crashes. Of the remaining alcohol-related deaths, it was estimated that 26 were from fires, 124 were due to falls, 21 were caused by drownings, and 40 were from a variety of other injuries.[6]

Although the above figures *approximate the actual number* of alcohol-related deaths in Minnesota, completely state-based data on alcohol-related injuries are available only for motor vehicle deaths and non-fatal injuries, drownings and recreational boating deaths, and fire deaths.[7] Motor vehicle crash data from the Minnesota Department of Public Safety are reported in the section, "Alcohol-impaired driving," and other existing state alcohol-related injury data are reported below. For an overview of all fatal and non-fatal injury in Minnesota, see *A perspective on injury in Minnesota: Trends in the 1980s—A focus on 1991* (Minnesota Department of Health [MDH], 1994).

Regarding non-fatal injuries in Minnesota, more comprehensive statewide data are needed in order to measure the extent of alcohol involvement. However, some general indicators of statewide non-fatal injury exist: (1) Using Behavioral Risk Factor Surveillance System survey data from a random sample of 3,400 Minnesotans for 1988, 1989, and 1990, the Minnesota Department of Health found that about 18% of Minnesotans 18 years of age or older experience a significant non-fatal injury[8] each year (MDH, 1994). (2) In 1992, the Annual Student Survey of the Minnesota Department of Education for the first time collected information about non-fatal injury among Minnesota students in 6th, 9th, and 12th grades. Of the 91% of students who responded, 51% reported having been injured at least once in the preceding 12 months (MDH, 1994).

The State Fire Marshal Division of the Minnesota Department of Public Safety reported 71 civilian deaths[9] and 336 civilian injuries in 1991 fires in Minnesota. One firefighter died and 259 were injured fighting fires in the same year (Minnesota Department of Public Safety, 1992a). Although fire victims were not routinely tested for blood alcohol levels in 1991, the practice has become policy since August 1993, when the Fire Marshal Division began conducting autopsies on all fire victims. From August 1993 through July 2, 1994, 64 individuals died in fires, of whom 21 (36%) were found at autopsy to have a positive blood alcohol content (Minnesota Department of Public Safety, 1994a). For five of the 64 deaths, blood alcohol level information was pending or unavailable.

Also, where multiple deaths occurred in one fire, the perpetrator may have been drinking but victims were not (e.g., the case of a "careless smok-

ing" fire in which the two adult victims had positive blood alcohol levels, but the two child victims did not. Although alcohol's relationship to the fire is not clearly known, it may have played a role in impairing judgment.) The alcohol-related percentage of fire deaths attributed to "careless smoking" was higher than that of all fire deaths: 64% of careless smoking deaths (9/14) showed positive blood alcohol levels in the victims. (However, it is difficult to show statistical significance with numbers this small.)

Minnesota-specific data on the number of alcohol-related falls are unavailable.

Minnesota data on drownings are available from the Minnesota Department of Natural Resources [DNR] (non-boat related drowning and recreational boating fatality reports) and the Minnesota Center for Health Statistics (death certificates). Data on alcohol involvement in recreational boating accidents[10] are believed to be considerable underestimates for several reasons: (1) There had been no law requiring alcohol testing of water accidents until 1994. However, a law which became effective August 1, 1994, requires county coroners to test for alcohol and controlled substances for operators and passengers for fatal snowmobile, all-terrain vehicle, boating, and drowning victims (Laws of Minnesota, 1994). (2) Many non-fatal accidents, perhaps up to 90%, go unreported. (3) Reports of boating accidents on private waters[11] are not required. (4) Accidents involving only slight injury or property damage less than $500 do not require reporting (TM Smalley, DNR, personal communication, June 29, 1994; US Coast Guard [USCG], 1992).

Keeping in mind these limitations, six boating fatalities and 25 boating injuries were reported to involve alcohol in 1991 in Minnesota (USCG, 1992). Data from the DNR indicate that alcohol has been involved in 50% of all boating fatalities since 1985 (DNR, 1992). Among non-fatal watercraft accidents reported in 1991, the craft operator's condition was reported as follows: 42 "had been drinking," 111 "had not been drinking," 80 "unknown," and 4 "other" (DNR, 1992).

The DNR also maintains a record of non-boat drownings in public and private waters. Of 38 non-boat drownings recorded by the DNR in 1991, 17 were recorded as involving consumption of alcohol by the victim (DNR, 1992). However, because alcohol testing for fatal water-related incidents was not required, this may be an underestimate.

A study of official state records of drownings in Minnesota from 1980 through 1985 revealed that 58% of DNR reports for people over 15 years of age listed alcohol consumption as contributing to the drowning (Hedberg, Gunderson, Vargas, Osterholm, & MacDonald, 1990). However, as the study noted, the number of people consuming alcohol who did not drown was unknown.

Violence and property crime

The number of crimes reported and the number of arrests made in Minnesota in 1991, by type of crime, are reported in Table 4A.6. "Offenses known

Data from the DNR indicate that alcohol has been involved in 50% of all boating fatalities since 1985. Among Minnesota drowning victims from 1980-1985, 58% of DNR reports for people over 15 years of age listed alcohol consumption as contributing to the drowning.

In an eight-county study of 1,390 offenders who had committed a crime against a person, the Minnesota Sentencing Guidelines Commission (1991) found that over 30% of all the offenders were under the influence of alcohol at the time of the offense, and an additional 6% were under the influence of both alcohol and illegal drugs. About 27% of the 1,390 offenders regularly abused alcohol, and another 26% regularly abused both alcohol and illegal drugs.

Table 4A.6 – Minnesota criminal offenses, 1991

Offense category	Offenses known or reported	Offenses cleared by arrest[1]
PART I		
Criminal homicide	135	81
Rape[2,3]	1,944	790
Aggravated assault*	8,051	4,532
Robbery (taking from a person)	4,434	806
Burglary (breaking and entering)	39,816	4,069
Larceny (property theft, except autos)	135,480	28,020
Auto theft	17,561	3,372
Arson	1,538	261

[1] Recording procedures for offenses adhere to state and federal guidelines. Some important points to note: "A criminal act may involve several crimes, several persons, and several victims, but all that is necessary for such an act to be reported and recorded...is one violation. If a given criminal act involves more than one offense, only the more serious offense is counted. 'Clearance by arrest' indicates that at least one person was arrested. It does not preclude the fact others may have also been involved in the offense. Any additional arrests are purely supplemental and are used for each department's record purposes only and not reported under the program" (Minnesota Department of Public Safety, 1992b, p. 3).

[2] National surveys indicate that rapes by strangers or nonstrangers are about 50% underreported in both cases (US Department of Justice, 1983, p. 25).

[3] For 1992 Minnesota data, analysis by the Minnesota Department of Public Safety indicated that some offenses were being miscoded by law enforcement agencies, resulting in corrected figures which showed an increase in rape and aggravated assaults and a decrease in other assaults and other sex offenses. The MDPS indicated that it is unclear whether this situation existed prior to 1992 (Bentfield, 1993).

Source: Minnesota Department of Public Safety (1992b).

or reported" and "Offenses cleared by arrest" are the two categories also used in the Alcohol-Related Disease Impact (ARDI) software calculations of public criminal justice system costs, although ARDI used national offense data prorated to Minnesota's population rather than the figures listed below (see chapter 3, section on Non-health sector cost components).[12]

Although the percentages of offenses in Minnesota involving alcohol are not known with certainty, and the role of alcohol is often unclear, a few sources provide relevant data:

(1) In an eight-county study of 1,390 offenders who had committed a crime against a person, the Minnesota Sentencing Guidelines Commission (1991) found that over 30% of all the offenders were under the influence of alcohol *at the time of the offense*, and an additional 6% were under the influence of both alcohol and illegal drugs. About 27% of the 1,390 offenders *regularly* abused alcohol, and another 26% regularly abused both alcohol and illegal drugs. The above figures were several percentage points higher for the subset of offenders who used a weapon during the crime. The drug of primary choice among the offenders who used chemicals was alcohol (85.6%). Of those who used alcohol, 43% did not use any other drug.[13]

The Sentencing Guidelines Commission notes in its report that data

were obtained primarily from probation officer files and court plea and sentencing transcripts, and that these documents were not available in every case.[14] Also, as is true with many studies of alcohol involvement, objective tests such as measurement of alcohol content in the offender's system immediately after the offense were not available. While recognizing its limitations, it is important to note that the Sentencing Guidelines Commission report appears to be the only currently available state study which distinguishes alcohol from other drug usage with respect to offenses that are not specifically classified as alcohol (e.g., DWI) or drug offenses.

(2) In a 1990 survey of 146 Minnesota probation and parole agents (Minnesota Planning, 1992), 66% of 7,834 offenders who had been screened or assessed for chemical use problems were found to be chemically abusive or dependent (*may be alcohol, drugs, or both*). Overall, 40% of the 12,975 offenders in the study were found to be chemically abusive or dependent. (The 12,975 offenders included those who were screened or assessed and those who were not).

About 45% of the offenders had committed an alcohol or illicit drug offense as the only offense or one of multiple offenses. Of these offenses, 79% were alcohol-related and 11% were drug-related.

(3) Minnesota law recently established the requirement that probation officers for convicted felons determine whether alcohol or drug abuse was a contributing factor to the offense being committed (Laws of Minnesota, 1991). However, aggregated statewide data are not yet available.

(4) Over 80% of nearly 4,000 Minnesota residents surveyed in 1992 felt that alcohol contributes to violent crime in their community (Minnesota Planning, 1994). This percentage was notably higher than the figures for other drugs: the second-highest perceived contributor to violent crime was cocaine, with a 51.4% positive response. (Respondents could check affirmatively to all drugs they felt were contributors.)

The degree of alcohol use by arsonists prior to arson crimes in Minnesota is unknown, since blood alcohol levels are tested only among the victims. In 1991, arson was the second leading caus . of fire, at 13% of the total (Minnesota Department of Public Safety, 1992a).

Regarding family violence, data on alcohol-related proportions of domestic assaults are not readily available, but investigations of child maltreatment do include determinations of alcohol and/or drug abuse. Domestic assault is a problem of considerable magnitude, as the following figures from the Minnesota Coalition for Battered Women and the Minnesota Department of Corrections illustrate: (1) From 1990 through 1992, a yearly average of 132,000 domestic assault cases were handled by local law enforcement officers in Minnesota. (2) In 1991, 4,800 women were sheltered. (3) In 1991, 11,000 petitions were filed for orders of protection (Minnesota Department of Health, 1993). To the degree that alcohol may play a part in domestic violence, alcohol-related social and economic costs could be substantial.

Reports on child abuse in 1991 in Minnesota show that about one fourth of cases involved alcohol abuse by the perpetrator. The Minnesota Department of Human Services (1993) reported that among 6,914 "determined cases of [child] maltreatment"[15] in Minnesota households in 1991, the following percentages of alcohol abuse

were reported (see Table 4A.7). Compared to other individual or household problems (drug abuse, disabilities), alcohol abuse was the problem most often reported for household members other than the victim.[16]

For thorough reports on violence as a public health problem and prevention efforts in Minnesota, see *Violence-Free Minnesota*, a 1994 report to the Minnesota Legislature from the Office of Drug Policy and Violence Prevention (Minnesota Department of Public Safety, [DPS] 1994b); *A Report to the Violence Prevention Taskforce* (DPS, 1995); *Violence Prevention Plan: Unlearning Violence* (Minnesota Department of Education, 1995); and *Public Health Approaches to Violence Prevention*, by the Minnesota State Community Health Services Advisory Committee (Minnesota Department of Health [MDH], 1993); and *Minnesota Public Health Goals* (MDH, 1995).

Table 4A.7 – Chemical abuse percentages for perpetrators, victims, and other household members for determined cases of child maltreatment, Minnesota, 1991

(n = 6,914)	Perpetrators	Victims	Other household members[1]	Entire household[2]
Alcohol abuse	20.5%	0.8%	6.5%	23.8%
Alcohol or drug abuse	25.6%	1.2%	8.4%	29.3%

[1] An assessment is counted for "Other household members" if the chemical abuse category applies to any person in the household other than a perpetrator or victim.

[2] An assessment is counted for "Entire household" if the chemical abuse category applies to any person in the household, including perpetrators and victims.

Source: DHS, 1993.

Cost implications

It is difficult to estimate alcohol-related costs of injury, violence, and property crime nationally and in Minnesota for a variety of reasons: (1) Many incidents are not reported to police, and injured individuals may not seek medical attention in many cases. (2) The involvement of alcohol is often not detected or measured, especially when only the perpetrator was consuming. (3) Minnesota-specific alcohol-related percentages by type of event do not exist in some categories (e.g., falls, domestic assaults). (4) There are many types of costs, and these are borne by individuals and the public, private, and non-profit sectors throughout society. (5) Many costs of injury, violence, and property crime are not measurable. Despite these difficulties, attempts have been made to quantify the cost of alcohol-related injury, violence, and property crime.

A national study of the costs of *all* non-fatal and fatal injuries and violent deaths in the United States estimated a total lifetime cost of $158 billion for persons injured or killed in 1985, including direct expenditures[17] as well as the value of lost productivity (Rice, MacKenzie, & Associates, 1989). In a 1980 national survey, injuries and violence were found to be the leading cause of direct medical costs for the non-institutionalized population aged 17-64 years (Harlan, Harlan, & Parsons, 1990). Evidence suggests that chronic alcohol consumption may increase injury-related medical costs. Blose and Holder (1991) found that from 1980 to 1987, chronic drinkers experienced significantly higher

injury-related medical costs than non-chronic drinkers—an average of $250 per year compared to $82. Manning, Keeler, Newhouse, Sloss, & Wasserman (1991) estimated the lifetime cost of property loss, strain on the criminal justice system, and social programs at $14,000 for each heavy drinker (defined as consuming two or more reported drinks per day).

A recent national survey estimated the total economic loss to victims of crime in the United States in 1991 at $19.1 billion (US Department of Justice, 1992, Appendix IV).[18] Rape, robbery, and assault cost $1.1 billion, personal larceny cost $3.5 billion, and burglary, household larceny, and motor vehicle theft together cost $14.5 billion.[19] These figures do not distinguish alcohol-related crimes from other crimes.

Estimates of alcohol-related health care costs of injury and violence in Minnesota are not readily available.

There are no estimates of alcohol-related non-health care costs of violence and property loss using *only* Minnesota data, due to the lack of a set of Minnesota-specific alcohol-related percentages of violent acts and property crimes.[20] However, the Minnesota Criminal Justice System DWI Task Force in 1990 estimated the cost of alcohol abuse to the Minnesota criminal justice system by applying national alcohol-related proportions of crimes to Minnesota 1987 arrests and government expenditures (cited in Commission on Confinement and Treatment of DWI Recidivists, 1993, pp. 100a-100h). The cost of processing alcohol-related cases (including driving-while-intoxicated charges) from arrest through adjudication, treatment, and incarceration was estimated at over $264 million for 1987, with state and local governments paying 87% of all costs through taxes. (This estimate did not include costs for city or county prosecutors, or the Attorney General's Office.) Alcohol-related costs by category were: (1) law enforcement - $120.3 million; (2) prosecution and public defenders - $4.4 million; (3) adjudication and treatment - $32.6 million; and (4) incarceration - $107 million.

Chronic drinkers experience significantly higher injury-related medical costs than non-chronic drinkers.

Data from the US Bureau of the Census showed the preliminary total of all Minnesota state and local justice expenditures for 1991, irrespective of the involvement of alcohol, to be slightly higher than $1.0 billion (Morgan, Morgan, & Quitno, 1994). Contributing costs included:

- Police protection–$485.3 million
- Corrections–$267.8 million
- Judicial and legal services[21]–$256.2 million.

Data from the US Bureau of the Census showed the preliminary total of all Minnesota state and local justice expenditures for 1991, irrespective of the involvement of alcohol, to be slightly higher than $1.0 billion. Since an estimated 30% of offenders were under the influence of alcohol when they committed a crime against a person, at least $300 million of 1991 state and local justice expenditures in Minnesota might be roughly estimated to be alcohol-related.

Since an estimated 30% of offenders were under the influence of alcohol when they committed a crime against a person (see Minnesota Sentencing Guidelines Commission reference above), at least $300 million of 1991 state and local justice expenditures in Minnesota might be roughly estimated to be alcohol-related. This estimate excludes offenses by individuals who were not proven to be drinking at the time of the offense, but who have ongoing excessive alcohol consumption problems. This figure is higher than the cost estimates from similar categories presented in the Alcohol-Related Disease Impact software calculations in chapter 3, Non-health care costs.

Some other Minnesota crime-related costs for which neither general cost data nor alcohol-specific data were readily available include: lost productivity costs for victims and perpetrators of crimes, state legal defense costs, lost quality of life due to fear of crime, and costs of time spent by the Minnesota Legislature and its supporting agencies in dealing with crime issues.

The alcohol-related proportions of arson losses and stolen property losses are not available.

Implications for public health promotion and protection

In setting public health goals for the year 2000, both the US Public Health Service (USPHS) and the Minnesota Department of Health (MDH) call for reductions in the abuse of alcohol as well as reductions in the incidence of fatal and non-fatal injuries (MDH, 1995; US Department of Health and Human Services, 1990b).

MDH seeks to strengthen and support public health activities which reduce the incidence of injury and move toward *zero tolerance* of violence (MDH, 1995). Some specific objectives include:

- Decrease the prevalence of injury hazards in the home, particularly as related to falls, scalds, and burns
- Reduce suicides from 10.6 to no more than 10 per 100,000 people
- Reduce violent death due to firearm injury from 7.5 per 100,000 population
- Reduce the homicide rate from 3.3 per 100,000 population
- Reduce physical abuse directed at women by male partners from 30 per 1,000 couples
- Reduce rape and attempted rape of women age 12 and under from 140 per 100,000 women

Numerous state and local agencies and organizations (DPS, 1995; MDE, 1995) share this commitment to reduce violence and acknowledge the relationship between alcohol and violent behavior.

Many health and human service organizations have issued policy statements addressing problems related to alcohol use and have called for public and private initiatives for prevention. For example, see the American Medical Association (AMA) policy compendium of statements on alcohol and other harmful substances adopted by 35 member organizations of the AMA National Coalition on Adolescent Health (Gans & Shook, 1994).

Although the role of alcohol as a possible cause of injuries and violence needs clarification, its strong and unambiguous association with both problems suggests that prevention initiatives are necessary. Such activi-

ties include efforts to minimize the use of alcohol in environments where injuries or violence would be more likely to occur. This is supported by findings that the relationship of alcohol to injuries is especially strong among more severe and fatal injuries, and that increased doses of alcohol accompany increased severity of injury (Smith & Kraus, 1988).

Areas for more research

Research is needed to address the "combinations of high-risk populations, victim-assailant relationships, and social settings that suggest the circumstances in which drinking leads to violence" (Martin, 1992, p. 236). As the complex mechanisms and interactions involving alcohol and violence become better understood, more effective prevention approaches may be developed and implemented.

Additional studies will hopefully clarify the relationship between alcohol and injury or violence. Ideally, these studies should compare rates of injury or violence across groups with different patterns of alcohol consumption. Specific topics for which further study would be especially helpful include: (1) non-motor vehicle injuries, especially falls; (2) non-fatal injuries and violence; (3) Minnesota-specific alcohol-related percentages of offenses, including data on domestic violence; and (4) Minnesota-specific health care and other costs of alcohol-related injury and violence.

In addition to educational efforts focused on curbing excessive individual consumption of alcohol, community prevention efforts provide an important means for changing social norms around alcohol use and strengthening policies designed to decrease alcohol-related injury and violence (Mosher & Jernigan, 1989). Changes in the social, economic, and physical environment of a community can conceivably work toward this end (Holder, 1993).

In addition to educational efforts focused on curbing excessive individual consumption of alcohol, community prevention efforts provide an important means for changing social norms around alcohol use and strengthening policies designed to decrease alcohol-related injury and violence.

Examples of research projects attempting to measure the effects of concerted community-wide programs include Minnesota recipients of grants from the US Government's Center for Substance Abuse Prevention; Communities Mobilizing for Change on Alcohol, through the University of Minnesota School of Public Health, Division of Epidemiology; and a prevention effort to reduce unintentional alcohol-related injuries and fatalities in three communities, through the Prevention Research Center, Berkeley, California (Holder, 1993).

Alcohol-related injury and violence: prevention into practice

Numerous state and community violence prevention activities which address alcohol are described in *Violence-Free Minnesota* (DPS, 1994b), *A Report of the Violence Prevention Taskforce* (DPS, 1995), and *What Works in Preventing Rural Violence: Strategies, Risk Factors and Assessment Tools* (Monsey et al., 1995).

Many efforts to decrease the incidence of injury and violence *in general* can have an effect on *alcohol-related* injury and violence *in particular* (e.g., handrails on stairs to prevent falls, control of sales of assault weapons to limit shootings). In addition, numerous

efforts specifically designed to promote healthy norms about alcohol use, stress management, and conflict resolution may reduce injuries and violence.

A study by the Search Institute demonstrated that adolescents at risk for one behavior are at risk for other behaviors (Benson, 1990). This research suggests that prevention projects that strive to lower risk factors and increase protective factors for youth have a potential for reducing youth chemical use *and* violent behavior.

For information on overall risk and protective factors for adolescents, see publications from the Search Institute (Benson, 1990; Blyth and Roehlkepartain, 1992; Search Institute, 1995). For a list of risk and protective factors associated with chemical use, see *Signs of Effectiveness In Preventing Alcohol and Other Drug Problems* (Center for Substance Abuse, USDHHS, 1993). For a list of risk and protective factors associated with violence, see *Public Health Approaches to Violence Prevention* (Minnesota Department of Health, 1993).

Alcohol-related injury and violence prevention efforts fall under primary, secondary, and tertiary prevention. Primary prevention activities aim to avoid the occurrence of alcohol-related injury or violence. Such activities include limiting the availability of alcohol at large public gatherings and events, organizing alcohol-free recreational activities for youth, and raising alcohol taxes to reduce consumption.

Secondary prevention seeks to minimize the damage after an alcohol-related injury or violent behavior has already begun. An example is the 911 emergency response line. A quick response may interrupt the event as it is occurring. Other examples are community-supported police intervention and consistently-applied consequences for alcohol-related injurious or violent behaviors.

The goal of tertiary prevention is to prevent further damage once the injury or violence has taken place. An example is chemical dependency treatment and aftercare for convicted offenders, which may help stem violent action by the offender in the future.

Activities at all three levels of prevention are needed to address the problems of alcohol-related injury, violence, and property crime. Public awareness and support, combined with capable political leadership, can improve the effectiveness of measures designed to create a safer environment for all Minnesotans.

Endnotes

[1] The degree of intentionality is often difficult to determine. See "Distinguishing between injuries and violence," in this section.

[2] Although arson-related fire deaths and non-fatal injuries are clearly intentional, the majority of fire casualties are more readily identifiable as unintentional. Therefore, fires are primarily covered here under "injury," although arson is covered under "violence," and all fire-related property damage (intentional or not) is discussed under "cost implications."

[3] There are some limitations to the use of Minnesota-specific data to amend ARDI software calculations of Minnesota costs, namely: (1) the state data categories do not always correspond directly or completely to the national ARDI data categories; and (2) ARDI cost calculations, especially for indirect morbidity costs, were made using complex models entered in ARDI software and not readily applicable in calculations not using ARDI.

[4] Anda et al. include suicide and homicide in their definition of "fatal injuries," in addition to fatal unintentional injuries.

[5] Alcohol's involvement in motor vehicle crashes nationwide is monitored through the Fatal Accident Reporting System and other National Highway Traffic Safety Administration surveillance. In Minnesota, the Department of Public Safety monitors alcohol-related motor vehicle crashes and publishes an annual report entitled *Minnesota Motor Vehicle Crash Facts*.

[6] When all individual categories of alcohol-related injury deaths are summed, the total is actually 458. This differs from the total of 457 stated in the text above, because all categories and totals were prorated from national figures and rounded. Therefore, there is a slight discrepancy in the estimated prorated total of 457 and the total of 458 derived from estimated deaths due to specific causes of injury, which were prorated by cause from national data and rounded.

[7] Trauma centers in Minnesota medical facilities collect some information on alcohol-related injuries among people treated on an in-patient basis. However, it would be difficult to use trauma registries to obtain meaningful aggregate statewide statistics on alcohol and injury since alcohol levels are drawn according to individual hospital protocol for patients who have sustained an injury. Another source of data on injuries in Minnesota is the Traumatic Brain Injury/ Spinal Cord Injury Registry, maintained by the Minnesota Department of Health since January 1993.

[8] A "significant non-fatal injury" was defined as one in which professional medical care was sought or usual activity was restricted for four or more hours in the previous year due to the injury.

[9] This number differs from the 57 fire deaths used in ARDI calculations of chapter 2. Mortality data used by ARDI were from the Minnesota Center for Health Statistics. Differing classifications of deaths account for the difference in figures across state agencies.

[10] The term "accidents" may be considered by some readers to be inaccurate when alcohol is involved, since the consumption of alcohol would usually imply that the drinker is aware of the increased risk for occurrence of a problem while boating. However, use of the term will be retained here to be consistent with Minnesota Department of Natural Resources usage, which adheres to US Coast Guard terminology. Some alternative terms might include "injuries" and "collisions."

[11] "Private waters" generally mean lakes under 10 acres and may have only one land owner around the perimeter. Boating on such waters is rare.

[12] Arson offenses were not included in the ARDI calculations of public criminal justice costs, but costs were instead included in the ARDI category "Fire destruction costs."

[13] Based on their criminal justice work, some Minnesota professionals suggest that some of these figures from the Minnesota Sentencing Guidelines Commission may be conservative.

[14] Data on the offenders were obtained through a variety of sources, including offense characteristics, offender characteristics, probation officer files, and court plea and sentencing transcripts.

[15] Child maltreatment includes sexual abuse, neglect, physical abuse, mental injury, and threatened injury. Of a total of 17,480 assessments made in 1991, there were 6,914 (39.6%) cases of maltreatment determined, involving 10,224 children.

[16] For the victim, the most frequently reported problem was developmental disabilities.

[17] These include medical and some non-medical costs to the injured person.

[18] This included only the costs reported by victims—losses from property theft or damage, cash losses, medical expenses, and amount of pay lost from work because of injuries. Costs external to victims, e.g., the costs of running the criminal justice system or increased insurance premiums, were not included. Costs of suicide, homicide, and arson were not included.

[19] Another estimate included a measure of lost quality of life and set lifetime costs of violence from 1987-1990 at $178 billion (Miller, Cohen, & Rossman, 1993). In their estimate, potential health-related costs (including unmet mental health needs) totaled $10 billion, lost productivity cost $23 billion, and reduced quality of life cost $145 billion (1989 dollars). The nonmonetary costs of lost quality of life—including pain, suffering, and fear—were estimated by jury compensation and "willingness to pay" techniques.

[20] For alcohol-related percentages of specific offenses used in Alcohol-Related Disease Impact Software estimates on non-health care costs, see Table 3.1 of chapter 3.

[21] Judicial and legal services include courts, prosecution and legal services, and public defense.

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Chapter 4 • Section B

Alcohol-Related Driving

Summary points

- In Minnesota, the percentage of motor vehicle fatalities that were alcohol-related decreased from 52% in 1984 to 35% in 1994. However, alcohol-related motor vehicle crashes remain the leading cause of death among 1-44 year olds by a substantial margin.
- Alcohol involvement increases the risk for fatal crashes and for more serious non-fatal injuries. Among Minnesotans of all ages, motor vehicle crashes remain the most common cause of fatal injury, severe non-fatal injury, and traumatic brain injury.
- Approximately 11% of motor vehicle injuries and 4% of property damage crashes were alcohol-related in 1994.
- An alcohol concentration (AC) of 0.10 is the legal threshold for impairment in Minnesota. Persons under 21 years who are convicted of drinking *any* amount of alcohol while operating a motor vehicle receive a suspension of driving privileges. If any person is driving in an unsafe manner and has been drinking, he or she may be charged with driving under the influence of alcohol irrespective of the amount of alcohol in his or her system.
- In 1990 in Minnesota, 37% of drinking drivers involved in a fatal crash had at least one prior DWI offense. Minnesota has one of the most comprehensive DWI statutes in the nation. The law applies to any kind of motor vehicle, including cars, boats, snowmobiles, farm tractors, bulldozers, mopeds, and riding lawn mowers.
- In a statewide telephone survey conducted in 1992, 11% of 18-24 year old men reported drinking and driving in the past month.
- In the 1992 Minnesota Student Survey, 30% of twelfth grade students reported that they have driven after drinking alcohol or using other drugs, and 46% reported riding with friends after they had been drinking or using drugs.
- Minnesota Planning and Minnesota Department of Public Safety estimated the cost of alcohol-related motor vehicle crashes in 1990 to total $189.6 million. The Minnesota Department of Health estimated the cost in 1991 at $180.5 million, using somewhat different methods and data.
- Promising strategies to prevent alcohol-related driving include legislative and economic policy change, as well as shifts in community norms through public information campaigns, school-based educational programs, and retail-focused programs.

Alcohol-Related Driving

Introduction

Alcohol-impaired driving is a persistent public health problem, with costly human and economic consequences. Almost half of all traffic fatalities in the United States are alcohol-related, and an estimated 40% of all persons may be involved in an alcohol-related traffic crash sometime during their lives (Centers for Disease Control, 1991; National Highway Traffic Safety Administration [NHTSA], 1991).

National and Minnesota data point to some encouraging trends in recent years. Among drivers involved in fatal crashes nationwide, intoxication[1] rates decreased for all age groups from 1982 to 1992 (NHTSA, 1993). In Minnesota, the percentage of motor vehicle fatalities that were alcohol-related[2] decreased from 52% in 1984 to 35% in 1994 (Minnesota Department of Public Safety [DPS], 1995).

Although these figures indicate improvements in recent years, losses due to alcohol-impaired driving continue to be significant. This section addresses the nature and magnitude of this ongoing problem, cost implications, and implications for the protection and promotion of the public's health. Sustained public attention is essential to shift social norms and drinking practices, and to achieve further declines in alcohol-related motor-vehicle crashes, injuries, and deaths.

Unlike many other consequences of alcohol consumption, the negative effects of alcohol-related driving are well documented in Minnesota. Several sources are cited in this section of the report. Extensive information is available from state agencies, particularly the Department of Public Safety, and from non-governmental organizations.

The nature of alcohol-related driving

Alcohol concentration and impairment

Alcohol impairment is legally defined by the alcohol concentration (AC) measured in a person's blood, breath, or urine. Sometimes only the blood alcohol concentration, or BAC, is mentioned in studies. The more inclusive term AC will be used here, except when citing studies which refer only to BAC. Measurement of AC and BAC is equivalent.

In the 1960s, the National Highway Traffic Safety Administration (NHTSA) established the federal legal threshold for alcohol intoxication or impairment—0.10 decagrams per centiliter of blood (Perrine, 1990). In recent years, some states have reduced the legal limit to an AC of 0.08. Several national organizations, such

as the National Safety Council and the National Commission Against Drunk Driving, recommend an AC of 0.08 as a new legal limit (NHTSA, 1992). An AC of 0.10 remains the legal threshold for impairment in Minnesota.

Under the influence is defined in terms of impaired ability to drive safely. It is not synonymous with an alcohol concentration of 0.10 or more. On the contrary, an alcohol concentration of 0.04 or more is relevant evidence of whether the person is under the influence of alcohol. In reality, most people are visibly impaired at alcohol concentrations well below 0.10. Accordingly, it cannot be assumed that it is legal to drive so long as one remains below the 0.10 line.

Although alcohol concentration provides a measure for legally defining impairment, actual alcohol impairment can occur before the legal threshold has been reached. In a review of 177 studies of the effect of alcohol on driving-related behaviors (SRA Technologies, 1988), findings showed that many behaviors were affected at levels considerably lower than 0.10 BAC. For example:

Tracking (steering)—a majority of studies reported impairment at or below 0.05

Divided attention (ability to attend to two or more sources of visual information at one time)—impairment began at less than 0.02

Information processing—most studies reported impairment at or below 0.08

Perception—some findings of impairment below 0.08

Other skills for which impairment was found at BAC levels below 0.08 include complex reaction time, visual functions (eye-motor control), and tasks requiring skilled motor performance and coordination. Overall, the reviews indicated that perceptual and cognitive tasks are most vulnerable to alcohol, whereas psychomotor skills are somewhat more resistant to impairment.

These findings indicate that crash risk is not only elevated among drivers with a high AC, but in drivers with a low to moderate AC as well (Moskowitz & Burns, 1990). Current laws on drinking and driving in all states recognize this by making it illegal to drive not only at the legal limit, but also if the driver's behavior is evidently impaired at any alcohol content level. If a person is driving in an unsafe manner and has been drinking, he or she may be charged with driving under the influence of alcohol irrespective of the level of alcohol content (NHTSA, 1992).

Drivers may be impaired not only by alcohol, but by interactions of alcohol and legal or illegal drugs. Although much is unknown about the exact nature of the risks and extent of the problem, known interactions do exist and pose a danger to driving (Doria, 1990). In the period of 1991 and the first quarter of 1992, screening for drug use among individuals arrested for driving while intoxicated (DWI) in Minnesota revealed that marijuana was the most prevalent drug detected after alcohol (Meyer and Jejurikar, 1992). In the same study, 1991 data showed that drugs were detected in 53% of drivers

The crash risks associated with alcohol increase markedly above 0.05 BAC and particularly above 0.08 BAC.

with alcohol concentrations between 0.00 and 0.10, and in 43% of drivers with alcohol concentrations of 0.10 and higher.

Alcohol and crash severity

Alcohol involvement increases the risk for fatal crashes and for more serious non-fatal injuries (Cherpitel, 1992). A drunk driver is estimated to experience a 3-15 times greater risk of involvement in a fatal crash than a nondrinking driver, and the risk increases for drivers under 24 or over 65 (Roizen, 1982). Alcohol not only impairs driving skills, but also leads to lower seatbelt and motorcycle helmet use, both of which are associated with greater injury severity (Roizen, 1982). Cost-of-illness research by Miller and Blincoe (1994) indicates that alcohol-involved non-fatal injuries typically are more severe, and 1.5 to 2 times more costly than other non-fatal crash injuries.

Repeat DWI offenders have nearly five times the risk of being involved in a fatal crash as intoxicated drivers without a prior DWI conviction (Fell, 1991). In 1990 in Minnesota, 37% of drinking drivers[3] involved in a fatal crash had at least one prior DWI offense (Minnesota Planning and Minnesota Department of Public Safety, 1992).

Minnesota definitions and laws

Minnesota has one of the most comprehensive DWI statutes in the nation. In Minnesota, it is a crime to drive, operate, or be in physical control of a motor vehicle while under the influence of alcohol and/or a controlled or hazardous substance; or while having an alcohol concentration of 0.10 or more. The law applies to any kind of motor vehicle, including cars, boats, snowmobiles, farm tractors, bulldozers, mopeds, and riding lawn mowers.

For drivers younger than 21, Minnesota legislation calls for a 30-day suspension of driving privileges on a first conviction of operating a motor vehicle with *any* measurable AC. The suspension period climbs to 180 days for a second or subsequent offense.

A DWI conviction in most cases is classified as a misdemeanor. However, a conviction may be classified as a gross misdemeanor if previous DWI offenses are involved; or it may be classified as a felony if the driver is responsible for a death or injury. Effective August, 1994, repeat offenders face increased penalties. Judges are required to order those convicted of DWI and related crimes to serve their sentences consecutively. For more information about DWI offenders, refer to the final report of the Commission on Confinement and Treatment of DWI Recidivists (1993).

In 1993, the Minnesota Legislature passed the Child Endangerment Provision (MN statute 169.121, subdivision 3, paragraph c, clause 4), which increases the penalties for driving drunk with a child[4] in the vehicle. The statute was designed to increase public awareness of this high-risk behavior and to apply more punitive measures to drunk drivers endangering child passengers. The provision aggravates generally-applied penalties by one level if a child was in the vehicle. For example, a first DWI normally is classified as a misdemeanor; with a child passenger, it becomes a gross misdemeanor. For a second offense, the license plate is taken; and for a third offense, the car is impounded.

The Minnesota Department of Public Safety classifies crashes as follows: (1) A *fatal crash* involves at least one fatality. There may also be injuries and property damage. (2) An *injury crash* involves at least one injury, but no fatalities. There may also be prop-

erty damage. (3) A *property damage crash* involves only property damage, but no fatalities or injuries.

For a fatal crash or fatality, determining whether the event was alcohol-related depends on both the investigating officer's perception of alcohol involvement, and the alcohol test results for any driver, pedestrian, or bicyclist involved. Minnesota law requires alcohol testing of any driver or pedestrian, 16 years of age or older, who dies within 4 hours as a result of a traffic crash.

A fatal crash is defined as alcohol-related if tests show an alcohol concentration of 0.01 or higher for anyone involved in the crash. For injury crashes, injuries, and property damage crashes, only the officer's perception is used. This may result in an underestimate of alcohol-related nonfatal cases (Minnesota Department of Public Safety [DPS], 1995).

Numerous other state laws also pertain directly or indirectly to drinking and driving. For a summary of these statutes, see Minnesota Planning (1992) and Minnesota Planning and Minnesota Department of Public Safety (1992).

Characteristics of alcohol-related crashes in Minnesota

The Minnesota Department of Public Safety [DPS] compiles motor vehicle crash data and produces an annual summary report. DPS (1995) characterizes 1994 alcohol-related motor vehicle crashes as follows:

- When compared to fatal motor vehicle crashes in general, fatal alcohol-related crashes tended to involve more collisions with fixed objects (28% vs. 17%) and overturns (20% vs. 16%).
- The majority of drivers killed in motor vehicle crashes tested negative for alcohol concentration, but almost one-third exceeded the legal limit. Of the 377 drivers killed in crashes, 303 (80%) were tested for alcohol concentrations. Of those tested, 60% had not been drinking, 8% had concentrations between .01 and .09, and 32% had concentrations of 0.10 or higher.
- The highest number of alcohol-related crashes (638), fatalities (26), and injuries (571) occurred in July.
- Most alcohol-related crashes occurred on weekends and late nights. Crashes on Friday, Saturday, and Sunday accounted for 63% of the total. Thirty-eight percent of the crashes and injuries, and 34% of the fatalities, occurred between 10:00 p.m. and 2:00 a.m.

The extent of alcohol-related driving

National and Minnesota population surveys and statistics on alcohol-related driving and its consequences provide information about the current situation and trends over time. The National Highway Traffic Safety Administration (NHTSA) Fatal Accident Reporting System (FARS) collects data on all fatal crashes, and the National Accident Sampling System (NASS) collects data on a sample of non-fatal injury crashes.

For the entire United States in 1992, NHTSA (1993) reported 17,699 alcohol-related crash fatalities, which was the lowest number in many years. Nonetheless, an alcohol-related crash fatality occurred once every 30 minutes, on average. Furthermore, in 36% of all traffic fatalities, at least one driver or pedestrian had a BAC of 0.10 or higher. NHTSA estimated that 45% of fatal crashes in 1992 involved alcohol.

Minnesota population surveys

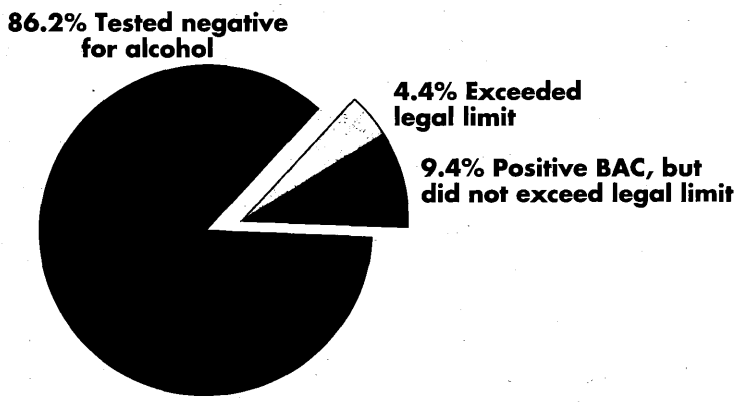
In Minnesota, population surveys as well as official records of DWI offenses and crashes provide a picture of the extent of drinking and driving and its consequences in the state. Population surveys include roadside research surveys, the Behavioral Risk Factor Surveillance Survey, and school surveys of adolescents.

Roadside research surveys are useful in that they test drivers directly for alcohol exposure, and therefore do not depend only on self-reported alcohol use prior to driving (Perrine, 1990). In 1990, DPS conducted a roadside survey of nighttime drivers to determine the incidence of drinking and driving on roadways in Minnesota. Of 2,813 drivers randomly stopped for testing in 16 Minnesota communities, 94% agreed to be voluntarily tested.[5]

The DPS reported the following findings from the roadside survey (Foss, Voas, Beirness, & Wolfe, 1990):

- Among the drivers who submitted to breath tests, 14% tested positive for alcohol (Figure 4B.1).
- 4% of drivers had AC levels over the legal limit of 0.10.
- The percentage of men found to be over the legal limit was double that of women (Figure 4B.2).
- The most likely times for drivers to be over the legal limit were very late at night (12:30 to 3:00 a.m.) and on weekend nights.
- A higher percentage of drivers over the legal limit were in non-metro sites.
- Drivers of pickups and other vehicles were more likely to be over the legal limit than drivers of cars and vans.
- 6% of drivers 21 to 34 years were over the legal limit, the highest percentage of any age category.

Figure 4B.1 – Distribution of BAC test results, Minnesota Roadside Survey, 1990[1]



[1] 2,813 drivers selected at random in 16 Minnesota communities provided a valid breath test for the survey. The data are weighted to reflect the traffic flow passing by the interview site.

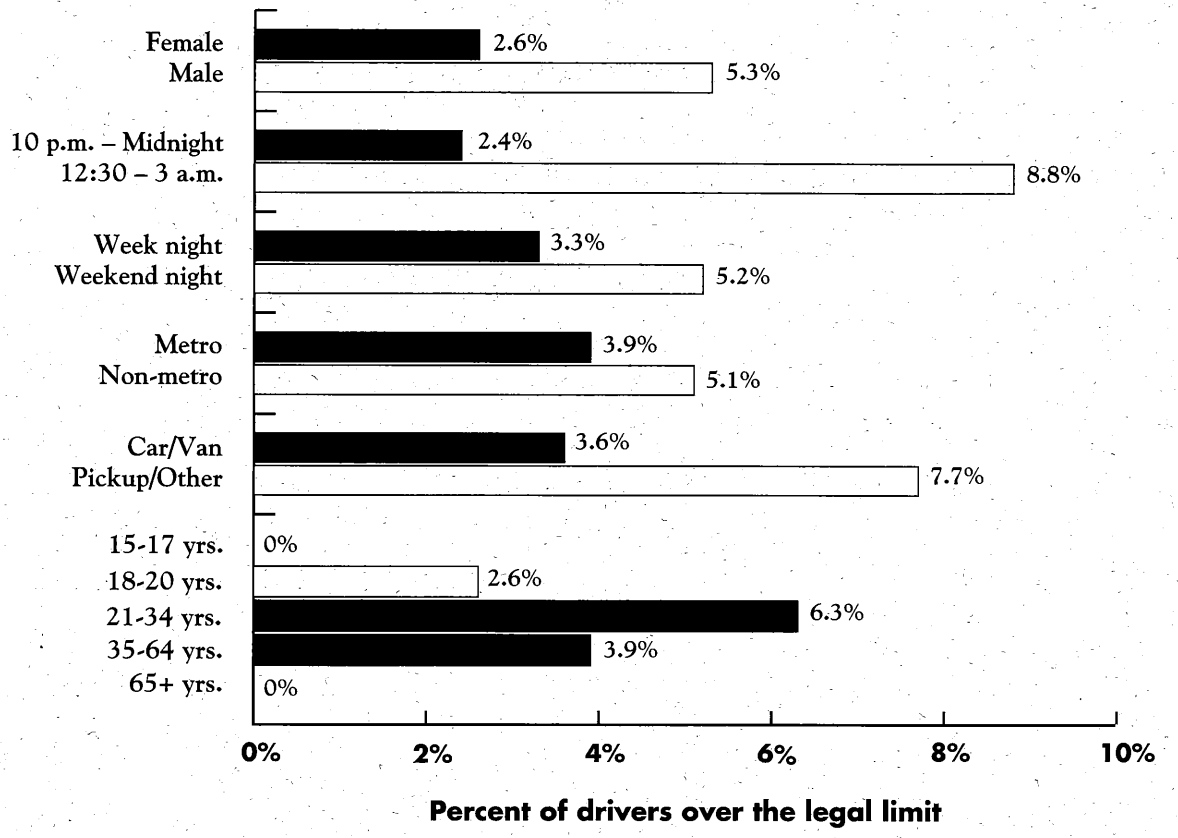
Source: Minnesota Roadside Survey of Drinking and Driving. See Foss, Voas, Beirness and Wolfe, 1990.

- Safety belt usage by drivers declined with increasing alcohol content in the driver's system (Figure 4B.3).

The drivers who participated in the roadside survey were also asked to complete a mail-in questionnaire about drinking and driving behaviors, attitudes, and perceptions (Minnesota House of Representatives Research Department, 1992). Over 1,200 drivers completed the mail-in questionnaire (44%). Key findings are highlighted below:

- 62% of respondents reported that during the past year they had driven within two hours of drinking at least some alcohol.
- 46% reported having driven when they felt under the influence of alcohol.
- 28% reported having driven when they *felt* they were intoxicated.
- Of those who believed they had driven when over the legal limit, 55% estimated that they had

Figure 4B.2 – Characteristics of drivers over the legal alcohol limit, Minnesota Roadside Survey, 1990[1]



[1] 2,813 drivers selected at random in 16 Minnesota communities provided a valid breath test for the survey. The data are weighted to reflect the traffic flow passing by the interview site.

Source: Minnesota Roadside Survey of Drinking and Driving. See Foss, Voas, Beirness and Wolfe, 1990.

In a statewide telephone survey conducted in 1992, 11% of 18-24 year old men reported drinking and driving in the past month.

driven over the legal limit 1 to 2 times; 27% estimated that they had driven over the legal limit 3 to 5 times; and 18% estimated 6 times or more.

Another population survey, the Behavioral Risk Factor Surveillance Survey (BRFSS), asks how many times *during the preceding month* respondents have driven after having perhaps too much to drink. The BRFSS random telephone survey of approximately 3,400 adults is conducted by the Minnesota Department of Health (MDH). Overall results show a decline in prior month prevalence of drinking and driving among adults in Minnesota from 5.5% in 1986 to 3.7% in 1992 (MDH, 1994). Young adult men (18-24 years) report a higher prevalence of drinking and driving than any other age/gender category. In the 1992 survey, 11% of 18-24 year old men reported drinking and driving in the past month.

In a statewide telephone survey conducted in 1992, 11% of 18-24 year old men reported drinking and driving *in the past month.*

The Minnesota Department of Education (MDE) conducts a periodic statewide survey of 6th, 9th, and 12th grade students (known as the *Minnesota Student Survey*). A survey of 131,000 students was conducted in 1992. Ninth and twelfth graders were asked about their attitudes and past behaviors related to drinking and driving.

Most 9th graders reported that they wouldn't drive after drinking any alcohol (57% of males and 66% of females), but substantially fewer 12th graders made the same claim (37% of males and 50% of females). Approximately 20% of 9th and 12th graders indicated that it's *okay* to drive after one drink. Boys were more likely to approve of driving after drinking, particularly at higher levels of drinking: 19% of 12th grade boys reported that it's okay to drive after 3-4 drinks (MDE, 1992a).

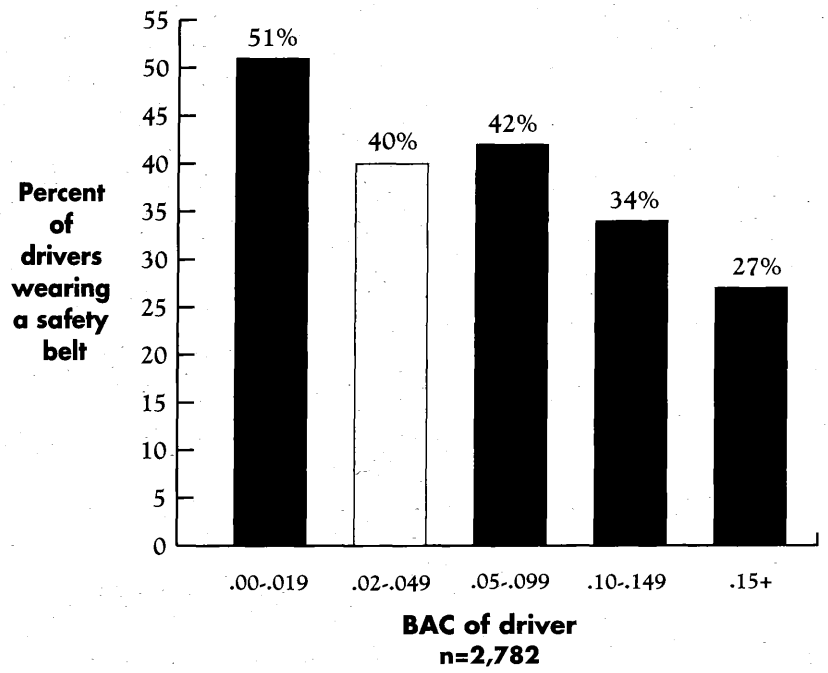
Among 12th grade students, 30% reported that they have driven after drinking alcohol or using other drugs, and 46% reported riding with friends after they had been drinking or using drugs. Of ninth grade students, 21% reported riding with friends who had been drinking or using drugs (MDE, 1992b).

Compared to the 1989 survey, fewer students reported in 1992 that they had driven with a driver who had been drinking or using drugs. Percentages dropped from 55% to 46% among 12th graders, and from 26% to 21% among 9th graders (MDE, 1992b).

Minnesota driving while intoxicated (DWI) data

Among the approximately 3.2 million licensed drivers in Minnesota, about 300,000 have DWI convictions or administrative implied consent license revocations[6] on their records. In 1994, there were 32,391 arrests for impaired driving. The majority of those arrested were male (82%). Of those arrested, 1 in 4 (25%) were younger than 24 years of age (DPS, 1994). More arrests occurred among 30-34 year olds (6,371 arrests; 20% of total) than any other 5 year age category.

Figure 4B.3 – Safety belt use by driver BAC, Minnesota Roadside Survey, 1990[1]



[1] A valid breath test and safety belt check were completed for 2,782 drivers (93%) randomly selected in 16 Minnesota communities. Data are weighted to reflect the traffic flow passing by the interview site.

Source: Minnesota Roadside Survey of Drinking and Driving. See Foss, Voas, Beirness and Wolfe, 1990.

Minnesota alcohol-related crash data

The Minnesota Department of Public Safety (DPS) collects and publishes data on alcohol-related fatalities, fatal crashes, injuries, injury crashes, and property damage crashes.[7] The following information and data are from the DPS publication, *Minnesota Motor Vehicle Crash Facts 1994* (DPS, 1995).[8]

- There has been a decrease in the percentage of alcohol-related motor vehicle fatalities since the mid-1980s (Table 4B.1). In 1984, 52% of total fatalities were alcohol-related; by 1994, the figure had fallen to 35%.
- 11% of motor vehicle injuries and 4% of property damage crashes were estimated to be alcohol-related in 1994.
- 226 people were killed and 5,262 were injured in alcohol-related crashes (Table 4B.2). 57% of alcohol-related deaths and 59% of alcohol-related injuries occurred among individuals aged 20 to 39. The highest losses occurred in the 20 to 24 year age group. 20-24 year olds accounted for 20% of all alcohol-related fatalities and 21% of alcohol-related injuries.
- 56% of alcohol-related motor vehicle fatalities were drivers or pedestrians who had been drinking (Table 4B.3).

Table 4B.1 - Drinking driver summary, Minnesota, 1985 - 1994

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Drunken Driving Arrests	35,383	36,390	34,664	32,827	34,562	37,261	33,574	31,973	32,518	32,391
%Male	85%	85%	84%	84%	84%	83%	84%	82%	82%	82%
%Female	15%	15%	16%	16%	16%	17%	16%	18%	18%	18%
Alcohol-related Driver License Revocations Processed[1]	40,807	42,586	40,899	37,530	38,619	42,470	37,679	36,511	35,309	32,742
Administrative Revocations for Refusing Test	9,219	8,468	8,336	7,907	7,943	8,354	7,452	6,742	5,743	5,246
(These are included in the total number of Revocations Processed below.)										
Drivers Killed	372	347	297	361	368	334	327	344	355	377
Tested	79%	81%	89%	87%	85%	78%	74%	85%	80%	80%
Alcohol Concentration										
(.00)	53%	51%	50%	52%	50%	50%	56%	58%	61%	60%
(.01-.09)	11%	9%	7%	10%	8%	9%	9%	5%	7%	8%
(.10 or higher)	37%	41%	43%	38%	41%	42%	35%	37%	32%	32%
Alcohol-related Fatalities	261	264	224	277	275	235	212	229	196	226
% of Total Fatalities	43%	46%	42%	45%	45%	41%	40%	39%	36%	35%

[1] Total alcohol revocations are higher than the number of DWI arrests because they include certain multiple offenders who are revoked twice, under separate statutes, and those who have their Minnesota driver's license revoked because of an arrest outside of Minnesota.

Information on Driver License Revocations Processed provided by the Driver and Vehicle Services division.

Information on Drunk Driving Arrests provided by the Bureau of Criminal Apprehension.

Information on Alcohol Concentration test results provided by the Fatal Accident Reporting System from information supplied by county coroners and the Bureau of Criminal Apprehension.

Source: Minnesota motor vehicle crash facts, 1994. See Minnesota Department of Public Safety, 1995.

Cost implications

Despite promising state and national trends, alcohol-impaired driving remains a pressing public health problem. The cost of fatal and non-fatal alcohol-related motor vehicle crashes, in both economic and human terms, is staggering. The national and state data highlighted here illustrate the economic costs.

Miller and Blincoe (1994) conducted an extensive analysis of federal databases[9] to estimate the incidence of alcohol-involved highway crashes in 1990 (crashes in which a driver or a non-occupant had been drinking). They used research in the medical care system to adjust their incidence estimate for police under-reporting, and subsequently calculated an economic cost for the projected number of alcohol-involved crashes nationwide in 1990.

Miller and Blincoe (1994) estimate that 22% of all motor vehicle crash victims nationwide in 1990 were injured in crashes involving alcohol. The comprehensive cost of these crashes amounted to approximately $148 billion, including $46 billion in monetary costs and $102 billion in lost quality of life.[10] This figure represents $1.09 in motor vehicle crash costs per drink of alcohol consumed nationwide in 1990.

Miller and Blincoe further estimate that *excluding drunk drivers and drunk non-occupants*, alcohol-involved crashes caused the deaths of 8,500 people; the permanent disabilities of 21,000 people; and serious injuries of another 605,000 people.

Table 4B.2 – Age of persons killed and injured in alcohol-related crashes, Minnesota, 1994

Age	Killed[1]	Injured[2]
0-4	3	52
5-9	2	66
10-14	4	91
15-19	29	772
20-24	45	1,130
25-29	35	761
30-34	29	687
35-29	20	511
40-44	19	369
45-49	11	222
50-54	6	143
55-59	0	80
60-64	8	50
65-69	6	55
70-74	6	28
75-79	1	13
80-84	1	10
85 & Older	1	4
Not Stated	0	218
Total[3]	226	5,262

[1] Includes alcohol test information as well as officer's perception of alcohol noted on accident report.

[2] Includes only police officer's perception of alcohol noted on accident report.

[3] 11 of the 226 alcohol-related fatalities were pedestrians who had been drinking. In 4 of these 11 cases, the motor vehicle driver had also been drinking.

Source: Minnesota motor vehicle crash facts, 1994. See Minnesota Department of Public Safety, 1995.

The Miller and Blincoe cost estimates are notably higher than those of most other studies, including the Rice et al. (1990) study, which serves as a source for many of the Minnesota cost figures presented in this report. This is due to Miller and Blincoe's inclusion of an economic cost estimate for lost quality of life, which most other researchers have not attempted to quantify.

Alcohol-Related Disease Impact (ARDI) software (Shultz, Parker, & Rice, 1989) incorporates Minnesota population data, along with national incidence and cost estimates (Rice et al., 1990) to estimate economic costs related to alcohol use in Minnesota (see chapter 3 for a full description).

The Alcohol-Related Disease Impact software (ARDI) estimates the lost economic productivity of people who die prematurely from alcohol-related causes (termed *indirect mortality costs*). Indirect mortality costs include lost productivity

costs for the year of the study *and all succeeding years*. In 1991, ARDI software estimated that 247 Minnesotans died in alcohol-related motor vehicle crashes.[11] The indirect mortality cost of these deaths totaled $124.6 million. This amounts to 32% of all alcohol-related indirect mortality costs statewide—more than any other single category of alcohol-related death. The indirect mortality costs of alcohol-related suicide ranked a distant second, at $76 million.

Table 4B.3 – Alcohol-related fatalities, level of alcohol concentration by traffic role, Minnesota, 1994

Traffic Role	Killed	Tested	Alcohol Concentration (.00)	(.01-.09)	(.10 +)
Car or Truck Driver	125	116	9	21	86
Car or Truck Passenger	55	14	1	4	9
Motorcycle Driver	12	12	2	2	8
Motorcycle Passenger	2	1	0	1	0
Snowmobile Driver	2	2	0	0	2
Pedestrian	22	13	5	1	7
Bicyclist	2	0	0	0	0
Other/Unknown	6	4	0	0	4
Total	226	162	17	29	116

Source: Minnesota motor vehicle crash facts, 1994. See Minnesota Department of Public Safety, 1995.

Minnesota alcohol-related motor vehicle crashes in 1991 accounted for approximately $55.9 million in non-health sector costs,[12] representing nearly 25% of all alcohol-related non-health sector costs. Alcohol-related motor vehicle crash costs were calculated as a proportion of legal and judicial costs, costs related to insurance administration, and vehicle damage. Alcohol-related motor vehicle crashes also accounted for an unknown proportion of direct health care and indirect morbidity costs. See chapter 3 for more information on the ARDI economic cost estimates.

Minnesota Planning and the Minnesota Department of Public Safety (1992) estimate that the economic cost of alcohol-related motor vehicle crashes in 1990 totaled $189.6 million. This figure is calculated by multiplying the number of persons killed or injured, and the number of property damage crashes by an annual cost estimate provided by the National Safety Council (NSC). The NSC cost estimates are based on wage loss, medical expenditures, insurance administration, and motor vehicle property damage.

Although there are some differences in the year of study and the methods and data used in the ARDI and the Minnesota Planning/DPS study, the cost estimates are relatively close: $180.5 million in 1991 (ARDI), compared to $189.6 million in 1990 (Minnesota Planning/DPS).

Considerable additional data are available from various Minnesota state agencies regarding the extent and cost of alcohol-related driving. For example, in 1991, 30,380 individuals were arrested in Minnesota for driving under the influence of liquor or narcotic drugs (Minnesota Department of Public Safety, 1992a). In addition to the Department of Public Safety, other data sources include Minnesota Planning, Department of Corrections, State Auditor, Department of Finance, and county governments.

Implications for public health promotion and protection

Motor vehicle crashes remain the most common cause of fatal injury, severe non-fatal injury, and traumatic brain injury in Minnesota (MDH, 1995).

The scope of premature mortality and disability stemming from motor vehicle crashes is clear. The connection between alcohol use and motor vehicle crashes is equally clear: In 1991, approximately 4 in 10 motor vehicle fatalities in Minnesota were alcohol-related (DPS, 1992). Although the proportion of alcohol-related crashes has gradually declined to 36%, alcohol-related motor vehicle crashes accounted for 226 deaths statewide in 1994 (DPS, 1995). This persistent public health problem warrants a sustained, multi-faceted strategy incorporating programs and policies at all levels of prevention.

During the 1980s, the minimum legal drinking age increased nationwide from 18 to 21 years. The subsequent declines in alcohol use and motor vehicle crash fatalities among young adults represent a remarkable primary prevention success story. Research by O'Malley and Wagenaar (1991) indicates that the higher minimum legal age was associated with less alcohol use by high school students and recent graduates. In addition, the reduced use seemed to persist into the early twenties, even after reaching the legal drinking age. Researchers generally agree that raising the drinking age resulted in a 9% to 13% decline in fatal crashes among adolescents and young adults (Hingson & Howland, 1991).

Additional policy strategies, such as an increase in the price of alcohol, show equal promise as a primary prevention strategy. Several studies have linked higher price with lower rates of alcohol use (see review by Ornstein & Levy, 1983), and with lower rates of traffic crashes and fatalities (Cook, 1981; Phelps, 1988). The American Academy of Family Physicians, the American Medical Association (AMA), and the American Public Health Association strongly support increased taxes on alcoholic beverages (AMA, 1994). Other organizations (National Association of Social Workers, American Nursing Association) support setting aside a proportion of alcohol tax revenue to support prevention, education and treatment programs. Some community groups have successfully mobilized to increase state alcohol taxes (Stivers, 1994).

In 1994, the Minnesota Health Care Commission considered the economic and public health implications of an excise tax increase. The Commission concluded:

> Price elasticity (the relationship between price increase and subsequent change in demand for a product) varies depending on the type of alcoholic beverage. The Minnesota Department of Revenue has estimated a price elasticity of -0.278 for beer, -0.571 for distilled spirits, and -0.680 for wine. In order to achieve a five percent decrease in consumption for each category of alcoholic beverage, the Minnesota Department of Revenue has estimated the excise taxes on beer would need to be increased from 8 to 38 cents per six-pack; on wine from 12 to 39 cents per liter; and on distilled spirits from $1.33 to $1.97 per liter. The five percent decrease in consumption could be maintained if the method of taxation was changed to an ad valorem tax. This would mean that beer would be taxed at 22.8% of wholesale price, wine at 13.6% of wholesale price, and distilled spirits at 27% of wholesale price. Heavy drinkers are less likely to change their behavior due to price increases

than moderate or occasional drinkers. However, if a five percent consumption reduction resulted in even a modest one percent decrease in health care and other costs, $8.5 million could be saved *each year*.

The Minnesota Commission on Confinement and Treatment of DWI Recidivists recommends an increase in the state alcohol tax to generate revenue to fund their DWI prevention strategy (1993). The Commission estimates that an increase of 5 cents per drink sold in Minnesota would generate more than $95 million annually in *additional* revenue. By comparison, in 1991, alcohol excise tax revenue totaled $55 million (Minnesota Department of Revenue).

The crash risks associated with alcohol increase markedly above 0.05 BAC, particularly above 0.08 BAC. Several national organizations recommend that states lower the legal limit for persons operating a motor vehicle to a BAC of 0.08 or lower. Organizations include the National Safety Council, the National Commission Against Drunk Driving, and the Surgeon General (NHTSA, 1992). In addition, the American Medical Association and the American Academy of Family Physicians endorse lowering the legal limit to a BAC of 0.05 percent or less (AMA, 1994).

Social settings and community norms are a focus of primary prevention. In Minnesota, anyone over 21 who knowingly serves alcohol to someone under 21 may be held civilly liable for any damages subsequently caused by the underage drinker.

Primary prevention strategies target social settings and the normative environment as well as the legislative and economic environments. Community norms can be shaped through public information campaigns, school-based educational programs, and retail-focused programs and policies such as responsible beverage server training and keg registration.

As a primary prevention strategy, several national public health and medical associations advocate reform in alcohol advertising and promotion (AMA, 1994). The American Medical Association urges colleges and universities to ban alcoholic beverage companies from sponsoring athletic events, music concerts, cultural events, and parties on campus; and to ban alcoholic beverage companies from advertising their products or their logo in school publications. The American Public Health Association calls for federal legislation requiring that broadcast alcohol advertisements be matched with an equal number of counter-advertisements. These and other primary prevention strategies are directed toward the general population with the goal of promoting sound choices around alcohol use, and reducing the scope of alcohol-related problems—including motor vehicle crashes.

Secondary prevention strategies seek to identify individuals likely to drive after drinking alcohol, and to minimize that likelihood. Examples include safe ride programs and employee assistance programs. Tertiary prevention strategies are designed to reduce the likelihood of repeat DWI offenses. Tertiary prevention strategies include: Strong, swift, and certain punishment; chemical dependency treatment programs for offenders; and breath alcohol ignition interlock devices.

Given the persistence and magnitude of this problem, a combination of prevention strategies is necessary to promote healthy norms around alcohol use, and to further reduce the incidence of drinking and driving, the alarming rates of mortality and disability, and the substantial economic costs stemming from alcohol-related motor vehicle crashes.

Endnotes

[1] Intoxication is defined here as having a blood alcohol content level of 0.10 or higher.

[2] For a definition of "alcohol-related," see Minnesota definitions and laws, later in this section.

[3] Drivers with an available driver's license record.

[4] The child must be under 16 and be at least 36 months younger than the driver.

[5] Drivers with an alcohol concentration greater than 0.05 were offered a ride home.

[6] An administrative implied consent revocation occurs when a driver either refuses an alcohol concentration test or takes a test with a result over 0.10.

[7] The Department of Public Safety uses the following definitions for alcohol-related crashes, fatalities, and injuries (Minnesota Department of Public Safety, 1995):

- Alcohol-related fatal crash/fatality: The investigating officer suspected alcohol involvement and/or there was a positive blood test for any driver, pedestrian or bicyclist involved in the crash.
- Alcohol-related injury crash/injury: The investigating officer suspected alcohol involvement for any driver, pedestrian or bicyclist involved in the crash. Since only the officer's perception is used in this definition, alcohol-related injury crashes and injuries are probably underestimated.
- Alcohol-related property damage crash: The investigating officer suspected alcohol involvement for any driver, pedestrian or bicyclist involved in the crash. Since only the officer's perception is used in this definition, alcohol-related property damage crashes are probably underestimated.

[8] Although the estimates presented in chapters 2 and 3 of this report are based on 1991 data, the most current drinking and driving data (for 1994) are used in this chapter. Data for the two years are fairly comparable (for example, see Table 4B.1), so the more recent data are presented here. For 1991 data, see *Minnesota Motor Vehicle Crash Facts 1991* (Minnesota Department of Public Safety, 1992).

[9] Miller and Blincoe's research (1994) is based on analysis using the following databases: Fatal Accident Reporting System (FARS), National Accident Sampling System (NASS), General Estimates System (GES), and Crashworthiness Data System (CDS).

[10] Miller and Blincoe (1994) operationalize monetary costs as medical and ancillary care, emergency services, lost wages and household production, workplace disruption, insurance administration, and legal proceedings. Lost quality of life is measured by estimating the value people place on avoiding fatal risks; i.e., how much they pay for small changes in probability of survival. The technique is described in Miller (1993).

[11] The Minnesota Department of Public Safety reported 212 alcohol-related motor vehicle crash fatalities in 1991 (DPS, 1992).

[12] Non-health sector cost components include the public criminal justice system, private legal defense, crime-related property destruction, fire destruction, social welfare administration, lost work days for incarcerated criminals and victims of crime, motor vehicle crashes.

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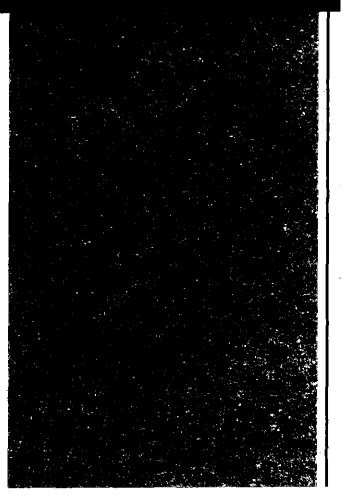
Chapter 4 • Section C

Alcohol Use During Pregnancy

Summary points

- Fetal alcohol syndrome (FAS) is the most evident expression of a range of adverse fetal outcomes that result from prenatal alcohol exposure.
- Diagnosis of FAS depends on observations of growth retardation, central nervous system damage, facial abnormalities, and a history of prenatal maternal alcohol consumption.
- When only some of the criteria for FAS are met, individuals may be described as having fetal alcohol effects (FAE). Individuals with FAE often have neurological damage resulting in such problems as hyperactivity, attention deficit, poor judgment, and delayed learning.
- FAS and FAE are irreversible conditions, causing medical and social problems throughout the lifetime of an affected individual.
- Efforts to determine the exact effects of prenatal alcohol exposure are complicated by measurement problems and complexities of fetal development. However, it is widely accepted that cases of FAS are preceded by heavy alcohol consumption throughout the mother's pregnancy. Further, binge drinking may lead to fetal damage at critical times of growth. Consumption levels sufficient to produce FAE are not known, and may vary depending on many factors.
- Due to uncertainty about the effects of even low levels of alcohol exposure on the fetus, many researchers and professional organizations have recommended *no* alcohol consumption by women who are pregnant or planning to become pregnant.
- Recent estimates of US population incidence of FAS range from 0.33 to 1.9 per 1,000 live births. The incidence of FAE has been estimated to be three times that of FAS.
- The number of cases of FAS and FAE in Minnesota is not precisely known, but statewide surveys provide some useful information about population risk. Among Minnesota women of childbearing age, 18.2% report drinking frequently, compared to a national median of 11.5%. In a recent Minnesota survey, 93% of women who normally consume alcohol reported reducing or stopping alcohol consumption upon learning they were pregnant.
- Estimates of the national cost of FAS vary widely, depending on what costs are included as well as the estimated incidence of FAS. Minnesota's FAS costs for 1991 were estimated at $44.8 million. These do not include costs of FAE or many hard-to-measure FAS costs.
- Successful efforts to address the problem require activities to prevent alcohol use during pregnancy, or minimize the risk of further damage if the mother has consumed alcohol. Multifaceted approaches are needed.

Alcohol Use During Pregnancy

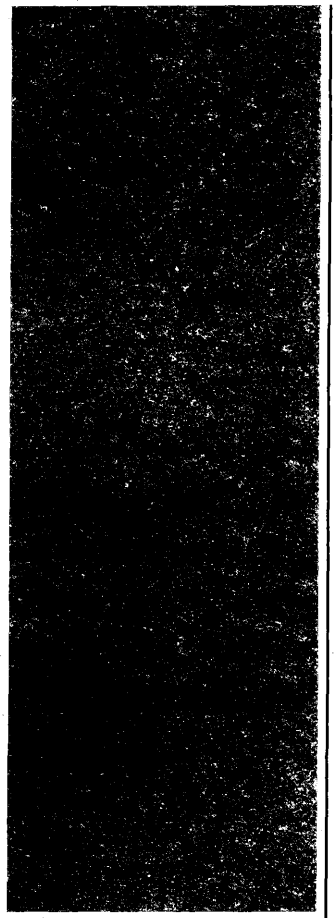


History

There is a long and varied history of concern about the effects of maternal alcohol use during pregnancy. Abel (1990) provides a thorough description, briefly summarized here. Ancient Hebrew, Greek, and Roman texts contain some passages which may refer to the prenatal effects of paternal drinking, but there do not appear to be any references to the effects of maternal drinking.

By the 1700s, commentaries were being written in England about the weakness of children whose mothers drank distilled liquors. The effects of prenatal exposure to alcohol did not receive critical attention until the mid- to late 19th century, when several studies were conducted in Europe. By the early to mid-20th century, opinion had changed, and most scientists rejected the idea of alcohol's harmful effects on the fetus. They believed instead that any effects were due to postnatal influences, or that alcohol abuse was simply associated with people from "bad stock" who passed their "defects" to their children irrespective of any possible effects of alcohol.

The characteristics that are evidence of fetal alcohol syndrome (FAS) represent "the most dramatic and specific patterns of malformations in a wide spectrum of adverse fetal outcomes that are related to maternal alcohol abuse" (Phillips, Henderson, & Schenker, 1989).



In the mid-20th century, however, French researchers studying alcohol's effects on the fetus found significant developmental and neurological problems among children of alcoholic parents. In 1968, Lemoine, Harousseau, Borteryu, & Menuet published a study of 127 children from families with alcoholism problems and described the features that later were identified as those of "fetal alcohol syndrome." This term was first applied by Jones and Smith (1973), whose work is often cited as that which attracted the current interest of the scientific community.

Definitions

The characteristics that are evidence of fetal alcohol syndrome (FAS) represent "the most dramatic and specific patterns of malformations in a wide spectrum of adverse fetal outcomes that are related to maternal alcohol abuse" (Phillips, Henderson, & Schenker, 1989, p. 220). The effects of prenatal alcohol exposure exist along a continuum, with gross morphological defects on one end, and more subtle cognitive-behavioral deficits on the other (US Department of Health and Human Services [USDHHS], 1990a). Individuals with FAS show multiple characteristics along this spectrum (see three criteria and "Characteristics and diagnosis" on the following page).

The minimal criteria for a diagnosis of FAS were established in 1980 by the Fetal Alcohol Study Group of the Research Society on Alcoholism, whose recommendations were based on a review of case reports by Clarren and Smith (1978). To be diagnosed as having FAS, a patient must show characteristics in each of the following three categories:

Diagnostic criteria for fetal alcohol syndrome

1. Prenatal and/or postnatal growth delay (weight, length, and/or head circumference below the tenth percentile when corrected for gestational age).
2. Central nervous system involvement (signs of neurologic abnormality, developmental delay, or intellectual impairment).
3. Characteristic facial dysmorphology with at least two of these three signs:
   (a) microcephaly (head circumference below the third percentile);
   (b) microophthalmia and/or short palpebral fissures [small eyes or short eye openings]; or
   (c) poorly developed philtrum [groove above the upper lip], thin upper lip, and flattening of the maxillary [midfacial] area.

   (Rosett, 1980, p. 119)

In addition, some researchers state that a fourth criterion is needed to diagnose FAS:

History of heavy alcohol consumption by the mother during pregnancy (Streissguth, Sampson, & Barr, 1989). This may include binge drinking.[1]

Modifications have since been proposed for these criteria (Sokol & Clarren, 1989; Abel, 1990). Sokol and Clarren offered minor modifications, and Abel's major change was the addition of organ/skeletal pathology. There is general recognition of the need for more definitional clarity as research advances.

In some cases, the effects of prenatal alcohol exposure may be different than those of FAS. For example, maternal drinking during pregnancy may lead to neurological damage without the accompanying anatomic features characteristic of FAS. When only some of the criteria for FAS are met, individuals have often been described as having "fetal alcohol effects" (FAE). Individuals with FAE often have such problems as hyperactivity, attention deficit, poor judgment, and delayed learning (Caruso & ten Bensel, 1993). Some researchers (e.g., Sokol & Clarren, 1989) believe that the term FAE is too ambiguous and may inaccurately suggest a less serious condition than FAS. They support using the broader term "alcohol-related birth defects" (ARBD), which some researchers now use to include both FAS and FAE. Other researchers have used ARBD to describe only those cases which are

Maternal drinking during pregnancy may lead to neurological damage without the accompanying anatomic features characteristic of FAS. When only some of the criteria for FAS are met, individuals have often been described as having "fetal alcohol effects" (FAE).

not diagnosed as having FAS. Consensus does not currently exist regarding definitions and usage of FAE and ARBD.

Characteristics and diagnosis of FAS and FAE

Although characteristics of FAS *may* be evident at birth, some physical and neurological abnormalities due to fetal alcohol exposure cannot be distinguished until much later, making early diagnosis difficult in many cases (Sokol & Clarren, 1989).

As described above, diagnosis of FAS depends on observations of altered growth, brain function, and facial appearance (Clarren & Smith, 1978). These three criteria can be expressed through numerous physical and behavioral abnormalities. Other conditions may be present as well. Abel (1990) provides a comprehensive review of studies documenting the characteristics of FAS. Many of these characteristics are summarized in the preceding text box.

In addition to the FAS indicators listed in the criteria above, other indicators of FAS and of FAE may include sleep disturbances, seizures, neurological damage, fine and gross motor problems, attention and memory problems, learning problems, difficulty with organization and problem solving, speech delay and impediments, greater than normal incidence of psychopathology (e.g., facial tics, phobias), and perceptual impairments (Streissguth, Sampson, & Barr, 1989; Abel, 1990). Intellectual impairment is one of the most common and serious problems of FAS (Clarren & Smith, 1978).

The effects of FAS and FAE persist into adolescence and adulthood. Although some of the characteristic physical traits of FAS infants and children may diminish over time, many remain. Cognitive and behavioral deficiencies continue into adulthood (Day, 1992; Spohr, Willms, & Steinhausen, 1993; Streissguth et al., 1989; Streissguth et al., 1991). Intelligence may vary widely across individuals with FAS, from severely impaired to normal. The typical child with FAS has significant mental impairment that does not subside with age. Maladaptive behaviors such as poor judgment, distractibility, and difficulty perceiving social cues are common among FAS adolescents and adults (Streissguth et al., 1991), although the causes of these behaviors may be related to a child's surroundings as well.

Alcohol and fetal damage: evidence and mechanisms

Alcohol's damaging effects on the fetus have been reported in case studies, epidemiological studies, and experimental studies. As of 1990, over 550 individual cases had been described in 155 studies, but these have lacked uniformity in criteria or focus (Abel, 1990). Numerous retrospective and some prospective[2] epidemiological studies have been conducted, showing a link between chronic heavy drinking or episodic binge drinking and fetal damage (see Abel, 1990; Coles, 1993; USDHHS, 1990a; Ernhart, 1991; Little & Wendt, 1991; and Phillips et al., 1989 for literature reviews). Most of the studies have focused on the effects of prenatal maternal alcohol consumption on fetuses, infants, and children, but some longitudinal studies are examining the persistent characteristics of FAS and other prenatal alcohol-related damage among

Intellectual impairment is one of the most common and serious problems of FAS.

The effects of FAS and FAE persist into adolescence and adulthood.

adolescents and adults (see preceding paragraph).

The use of animal models has permitted researchers to isolate the effect of alcohol on the fetus by controlling for the possible damaging effects of additional factors such as smoking, other drugs, malnutrition, poor environmental conditions, and disease (see USDHHS, 1993 for a thorough review of experimental studies; see also Phillips et al., 1989; and Randall, 1987). Animal studies also allow experimental control of the quantity, duration, and timing of alcohol exposure, permitting further insight into possible mechanisms of FAS (Phillips et al., 1989).

Recent investigations of the mechanisms of fetal alcohol damage have addressed (1) the direct toxic effect of ethanol and the effect of its primary metabolite, acetaldehyde; (2) the role of malnutrition, perhaps due to impaired placental transfer of nutrients; (3) synergistic effects of nicotine and caffeine; (4) altered protein synthesis; (5) prostaglandin inhibition; (6) hypoxia (reduced oxygen supply); and (7) paternal contributions (Phillips et al., 1989). Although findings indicate a direct damaging effect of ethanol, much remains to be understood about its exact mechanism and those of the other possible factors listed here.

Literature reporting evidence of alcohol-related damage through spontaneous abortion or at birth is reviewed by Abel (1990) and summarized here. The most extreme fetal result of maternal alcohol consumption is spontaneous abortion. Numerous clinical case studies, epidemiological studies, and nonhuman primate studies conclude that heavy drinking[3] is associated with an increased risk of spontaneous abortion. The majority of studies fail to find an association between alcohol consumption and stillbirth. However, numerous studies have found a positive association between FAS and premature birth. The exact relationship between maternal alcohol consumption and prematurity is still unknown. Finally, the incidence of breech births appears to increase with alcohol consumption.

Although a link between chronic heavy maternal alcohol consumption and fetal damage has been established, much uncertainty still exists about the mechanism of damage, as described above. This is also illustrated by the phenomenon that some alcohol-abusing women do not give birth to children with apparent effects of prenatal alcohol exposure. Based on retrospective and prospective studies, the incidence of adverse outcomes in offspring of alcohol-abusing women who continue drinking heavily during pregnancy ranges from 30-50% (Jones, 1986).

Abel & Sokol (1987) found that full FAS occurs in only approximately 6% of the offspring of alcoholic mothers. In contrast, Streissguth and LaDue (1987) observed that 30-40% of the children of chronic alcoholic mothers who drank during pregnancy had full FAS. The lower incidence of FAS relative to the number of women who drink heavily, combined with a far higher incidence of FAS in families already having a child with FAS, indicate that maternal characteristics (e.g., age, number of previous births, genetic factors) may play some role (Abel, 1990).

Factors which have been studied for their possible impact on alcohol's damaging fetal effects include variations in dose of alcohol, gestational timing of exposure, maternal factors such as health and metabolism, fetal susceptibility or resistance, race and socioeconomic class, and genetic susceptibility (Abel, 1990; Sokol & Clarren, 1989).

To date, researchers have not been able to identify a threshold amount of alcohol consumption nor a predictable dose-response relationship that can be linked to FAS (Anderson & Novick, 1992). Most studies have shown increasing abnormalities with greater doses of alcohol, and full FAS occurring only with heavy drinking throughout pregnancy. However, specific dose-response relationships for individual components of the syndrome may differ (USDHHS, 1991; Little & Wendt, 1991). Neurobehavioral effects are produced at lower prenatal exposure levels than the structural or growth effects (Riley & Vorhees, 1986). Clarren, Bowden, & Astley (1987) state: "It is probable that there is no single dose-response relationship for ethanol teratogenesis [fetal damage], but rather that each abnormal outcome in brain structure or function, morphology, and growth has its own dose-response and gestational timing parameters" (p. 345).

Some recent studies have suggested that peak blood alcohol levels, rather than the cumulative amount of alcohol consumed per se, constitute the critical dosage (USDHHS, 1990a). Binge drinking by a pregnant woman may therefore lead to fetal damage at critical times of growth, with abnormalities being unique to the period of exposure (USDHHS, 1991). Laboratory research on animals indicates that binge-like alcohol exposure may produce greater harm than the same or higher amounts of alcohol consumed more evenly over time (Bonthius & West, 1990; in USDHHS, 1993).

As noted in the previous paragraph, the timing of alcohol exposure as well as dosage affects the fetus. Some research has shown the time of conception to be the critical period for alcohol damage (e.g., Ernhart et al., 1987), while other studies identify much later periods, such as the second and third trimesters, as equally or more important (e.g., Jacobson et al., 1993). Studies of dosage and timing are complicated by the fact that the data must be based on self-reported consumption.

Most studies have shown increasing abnormalities with greater doses of alcohol, and full FAS occurring only with heavy drinking throughout pregnancy.

The effects of moderate drinking on the fetus during pregnancy are not well established. Moderate drinking levels are more difficult to ascertain than heavy or alcoholic consumption; and rigorous tests would depend on the use of objective measures of alcohol intake, alcoholism, and vulnerability factors (Russell, 1991). The effects of moderate drinking are more subtle and variable than those caused by heavier drinking. They are also more neurological and behavioral than physical, making detection difficult (USDHHS, 1990a). Some large-scale longitudinal studies are addressing the effects of moderate drinking on the fetus (e.g., the Seattle Pregnancy and Health Study — see Streissguth et al., 1989; Streissguth et al., 1991).

Binge drinking by a pregnant woman may lead to fetal damage at critical times of growth, with abnormalities being unique to the period of exposure (USDHHS, 1991).

Due to uncertainty about the effects of even low levels of alcohol exposure on the fetus, many researchers and professional organizations have recommended no alcohol consumption by women who are pregnant or planning to become pregnant. For example,

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the American Academy of Pediatrics (1993) and the American College of Obstetrics and Gynecology (1994) recently issued such a recommendation. The Minnesota Department of Health also recommends no alcohol consumption during pregnancy (Booth, 1993).

Incidence of FAS and FAE

The incidence or rate of FAS occurrence in a population is difficult to measure, especially at birth, when diagnosis can be difficult. Also, mothers' self-reported drinking behavior is subject to underreporting, especially during pregnancy, so that medical staff often do not have this additional information for diagnosis (USDHHS, 1991).

The incidence or rate of FAS occurrence in a population is difficult to measure.

Incidence is measured through the use of prospective, retrospective, and catchment studies. Prospective studies follow infants from birth forward in time. Retrospective studies identify FAS at a later stage. Catchment studies monitor for FAS at the time of birth only. The choice of study population is a crucial determinant of the incidence rate (USDHHS, 1991).

In 1987, Abel and Sokol reviewed retrospective and prospective studies and estimated a national incidence of 1.9 FAS cases per 1,000 live births in the general population (Abel & Sokol, 1987). Since that time, they have revised their estimate downward to 0.33 cases per 1,000 live births (Abel & Sokol, 1991). This newer estimate uses prospective studies only, which Abel and Sokol consider more accurate than retrospective studies. Based on the newer rate, Abel and Sokol have estimated that about 1,200 children are born with FAS each year in the United States.

Day (1992) notes that many researchers consider this new rate an underestimate. Methods which may have led to an underestimate include the use of medical records and birth defects registries as a data source for some populations, and the exclusion of data (where no prospective studies exist) for some populations which appear to have higher-than-normal incidence (USDHHS, 1993).

Data from the National Birth Defects Monitoring Program suggest that the incidence of FAS increased six fold between 1979 and 1993 (from .10 per 1,000 newborns to .67 per 1,000 newborns). However much of this increase may be due to increased diagnosis and reporting by health care professionals (CDC, 1995).

The incidence of fetal alcohol effects (FAE) has been estimated at approximately three times that of FAS (Abel, 1984), using the 1.9/1,000 live births estimate for FAS. Apparently a revision of FAE incidence has not been made since the downward revision of FAS incidence to 0.33/1,000 live births.

Some researchers have investigated FAS incidence among particular population groups. There appears to be a greater incidence of FAS where socioeconomic status is low, although the reason for the relationship is unclear (Abel & Sokol, 1991).

For Native Americans, FAS incidence varies among cultures. Navajo

and Pueblo groups report levels similar to the US population as a whole, while incidence in some other groups greatly exceeds the US population incidence (USDHHS, 1991).

Among African Americans, one study found that African American women were seven times as likely to have an infant with FAS as white women in the same socioeconomic group (Sokol et al., 1986). This finding is somewhat perplexing because researchers have found that alcohol abstinence is more common among African American women than white women, and heavy drinking is more common among white women than African American women (Chávez, Cordero, & Becerra, 1989; Darrow, Russell, Cooper, Mudar, & Frone, 1992).

It is important to interpret findings of many studies of minority populations with caution, due to problems of reporting bias based on race. For example, examiner bias may exist because members of minority populations are often evaluated according to standards derived from the white population (Abel & Sokol, 1991).

The incidence of FAS is higher among women who consume alcohol frequently than among the general population of women. In a review of studies of the incidence of FAS among children of alcohol-abusing women,[4] Abel (1990) reported that the US rate varied between 24 and 42 FAS cases per 1,000 live births. A University of Minnesota Hospital and Clinic study conducted among 46 pediatric patients whose charts listed prenatal maternal alcohol consumption identified 38 as having FAS (Caruso & ten Bensel, 1993), although the level of consumption was not known. Incidence of FAS also seems to be greater among women who already have one child with FAS than among the general population. Abel and Sokol (1987) determined that there is a 70% probability of subsequent FAS births once a woman bears a child with FAS.

Recent estimates of the population incidence of FAS range from 0.33 to 1.9 per 1,000 live births. The incidence of FAE has been estimated to be three times that of the higher FAS estimate.

It is important to interpret findings of many studies of minority populations with caution, due to problems of reporting bias based on race. For example, examiner bias may exist because members of minority populations are often evaluated according to standards derived from the white population (Abel & Sokol, 1991).

Minnesota data on incidence

In Minnesota, some statewide efforts have been undertaken to monitor the extent of FAS, but currently no reliable measurement is available due to lack of sufficient data (Minnesota Department of Human Services [DHS], 1993). Three statewide surveys may offer some insight into the level of FAS/FAE risk that exists in Minnesota:

- The 1989 Household Survey of Drug and Alcohol Use in Minnesota, conducted by the Minnesota Department of Human Services, provides a statewide estimate of drinking behaviors during pregnancy. This in-person survey included 1,639 women aged 18 or older who were asked (among other questions) how frequently

they used alcohol during their most recent pregnancy. DHS is replicating this survey at the time of publication.

- The Minnesota Department of Health gathers information on drinking patterns of the Minnesota population through the Behavioral Risk Factor Surveillance System (BRFSS), an annual telephone survey of Minnesotans over the age of 18. Although the BRFSS does not specifically address drinking during pregnancy, patterns among women of childbearing age may be examined. Approximately 1,050 women of childbearing age are surveyed each year.
- A special statewide telephone survey conducted among 1,017 Minnesota women of childbearing age during 1993 and early 1994 examines women's beliefs and practices about alcohol, tobacco, and pregnancy (Mueller, 1994). The survey was conducted by Amherst H. Wilder Foundation for the Minnesota Department of Health.

Among Minnesota women of childbearing age (18-44 years), 18% reported frequent drinking, the fourth highest level reported among 47 states and the District of Columbia (Centers for Disease Control and Prevention, 1994).

Although very little is known about the actual extent of FAS and FAE in Minnesota, the following findings of these three surveys provide useful information about alcohol consumption among women of childbearing age.

(1) The 1989 DHS Household Survey found that 41% of women aged 18 to 40 reported drinking at least one alcoholic drink during their most recent pregnancy. While acknowledging the limitations of using the survey data to extrapolate prenatal alcohol exposure and consequences, DHS estimated the number of infants affected yearly by FAS *or* FAE in Minnesota to range from 268 to 804 (DHS, 1993).

By comparison, if Abel and Sokol's (1987) estimated FAS incidence of 1.9 per 1,000 live births and the tripled incidence of FAE to FAS (Abel, 1984) were applied to the 67,037 live births in Minnesota in 1991[5] (Minnesota Center for Health Statistics, 1993), the combined FAS and FAE incidence in Minnesota would be 508 (127 FAS and 381 FAE cases).[6] Use of Abel and Sokol's (1991) conservative later estimate of FAS incidence (0.33/1,000) would lower this estimate considerably.

(2) The Behavioral Risk Factor Surveillance System (BRFSS) survey, conducted by the Minnesota Department of Health, may also be used to estimate levels of risk. The BRFSS asks questions of a sample of Minnesota residents regarding the frequency and quantity of alcohol consumption, among other topics.

Data from the BRFSS for 1991 showed that among approximately 1,050 Minnesota women of childbearing age (18-44 years), 18.2% reported frequent drinking,[7] the fourth highest level reported among 47 states and the District of Columbia[8] (Centers for Disease Control and Prevention, 1994). In 1992, Minnesota women aged 18-24 reported the highest levels of binge drinking (23.8%) and heavy drinking[9] (3.6%) of any age group of women in the state (Minnesota Center for Health Statistics, 1994).[10]

(3) In a special study, the Minnesota Department of Health surveyed a representative sample of 1,017 Minnesota women of childbearing age (18-45 years) in 1993 and 1994 to determine the beliefs and practices of Minnesota women regarding alcohol, tobacco, and pregnancy (Mueller, 1994). The survey showed that only 4% of women reported drinking 30 or more alcoholic drinks in the previous month, but that 22% engaged in binge drinking.[11] (These two categories together comprise the BRFSS definition of "frequent drinking.")

Of women surveyed who drank before their most recent pregnancy, 93% reported that they reduced or stopped drinking while pregnant, although some women may have consumed a significant amount of alcohol before they realized they were pregnant. Among the 686 women who had ever been pregnant (67%),[12] 24% reported drinking some alcohol during their most recent pregnancy. Of these women, about 9 in 10 reported drinking one drink or less per week. Nevertheless, of the 24% of women who drank during their most recent pregnancy, 5% of these reported binge drinking, and 6% reported averaging three to four drinks on the days they drank.[13]

Although the percentage of women who engage in binge or heavy drinking during pregnancy is low, maternal alcohol consumption merits serious attention because the potential fetal damage is permanent, and the condition is completely preventable.

Other Minnesota data are also available through the Department of Health (birth certificate reporting on possible FAS and maternal drinking during pregnancy) and the Department of Human Services (child abuse reports and Medical Assistance data). However, these sources are believed to reflect significant underreporting of the problem (DHS, 1993).

Cost implications

Fetal alcohol syndrome and other problems related to fetal alcohol exposure are the source of significant costs to individuals and to society. The cost of FAS alone in Minnesota in 1991 was estimated at $44.8 million (see chapter 3 for a full description). This estimate was calculated by Alcohol-Related Disease Impact (ARDI) software (Shultz, Parker, & Rice, 1989) using Minnesota population data and national incidence and cost estimates by Rice, Kelman, Miller, & Dunmeyer (1990).[14]

This estimate does not include hard-to-measure costs, such as social support and education, foster care, civil and criminal justice system costs, non-surgical and non-intensive medical care, lost productivity, family expenses such as lost work time, nor the immeasurable costs of pain and suffering by the individual and his or her family. Also, this estimate does not measure the costs of fetal alcohol effects (FAE) and other problems resulting from fetal alcohol exposure that are not expressed as FAS.

Although the percentage of women who engage in binge or heavy drinking during pregnancy is low, maternal alcohol consumption merits serious attention because the potential fetal damage is permanent, and the condition is completely preventable.

Because the Minnesota cost estimate of $44.8 million was derived from a national cost estimate, expenditures on prevention and treatment programs particular to Minnesota may not be

adequately reflected. For example, the Minnesota Legislature appropriated funding for a three-year program to prevent alcohol and drug use during pregnancy. Beginning in mid-1992 and implemented through the Minnesota Department of Health, the program has focused on public information, professional education, and research.

Because fetal alcohol syndrome and other conditions resulting from fetal alcohol exposure are completely preventable, public health efforts to curb alcohol consumption during pregnancy have the potential to lower their incidence significantly.

Cost estimates for FAS depend on the items chosen for inclusion, the cost for each type of treatment or care, and the estimated incidence of FAS in a population. The highest national FAS cost estimate cited in this report is $1.6 billion (Rice et al., 1990, cited in chapter 3, section on fetal alcohol syndrome costs). This figure includes treatment and care from birth to age 21 as well as the cost of residential care for adults over 21 years. It also assumes an incidence of 1.9 FAS cases per 1,000 live births, based on Abel and Sokol (1987). This estimate was used in ARDI software calculations of Minnesota's FAS cost in 1991.

While Abel and Sokol based their national cost estimate on an incidence of 1.9/1,000 live births, they did not include care for adults over 21. As a result, they arrived at a cost of $321 million, a substantially lower figure than the $1.6 billion cost estimate of Rice et al. When Abel and Sokol (1991) subsequently lowered their estimate of FAS incidence to 0.33/1,000 live births, their national cost estimate was reduced to $74.6 million. This implies that the Minnesota cost of FAS might be closer to $10 million (rather than $44.8 million) if the ARDI software cost estimates were recalculated based on the conservative most recent FAS incidence estimate of Abel and Sokol.[15] It is apparent from the wide range of these estimates that much uncertainty surrounds the true costs of fetal alcohol syndrome and fetal alcohol effects.

Implications for public health promotion and protection

The US Public Health Service in its Healthy People 2000 objectives set a goal to reduce FAS incidence to no more than 0.12 per 1,000 live births by the year 2,000 (USDHHS, 1990b). Achieving this goal depends on reducing the incidence and prevalence of alcohol use during pregnancy.

As shown in this section, the link between poor birth outcomes and binge drinking (periodically consuming five or more drinks) and moderate drinking (an average of one drink per day) has become more apparent in recent research. As a result, reducing the prevalence of binge, moderate *and* heavy drinking among women of childbearing age is an important focus for primary prevention of FAS.

The Minnesota Department of Health (MDH) set a statewide objective to reduce from 18.2% to 15% the proportion of Minnesota women of childbearing age (18-44) who report frequent alcohol use (MDH, 1994). Women are considered frequent drinkers if they report binge or moderate drinking in the past month.

To achieve this objective, communities must acknowledge, seek to understand, and address the underlying reasons for alcohol use among women generally—not just during pregnancy (see NIAAA, 1994). Prevention of FAS cannot be separated from social norms and policies that affect both alcohol use and health.

The following primary prevention strategies illustrate the practical application of these principles:

Primary Prevention Strategies

- City ordinances adopted in some Minnesota communities, which require that all establishments licensed to sell alcohol post signs warning about drinking during pregnancy
- A requirement that alcoholic beverages be labeled with a warning about the risks of drinking during pregnancy (in effect nationally since November 1989)
- Beverage server training to discourage alcohol consumption by pregnant women
- Mass media campaigns to promote alcohol-free pregnancy
- Increasing alcohol excise taxes to reduce alcohol consumption
- Medical professionals routinely advising all women about alcohol use prior to pregnancy.

Secondary prevention is aimed at early identification of women who are drinking alcohol during pregnancy. Examples of secondary prevention include screening of pregnant women during prenatal visits; providing information to help women reduce or stop drinking during pregnancy; and offering services such as counseling, family planning, parenting classes, support groups, assistance with finances, and transportation. Even if a woman drinks heavily early in pregnancy, by reducing or stopping alcohol use, she reduces risk to the fetus (Coles, 1994).

Tertiary prevention seeks to prevent additional health and social problems once a child is born affected by prenatal alcohol exposure. Although FAS and FAE are irreversible conditions, tertiary prevention strategies include: minimizing long-term disability by developing educational plans; promoting independence and social skills through employment planning and counseling; minimizing medical complications through appropriate medical care; and when necessary, providing chemical dependency treatment to family members. Children born with

"Despite problems and barriers, experience demonstrates that community-based prevention activities can have an impact on perinatal alcohol and drug use. Broad-based prevention approaches can create and nurture an environment in which people make informed choices about drinking and drug use, supported by a broad array of economic, social, and health policies and services that address the multiple factors that underlie alcohol and drug use."

Soman, 1993, p. 79

Better data on the incidence and support systems for individuals with FAS, FAE, and other alcohol-related birth outcomes will help the efficacy of prevention and treatment efforts.

FAS or FAE may be particularly vulnerable to further developmental delays in an unstable home environment with binge or heavy alcohol use by one or more parents.

Better data on the incidence and support systems for individuals with FAS, FAE, and other alcohol-related birth outcomes will help the efficacy of prevention and treatment efforts. Measures to improve surveillance, screening, diagnosis, prevention, and treatment are underway both nationally (Anderson & Novick, 1992; LaFlash, Aaronson, & Uttech, 1993; Moore & Givens, 1994) and in Minnesota[16] (Leonard, Boettcher, & Brust; Minnesota Institute of Public Health, 1994; Mueller, 1994; Perinatal Connection, 1994; and Rosengren, 1990).

FAS and FAE are both entirely preventable. This challenging public health problem warrants sustained, collective action. To be most effective, multiple strategies at each level of prevention are essential. Numerous community and clinic-based prevention programs and policies have demonstrated success, and can guide future prevention initiatives (Campion et al., 1994; Casiro et al., 1994; Kaskutus & Graves, 1994; Russell, 1994; Soman, 1994; Weiner et al., 1988).

Endnotes

[1] Although binge drinking (consuming five or more drinks on one occasion) is not specifically mentioned in the diagnostic criteria, Streissguth et al. (1989) included binge drinking as a measure of maternal alcohol use. It was found to be one of the most useful predictors of later offspring effects.

[2] In retrospective studies, children are identified as having FAS at some time after birth, whereas in prospective studies, children are followed over time and assessed at intervals from birth onward (USDHHS, 1991).

[3] Heavy drinking is defined differently in the various studies. See Abel (1990) for a description of the studies.

[4] Alcohol abuse is defined in these studies as "the consumption of two or more drinks per day, or five to six drinks per occasion; clinical judgement of alcohol abuse; or a positive response to a questionnaire such as the MAST [Michigan Alcoholism Screening Test]" (Abel, 1990).

[5] 1991 data are used here for comparability to other data in this report. Although the DHS data are for 1989, the number of live births in 1989 was 67,490, very similar to the number in 1991. Estimated FAS incidence would be nearly the same for 1989 and 1991, as would FAE incidence.

[6] As noted, these figures pertain only to live births. Heavy or binge drinking during pregnancy may also be related to spontaneous abortion.

[7] "Frequent drinking" is defined here as more than 30 alcoholic drinks during the preceding month (moderate to heavy drinking), or five or more drinks on at least one occasion in the preceding month (binge drinking).

[8] Nationally, the median percentage of women reporting frequent drinking was 11.5%.

[9] "Binge drinking" is defined as consuming five or more drinks on at least one occasion in the month preceding the survey. "Heavy drinking" is defined as consuming 60 or more drinks in the preceding month.

[10] See Tables 7-9 of chapter 1 for Minnesota drinking patterns by age and gender.

[11] See endnote 9 for the definition of binge drinking.

[12] Only pregnancies of five or more months' duration were included.

[13] The women who reported binge drinking during their most recent pregnancy comprised 1% of *all* women during their most recent pregnancy, including the 76% who reported no drinking. The women who reported consuming an average of 3-4 drinks on days they drank also comprised about 1% of all pregnant women. There may be overlap in these two groups of drinking patterns.

[14] Rice et al. (1990) data were based on Abel and Sokol (1987) data, and Rice et al. estimates for residential care for FAS-affected individuals over 21 years of age.

[15] This is an estimate. These calculations have not been done.

[16] At the time of publication of this report, the Minnesota Department of Health is testing feasible and effective methods to collect incidence and prevalence data on FAS and FAE, and on the prevalence of alcohol use among pregnant women in Minnesota.

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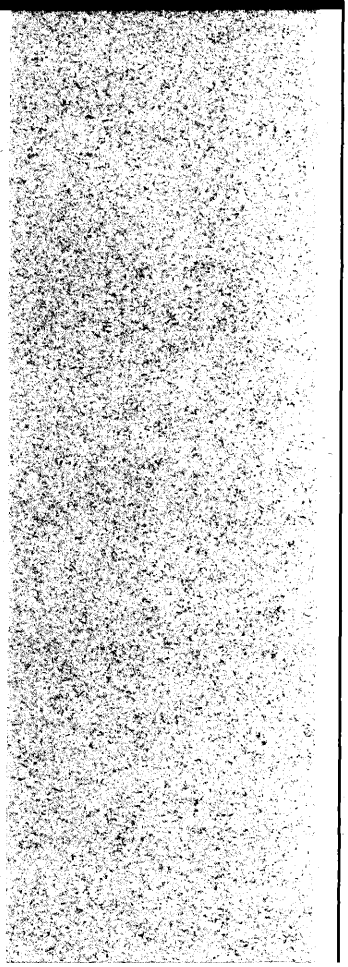
Alcohol-Related Diseases

Summary points

- Behaviors such as smoking may interact with alcohol to create health problems. Also, alcohol consumption may aggravate existing medical problems.
- Cirrhosis is among the 10 most common causes of death in North America, and cirrhosis rates are highly correlated with alcohol consumption. Cirrhosis death rates in the US have been decreasing in recent decades. They are at their lowest level since 1956 and are 32% lower than their 1973 peak level.
- Chronic alcohol consumption is associated with a variety of neurologic disorders and impairments in learning, attention, memory, abstraction, and fine motor coordination.
- Alcohol use is a major risk factor for some cardiovascular diseases, including cardiomyopathy (heart muscle disease), arrhythmias (heart rhythm disturbances), hypertension, and hemorrhagic stroke.
- Among cancers, heavy alcohol consumption has been most strongly associated with upper airway and digestive tract cancers. The relationship of alcohol to breast and large bowel cancers needs clarification.
- Alcohol can suppress immune system responses and appears to be associated with an increased incidence in infectious diseases. Greater susceptibility to infection among alcoholics may also be due to malnutrition and liver disease.
- Alcohol is associated with sexual risk-taking behavior, which may lead to sexually transmitted diseases. Whether alcohol actually causes disinhibited behavior is an ongoing area of research.
- Health care professionals can provide necessary leadership to prevention initiatives in the clinic setting, and in the community as well.

Alcohol-Related Diseases



Notes:

This section consists of abridged literature reviews and studies published in various issues of *Alcohol Health & Research World*, published by the National Institute on Alcohol Abuse and Alcoholism. Articles from *Alcohol Health & Research World* are in the public domain and can be freely reprinted. Source articles are listed at pertinent points in the text that follows.

The term "alcohol abuse" rather than "alcohol use" is employed in articles from *Alcohol Health & Research World*. Although the rest of this report generally utilizes the term "alcohol use," this section will retain the wording "alcohol abuse" to be consistent with its usage in the original articles.

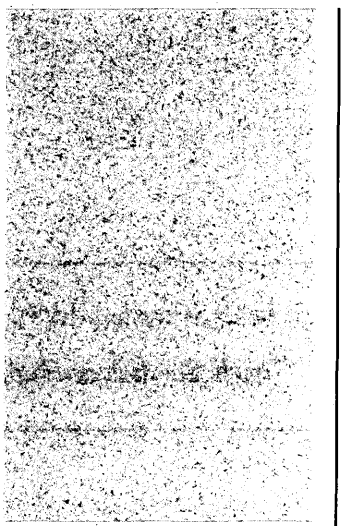
The epidemiology of alcohol-related chronic disease

Source:

Arria, AM, & Van Thiel, DH. (1992). The epidemiology of alcohol-related chronic disease. *Alcohol Health & Research World*, *16*, 209-216.

Epidemiologic studies have established that alcohol abuse[1] is associated with premature death (Eckardt et al., 1981) and may increase the risk for developing several chronic conditions. These epidemiologic studies support clinical and experimental evidence that alcohol abuse can directly or indirectly have toxic effects on a variety of organ systems.

Epidemiologic studies have established that alcohol abuse is associated with premature death and may increase the risk for developing several chronic conditions.



The most common medical condition associated with alcohol abuse is liver disease. Following a discussion of liver cirrhosis below, this section will focus on three other main categories of alcohol-related chronic conditions: alcohol-related neurologic disorders and cognitive impairments; alcohol-related cardiovascular diseases; and alcohol-related cancer of the upper airway, stomach, and liver. Although clinical and experimental studies have found an association between alcohol abuse and other medical conditions, such as gastrointestinal disturbances, pancreatitis, immunologic dysfunction, and endocrine and nutritional disturbances, population-based epidemiologic studies have not yet tested these relationships.

The relationship between alcohol abuse and health problems is complex. Often, a third variable acts on a person's health along with the alcohol. For one, alcohol abuse is associated with many behavioral and lifestyle factors that can

independently strain health. For example, smoking, which is commonly associated with heavy alcohol consumption (Schoenborn & Benson, 1988), can increase risk for the development of upper airway cancers. Alcohol abuse and smoking are interactive risk factors for the development of esophageal cancer, such that one can exacerbate the effect of the other.

Also, alcohol may aggravate an existing medical problem; however, this contribution may be difficult to quantify. For example, although liver disease can result from long-standing alcohol abuse, this condition has several other causes—whether the end-stage condition is a result of alcohol abuse or some other cause is difficult to determine. Therefore, epidemiologists may not be able to easily estimate the incidence and prevalence of these types of "alcohol-related" medical problems. Fortunately, research has begun to identify specific features of medical problems that may provide clues as to whether the condition was related to alcohol abuse and what proportion of the risk is attributable to alcohol.

Liver cirrhosis

Source:

Smart, RG, & Mann, RE. (1992). Alcohol and the epidemiology of liver cirrhosis. *Alcohol Health & Research World, 16*, 217-222.

Cirrhosis was described in detail and named by Laennec in the early 1800s, although alcohol was known to cause liver damage before then. Cirrhosis remains a major cause of death and suffering in developed countries. In North America, cirrhosis is among the 10 most common causes of death. Nevertheless, rates of cirrhosis are declining considerably in many countries. This article reviews data on rates of cirrhosis and the relationship of cirrhosis to alcohol consumption and diet, as well as trends in cirrhosis and the reasons for these trends.

Cirrhosis rates are highly correlated with alcohol consumption.

Cirrhosis has had an important historical place in alcohol research. It was one of the first physical consequences of alcohol consumption to be studied seriously. For example, a review by Jolliffe and Jellinek (1941) found 20 early studies using autopsies. Jellinek later made cirrhosis deaths the basis of his formula for estimating the population of alcoholics. Epidemiologists such as Ledermann (1964), Schmidt (1977), and Popham and Schmidt (1958) focused on liver cirrhosis as the main, and the most easily studied, alcohol-related problem in their influential studies on prevention of alcohol-related problems.

More recently, research by Smart and Mann (1987) and many others has shown that cirrhosis rates are highly correlated with alcohol consumption, and therefore with other alcohol-related problems, such as accidents and poisonings, and with rates of alcohol dependence as well. Those correlations make cirrhosis a useful indicator variable; that is, its occurrence can indicate the presence of other alcohol-related effects that may be more difficult to recognize or quantify, although it does not actually cause these effects.

Cirrhosis is not the only liver problem arising from heavy alcohol consumption. Fatty liver involves the accumulation of fat droplets, and some level of fat in the liver probably follows all drinking. The process is reversible if drinking is stopped. Alcoholic hepatitis is an acute and chronic inflammation of the liver in response to alcohol that

may occur with or without cirrhosis, and is often a precursor of cirrhosis. Alcoholic cirrhosis itself is marked by progressive inflammation and destruction of liver cells. The liver tissue regenerates, but in a disorganized fashion: instead of damaged tissue being restored to health, it is rearranged into abnormal nodules, permanently disrupting the normal architecture of the liver. Fibrous connective tissue proliferates, forming a network of scars that chokes off blood vessels and further impairs liver function.

Current cirrhosis levels

There are different ways of defining cirrhosis. This creates a serious problem when analyzing cirrhosis trends and making comparisons among countries. Currently, the yearly mortality rate from all liver cirrhosis [alcohol-related or not] is about 10.8 deaths per 100,000 persons age 25 and over in the United States (Grant, DeBakey, & Zobeck, 1991). This amounted to 26,572 deaths in the United States in 1988. Overall, death rates from liver cirrhosis are about two to three times as high for males as for females. Nonwhites have higher cirrhosis death rates than do whites.

Liver cirrhosis is the most common cause of death for which alcohol is the main factor, with the exception of traffic crashes. Although deaths are usually the focus of research, it should be noted that hospital admission rates for cirrhosis are five to six times higher than death rates for cirrhosis.

Cirrhosis, alcohol consumption, and diet

Although cirrhosis and alcoholism seem closely linked, relatively few alcoholics progress to cirrhosis. The prevalence of cirrhosis is related to the duration of heavy drinking: alcoholics with cirrhosis are about 20 years older, on average, than those without it.

Alcoholics who reduce their drinking level can reduce their risk of getting cirrhosis. In addition, individuals with cirrhosis can increase their chances of survival by curtailing their drinking (Borowsky, Strome, & Lott, 1981).

Most studies have found that steady, daily drinkers have higher rates of cirrhosis than do binge drinkers. However, daily drinkers usually consume more, on average, than binge drinkers, so the independent influence of drinking pattern has not been clearly established.

A prominent theory of cirrhosis a few years ago was that it resulted not from alcohol consumption per se but from dietary deficiencies. However, experimental studies with animals show that alcohol alone, without dietary deficiencies, is sufficient to produce cirrhosis (for example, see Popper & Lieber, 1980). There is evidence, though, that alcohol can impair the digestion, absorption, and utilization of food (for example, see Nanji & French, 1985).

Trends in cirrhosis rates and factors in recent declines

Many Western countries experienced large increases in alcohol consumption and liver cirrhosis rates between 1950 and approximately 1975. During the late 1970s, however, some countries showed signs of a decreasing trend in cirrhosis deaths, including many countries with the largest increases during earlier periods.

Cirrhosis death rates in the United States are at their lowest level since 1956, and are 32% lower than their

peak in 1973. A variety of explanations have been offered for the marked decrease in cirrhosis rates, such as declines in alcohol consumption, changes in the classification of diseases (or other artifacts of recordkeeping), improvements in diet, increased incidence of spontaneous recovery or medical intervention with alcoholics, and improved treatment for alcoholism.

Cirrhosis death rates in the United States are at their lowest level since 1956, and are 32% lower than their peak in 1973.

Neurologic disorders and cognitive impairments

Source:

Arria, AM, & Van Thiel, DH. (1992). The epidemiology of alcohol-related chronic disease. *Alcohol Health & Research World*, 16, 209-216.

Chronic alcohol abuse is associated with a spectrum of cerebral impairments (Parsons, Butters, & Nathan, 1987). These impairments range from specific disorders, such as alcoholic dementia and Korsakoff's syndrome, to more general cognitive impairments, including deficits in learning, attention, memory, abstraction, and fine motor coordination (Ryan & Butters, 1986).

Chronic alcohol abuse is associated with a spectrum of cerebral impairments. These impairments range from specific disorders to more general cognitive impairments.

Specific neurologic disorders

Alcoholic dementia

Alcoholic dementias, or general cerebral impairments associated with long-term alcohol intake, account for approximately 10% of adult dementias (Oscar Berman, 1990). This estimate is probably conservative given the possibility that dementias may be undetected in a person's lifetime. Because of the difficulty in diagnosis, virtually no studies have followed the progression of alcohol-related dementias over time.

Korsakoff's syndrome

This condition of brain damage is a late-stage development of thiamine, or vitamin B, deficiency. The relationship between alcohol abuse and Korsakoff's syndrome is indirect, as severe alcohol abuse can result in thiamine deficiency via decreased intake and impaired absorption of the vitamin. Korsakoff's syndrome is characterized by an inability to recall recently learned events (anterograde amnesia) and, in some cases, widespread cognitive damage. Autopsy studies have shown that the syndrome occurs in 1.7% to 2.8% of alcoholics (Victor, Adams, & Collins, 1989).

General cognitive dysfunction

Brain damage associated with chronic alcohol consumption results in various neuropsychologic deficits including attention deficits, visual and verbal memory losses, problems with abstract thought, and decreased motor coordination (Ryan & Butters, 1986). In addition, chronic alcohol abuse can impair "higher" cognitive abilities, such as the ability to plan, organize, and regulate behavior. These brain functions can be measured using standardized neuropsychologic tests. Several reviews of the literature document the wide variety of cognitive impairments observed in alcoholics (Parsons

et al., 1987; Tarter & Edwards, 1986; Lishman, 1990).

Alcohol consumption can be associated with these cognitive impairments in many ways, for example, by directly "killing" brain cells, a process known as neurotoxicity. In addition, alcohol consumption may indirectly cause significant brain damage by affecting liver functioning, by causing vitamin deficiencies, or by interacting with other drugs (Tarter, Van Thiel, Arria, Carra, & Moss, 1988).

Cardiovascular system

Cardiovascular diseases account for 30% to 50% of the mortality in the United States. These diseases include heart muscle disease (cardiomyopathy), coronary artery disease, high blood pressure (hypertension), arrhythmias (disturbances in heart rhythm), stroke, rheumatic heart disease, congenital heart diseases, degenerative valve conditions, and others. Several major risk factors, including alcohol, have been identified for each of these disorders.

Although ways to decrease the risk of developing cardiovascular disease have been identified, it remains the leading cause of death in the United States. Coronary artery disease accounts for approximately 88% of all cardiovascular mortality.

Epidemiologic studies have suggested that alcohol use is a risk factor for some forms of cardiovascular disease, namely, cardiomyopathy, hypertension, and hemorrhagic stroke.[2] The nature of the relationship between these diseases and alcohol appears to be dose-dependent—the more alcohol consumed, the higher the risk. For coronary artery disease and ischemic stroke, population studies have shown a protective effect of light to moderate drinking. However, it is essential that any results of these population studies be interpreted in light of the effects of alcohol on the heart and vascular system as a whole; any potential protective effects of alcohol must be measured against the overall effects of alcohol on individuals and communities.

In one study of middle-aged women, moderate alcohol use *lowered* the risk of death from coronary artery disease and thrombotic stroke, but *increased* the risk of hemorrhagic stroke (Stampfer et al., 1988). The same level of alcohol use associated with decreased risk for some forms of cardiovascular disease is also associated with increased risk for motor vehicle crashes, traumatic injury, and birth defects (USDHHS, 1992; see also chapter 1).

Epidemiologic studies have suggested that heavy drinking is a risk factor for some forms of cardiovascular disease, namely, cardiomyopathy, hypertension, and hemorrhagic stroke.

The following discussion will focus on epidemiologic studies examining the relationship between alcohol consumption and hypertension, arrhythmias, cardiomyopathy, stroke, and coronary artery disease.

Hypertension

Hypertension increases the risk of stroke and heart attack; therefore, alcohol-associated hypertension may be an important mediator in the development of these cardiovascular diseases.

An exhaustive review (MacMahon, 1987) of the epidemiologic studies on the relationship between alcohol consumption and risk of hypertension concluded that studies conducted on general population samples demonstrated an increase in blood pressure with increases in

alcohol consumption, independent of age, body weight, and cigarette smoking.

Almost all studies show an increased risk for hypertension in heavy drinkers and little to no effect in light drinkers. Whether there is a potential benefit of having one drink a day versus abstention (i.e., a J-shaped effect) is uncertain.

Even though epidemiologic studies have demonstrated a relationship between alcohol consumption and hypertension, more clinical and experimental studies are needed to define the mechanism responsible for alcohol's effects.

Alcoholic cardiomyopathy

Cardiomyopathy refers to a group of disorders characterized by disease of the heart muscle, or myocardium. These disorders can be a result of such factors as infections, autoimmune diseases, and toxic substances, including alcohol. However, many cases of cardiomyopathy are of unknown origin (Moushmoush & Abi-Mansour, 1991).

The cardinal feature of cardiomyopathies is a dilated, weakened heart muscle. In the end stages of the disease, the heart's left ventricle may fail, leading to lung congestion, rhythm disturbances that may result in sudden death, and blood clots in arteries in the extremities that may result in right-sided heart failure (Regan, 1990). Because alcoholic cardiomyopathy is so similar to other forms of cardiomyopathy, its diagnosis depends on documenting a clinical history of alcohol abuse. It is therefore difficult to ascertain the proportion of alcohol-associated cases. Depending on the samples studied, researchers estimate that 21% to 32% of cardiomyopathy cases can be attributed to alcohol abuse (Regan, 1990).

Studies have shown that abstinence from alcohol does improve the clinical course of cardiomyopathy in a majority of patients if the abstinence occurs early in the course of the disease. However, the proportion of patients who will benefit from abstinence decreases if the condition has advanced to congestive heart failure or heart muscle degeneration (Rubin & Doria, 1990).

Alcohol-related arrhythmias

Arrhythmias, or disturbances of the normal heart rhythm, are commonly observed in association with acute alcohol intoxication and a history of prolonged alcohol consumption. Atrial fibrillation (irregular twitching of the atrial muscle) is the most common arrhythmia associated with alcohol use (Regan, 1990), although ventricular arrhythmia has also been observed. Cohen and colleagues (1988) showed that an average of six or more drinks per day was associated with two times the normal risk for atrial fibrillation, atrial flutter, rapid heart beat (tachycardia), or premature atrial complexes compared with control subjects who averaged less than one drink per day (Cohen, Klatsky, & Armstrong, 1988).

Cerebrovascular disease or stroke

Stroke is a major cause of mortality as well as a significant contributor to long-term disability in the United States. Established risk factors for stroke include increasing age, hypertension, diabetes, and smoking

combined with oral contraceptive use. Males typically have higher rates of stroke than females, and blacks have higher rates of stroke than whites (Camargo, 1989; Calandre et al., 1986).

Gorelick (1989) showed that heavy drinking (defined as greater than 60 grams of alcohol, or approximately four drinks, per day) is related to increased risk for stroke. A review of several epidemiologic studies concluded that moderate drinking also increases risk for stroke (Camargo, 1989). Interestingly, the results of some studies suggest that the relationship between alcohol consumption and stroke depends upon the type of stroke involved. Alcohol consumption is associated with a fourfold increase in the risk of hemorrhagic stroke, but the relationship between alcohol consumption and ischemic stroke may be J-shaped (Gorelick, 1989; Klatsky, Armstrong, & Friedman, 1989). The difference may be explained by alcohol's effect on the blood itself. Moderate alcohol consumption reduces the viscosity of blood by increasing the anticlotting activity of platelets (Veenstra, Van de Pol, & Schaafsma, 1990). This may result in a higher likelihood of hemorrhages and hemorrhagic stroke, due to a thinning of the blood, but a lower likelihood of the formation of clots, which are usually associated with ischemic stroke.

Coronary artery disease

When the heart does not receive the amount of oxygen needed to maintain its normal function, coronary artery disease (CAD) results. Blockages in the arteries carrying blood to the heart (atherosclerotic occlusive lesions) can limit blood flow, and therefore oxygen, to the heart. Exercise, emotional stress, and hypertension increase the heart's demand for oxygen and may lead to ischemic injury or heart attack.

Early clinical studies (Dyer, Stamler, & Paul, 1977) suggested that alcoholics were at increased risk for CAD. However, the majority of these studies did not take into account the contribution of risk factors that we now know to be associated with CAD. Population-based research has determined the risk for CAD in light, moderate, and heavy drinkers. These data suggest that a J-shaped relationship exists between alcohol consumption and the risk for CAD; that is, nondrinkers have a slightly higher rate of coronary heart disease than light or moderate drinkers, and heavy drinkers have an elevated risk (Rosenberg et al., 1981; Klatsky, Armstrong, & Friedman, 1990; Stampfer, Colditz, Willet, Speizer, & Hennekens, 1988).

The interpretation of the results from these population studies is controversial. The interpretation must be viewed in light of the data-gathering methods; usually the subject is asked to average his or her consumption level over a specified period of time (e.g., the last 2 weeks or the last year). Also, the risk for CAD is always relative to nondrinkers in the sample. Most studies have taken into account that nondrinkers are sometimes ex-drinkers who reduced or quit drinking because of health or other reasons; however, some studies do not specify the characteristics of the nondrinking population (Shaper, 1990). Another explanation of the relationship may be that the increased risk among nondrinkers is due to another risk factor that is either related to abstaining from alcohol, such as diabetes, or unrelated to abstaining, such as lower physical activity.

Collectively, the data accrued to date suggest a potential benefit of moderate drinking in reducing risk for CAD. Determining the mechanisms underlying the apparent "protective" effect of moderate drinking has been an area of much interest to investigators. Since increased cholesterol is a major risk factor for CAD, some researchers have turned to the effects of alcohol on blood cholesterol levels in an effort to pinpoint this mechanism.

Another way in which moderate alcohol consumption may decrease risk for CAD is by modifying the clotting activity of blood (Zakhari, 1991). Further research is needed to determine the relevance of this mechanism.

Alcohol and cancer

Upper airway, stomach, and liver cancer

Although alcohol has never been shown to cause cancer in experimental animals, researchers have clearly demonstrated its role in the cause of some human cancers. In 1988, the International Agency for Research on Cancer concluded that "there is sufficient evidence to suggest that alcoholic beverages are carcinogenic to humans" (International Agency for Rese rch on Cancer, 1988). The following discussion will review epidemiologic studies conducted to define the relative contribution of alcohol abuse among other known carcinogens and risk factors for the development of cancer. This review will cover only those cancers for which data indicate alcohol abuse may be a contributory factor. More studies are needed on the relationship between alcohol abuse and other forms of cancer.

The strongest association between alcohol abuse and cancer has been observed in the upper airway and digestive tract.

Alcohol abuse is an important cofactor in the development of primary liver cancer.

The strongest association between alcohol abuse and cancer has been observed in the upper airway and digestive tract. Alcohol abuse, tobacco smoking, and possibly personal hygiene are interrelated for cancers of the mouth, pharynx, larynx, and esophagus. The available data suggest that alcohol exerts an independent effect for risk of these cancers above and beyond the effects of smoking (Hsairi et al., 1989; Talamini, Franceschi, Barra, & La Vecchia, 1990).

The risk for cancers of the mouth has been found to be directly related to the number of drinks consumed per day, even after adjustment for smoking (Tuyns, 1990; Martinez, 1970; International Agency for Research on Cancer, 1988). For cancers of the hypopharynx, the effect of alcohol consumption is exacerbated by smoking — that is, if people smoke *or* abuse alcohol they have a certain risk for hypopharyngeal cancer, and if they smoke *and* abuse alcohol they have an even higher risk (Tuyns et al., 1988). Cancer of the larynx is more frequently observed in males than in females. That there is great variation in the rates of laryngeal cancer worldwide suggests that environmental factors, such as diet, play an important role in the development of this disease.

The role of alcohol consumption in cancers of the gastrointestinal tract remains controversial. The emerging evidence suggests little to no elevated risk for these forms of cancer in people who abuse alcohol. The studies examining the causative role of alcohol consumption in stomach, pancreatic, and colon cancers have found little to no elevated risk in alcohol consumers as compared with control subjects

(Ferraroni, 1989; Farrow & Davis, 1990; Bouchardy, Clavel, La Vecchia, Raymond, & Boyle, 1990; Nomura, Grover, Stemmermann, & Severson, 1990; Olsen, Mandel, Gibson, Wattenberg, & Schuman, 1989). There is some evidence to support a link between alcohol consumption and rectal carcinoma (Stemmermann, Nomura, Chyou, & Yoshizawa, 1990), and it is postulated that alcohol may displace protective dietary factors, such as fiber, for this type of cancer.

Alcohol abuse is an important cofactor in the development of primary liver cancer (hepatocellular carcinoma), but the mechanism for alcohol's action is not usually direct and can vary. Liver cancer frequently results from cirrhosis of the liver, which is caused by either alcohol or a viral hepatitis infection. However, cirrhosis is not a necessary condition for the development of liver cancer. Hepatitis B virus can also lead to primary liver cancer (Brechot et al., 1982; Hadengue, N'Dri, & Benhamou, 1990), and the virus responsible for hepatitis C may also play a role in the development of this cancer. Preliminary studies have implicated alcohol in increasing the risk of contracting the hepatitis B and hepatitis C viruses. One study found that alcohol consumption and cigarette smoking elevated the risk for liver cancer even in the absence of hepatitis B (Ohnishi, Terabayashi, Unuma, Takahashi, & Okuda, 1987). Although the exact relationship between hepatitis B virus, hepatitis C virus, and alcohol consumption is still unclear, all seem to play an important and interrelated role in the development of hepatocellular carcinoma.

Breast and large bowel cancer

Source:

Longnecker, MP. (1992). Alcohol consumption in relation to risk of cancers of the breast and large bowel. *Alcohol Health & Research World, 16,* 223-229.

Alcohol consumption may increase the risk of cancers of the breast and large bowel (colon and rectum). Epidemiologic data strongly support a subtle dose-response[3] association of alcoholic beverage consumption with increased risk of cancer of the breast and large bowel. Despite the large number of studies, whether alcohol consumption causes cancer at these sites cannot be determined from the available data. The difficulty in establishing causality lies in the weakness of the associations and, in the case of breast cancer, the variability of results.

Immunity and infectious diseases

Source:

Roselle, GA. (1992). Alcohol and the immune system. *Alcohol Health & Research World, 16,* 16-22.

Laboratory evidence indicates that alcohol can directly suppress various immune responses, and clinical studies have found alcohol abuse to be associated with an increased incidence in the number of infectious diseases. Still, the linkage between alcohol consumption, altered host immune responses, and infection remains controversial and incompletely understood.

Clinical evidence supports a correlation between excessive alcohol consumption and certain bacterial infections. But it is important to realize that other factors, unrelated or indirectly related to immune function,

contribute to alcohol-associated predisposition to infection. For example, many alcoholics suffer from malnutrition and liver disease, conditions that may themselves compromise the immune system's capacity to resist infection (Mendenhall, 1992; Rosman, 1992).

Immunity, malnutrition, and alcohol

Source:

Mendenhall, CL. (1992). Immunity, malnutrition, and alcohol. *Alcohol Health & Research World, 16,* 23-28.

An important topic that should be added to a discussion of alcohol consumption, infections, and immunity is malnutrition, and, in particular, protein energy malnutrition, or PEM. Protein energy malnutrition is a deficit in needed proteins that results from an inadequate diet.

Alcoholics often show some evidence of malnutrition, which is a reliable prognostic indicator of survival (Mendenhall, Anderson, Weesner, & Goldberg, 1984; Mendenhall et al., 1986). In studies of alcoholics, the frequency and severity of malnutrition are found to increase with the subjects' development of alcoholic liver disease. When liver disease is present along with alcoholism, the incidence of nutritional abnormalities rises to 100%. Abnormalities associated with PEM increase in frequency and severity as the severity of the liver disease increases. These changes in nutritional status are significant predictors of mortality for patients with alcoholic hepatitis.

Laboratory evidence indicates that alcohol can directly suppress various immune responses, and clinical studies have found alcohol abuse to be associated with an increased incidence in the number of infectious diseases.

Alcohol and increased behavioral risk for sexually-transmitted diseases

Source:

Cooper, ML. (1992). Alcohol and increased behavioral risk for AIDS. *Alcohol Health & Research World, 16,* 64-72.

Recently, systematic attention has turned to the relationship between alcohol use and sexual risk-taking. This small but growing body of literature provides support for an association between drinking and risky sex, but leaves key questions regarding the underlying causal relationship between alcohol use and risky sexual behavior largely unanswered. In particular, it remains unclear whether drinking in sexual situations causes sexual risk-taking behavior, or whether both alcohol use and risky sex are linked by some third, underlying cause such as an enduring personality trait or lifestyle variable (e.g., risk-taking propensity or unconventionality).

Two mechanisms are known to be at work in the consumption of alcohol: the drug mechanism (or pharmacological effects) and the expectancy mechanism (or psychological effects). Results of laboratory studies present a complex picture of alcohol's effects on sexual behavior. As Crowe and George (1989) concluded in their review of the literature, alcohol appears to enhance psychological sexual arousal, but to suppress physiological arousal (especially at higher doses). Moreover, disinhibition appears to be associated primarily with alcohol expectancy effects, whereas suppression appears to be strictly pharmacological.

The results of these studies clearly call into question the conventional wisdom that alcohol disinhibits sexual

behavior as a direct result of its drug action. Instead, the studies suggest that personal beliefs about the effects of alcohol on social and sexual behavior play an important role.

Findings from survey studies of alcohol effects on sexual behavior suggest that individuals hold preexisting beliefs about alcohol's power to disinhibit or enhance sexual behavior. Although individuals do not readily acknowledge that alcohol has a strong liberalizing effect on their own sexual behavior, survey research consistently reveals an association between alcohol use and several indices of liberalized sexual behavior (see Ensminger, 1987, for a review).

In sum, the bulk of the evidence supports a link between patterns of alcohol use, drinking in sexual situations, and increased sexual risk-taking behavior. However, the measures used by these studies make it difficult to conclude that alcohol use causes sexual risk behaviors. The acute effects of alcohol on sexual risk-taking may depend to a significant degree on the presence or absence of other factors that determine whether the behavior would have been inhibited in a sober state.

Source:

Stinson, FS, DeBakey, SF, Grant, BF, & Dawson, DA. (1992). Association of alcohol problems with risk for AIDS in the 1988 National Health Interview Survey. *Alcohol Health & Research World, 16,* 245-252.

Using data from the 1988 National Health Interview Survey (NHIS), which included supplementary sets of questions on alcohol consumption and on knowledge and attitudes concerning acquired immunodeficiency syndrome (AIDS), Stinson and colleagues found that alcohol problems are associated with a higher risk for AIDS.

The bulk of the evidence supports a link between patterns of alcohol use, drinking in sexual situations, and increased sexual risk-taking behavior.

One item in the NHIS AIDS supplement directly addressed behavioral risk, and several proxy variables (e.g., plans for a voluntary AIDS blood test) appeared to be alternate ways to assess risk for AIDS.

In almost all comparisons, alcohol risk (dependence/abuse, heavier drinking, or nine or more drinks per occasion) is associated with significantly greater risk for HIV infection.

In almost all comparisons, alcohol risk (dependence/abuse, heavier drinking, or nine or more drinks per occasion) is associated with significantly greater AIDS risk. From these data, the cause of the association is unknown. It may be that intoxication leads to a disinhibition that allows people to engage in sexual behavior more risky than a sober person would engage in. It may also be that some other personality factor leads to risky behavior in general, including both alcohol and AIDS risks.

Cost implications

For a discussion of cost implications of alcohol-related disease, please refer to the sections of chapter 3 which discuss direct health care costs, indirect mortality, and indirect morbidity. Cost implications are discussed both in the main body of the chapter as well as the appendix.

Implications for public health promotion and protection

Both the US Public Health Service (USPHS) and the Minnesota Department of Health (MDH) have addressed alcohol-related diseases in their public health goals for the year 2000 (US Department of Health and Human Services, 1990; MDH, 1995). The USPHS has called for a reduction in cirrhosis deaths to no more than 6 per 100,000 people (1987 age-adjusted baseline: 9.1 per 100,000), as well as for reductions in risk behaviors and increases in services and protection.

In Minnesota, MDH has identified alcohol use as a contributor to premature death and has called for primary prevention programs to reduce the use and abuse of alcohol and other drugs. Minnesota specific objectives have been established to reduce the incidence and prevalence of chronic diseases related to alcohol use, such as cancer and mental disorders (MDH, 1995).

Individual risk for alcohol-related problems increases markedly at higher levels of use (Williams, Dufour, DeBakey et al., 1993). Yet alcohol-related problems are not limited to the relatively small group of heavy drinkers in any community. To the contrary, the majority of those who experience alcohol-related problems are light or moderate drinkers who are not addicted to alcohol (USDHHS, 1993; Kreitman, 1986; Moore & Gerstein, 1981; see chapter 1).

Population-based primary prevention strategies seek to reach people before they are symptomatic, at a time when promoting healthful behaviors can prevent problems. Community-based chemical health promotion seeks to mobilize all factions of a community to encourage, develop, and maintain social and environmental conditions and personal attributes that reduce or eliminate negative consequences from the use of alcohol and other chemicals.

Physicians and other health care providers have an essential role in the prevention of alcohol-related diseases (USDHHS, 1994). For example, providers can support primary prevention by educating their patients about alcohol's contribution to disease (Bradley, Donovan & Larson, 1993). Outside of the clinic setting, health care providers increasingly bring leadership and advocacy to chemical health programs and policies (AMA, 1994).

Secondary prevention efforts are undertaken to minimize damage once an alcohol-related problem or disease has developed. For example, providers can counsel and, as necessary, refer to alcohol treatment programs patients who report binge or heavy drinking (Bien et al., 1993; Saunders et al., 1993). Tertiary prevention efforts seek to avoid further damage due to more advanced states of alcohol-related disease. Although tissue damage by alcoholic cirrhosis of the liver is permanent, chemical dependency treatment and medical intervention can lead to greater chances of survival (Smart & Mann, 1992).

Some additional issues to be addressed in focusing prevention efforts include: (1) the importance of tobacco use prevention in conjunction with alcohol efforts, since tobacco and alcohol in combination lead to a greater risk of incidence of some diseases; (2) the need for more research into the reasons why some alcohol-related diseases occur at different rates by gender and racial group; and (3) the need to balance the apparently beneficial effects of moderate alcohol consumption on the risk of coronary artery disease with other known harmful health effects of alcohol consumption. For a more complete discussion of alcohol use and cardiovascular disease, see chapter 1.

For further discussion of alcohol-related diseases, see chapter 2, "Minnesota alcohol-related deaths."

Endnotes

1 Throughout this article, we use the terms "alcohol abuse," "alcoholism," and "heavy drinking." There is overlap among these terms in the literature; therefore our wording at any given point must rely on the terms used by the authors in each report cited.

2 There are two types of stroke-hemorrhagic and ischemic. Hemorrhagic stroke is associated with thinning blood and results in blood leakage into an area of the brain. Ischemic stroke refers to a loss of blood flow to an area of the brain.

3 A dose-response relationship exists when the risk of a disease increases with greater levels of exposure to a chemical or agent suspected of causing the disease. The presence of a dose-response relationship is generally taken as strong evidence of a causal relationship; however, not all associations that show dose-response relationships are necessarily causal.

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