

# MAGNITUDE OF ALCOHOL-RELATED MORTALITY AND MORBIDITY AMONG U.S. COLLEGE STUDENTS AGES 18–24: Changes from 1998 to 2001

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■ **Abstract** Integrating data from the National Highway Traffic Safety Administration, the Centers for Disease Control and Prevention, national coroner studies, census and college enrollment data for 18–24-year-olds, the National Household Survey on Drug Abuse, and the Harvard College Alcohol Survey, we calculated the alcohol-related unintentional injury deaths and other health problems among college students ages 18–24 in 1998 and 2001. Among college students ages 18–24 from 1998 to 2001, alcohol-related unintentional injury deaths increased from nearly 1600 to more than 1700, an increase of 6% per college population. The proportion of 18–24-year-old college students who reported driving under the influence of alcohol increased from 26.5% to 31.4%, an increase from 2.3 million students to 2.8 million. During both years more than 500,000 students were unintentionally injured because of drinking and more than 600,000 were hit/assaulted by another drinking student. Greater enforcement of the legal drinking age of 21 and zero tolerance laws, increases in alcohol taxes, and wider implementation of screening and counseling programs and comprehensive community interventions can reduce college drinking and associated harm to students and others.

## INTRODUCTION

National surveys have focused attention on the heavy drinking patterns of many college students. In 1993, 1997, and 1999, the Harvard School of Public Health College Alcohol Surveys (CAS) monitored among college students heavy or binge drinking, defined as five or more drinks in a single drinking session for males and four or more for females (77–79). In 1999, of 14,138 full-time students randomly

selected at 128 4-year colleges and universities, 44% reported at least one heavy drinking episode in the previous year, the same percentage as in 1993 (79). About one fourth (23%) frequently drank in this manner (3 or more times in the past 2 weeks), up from 20% in 1993. Similarly, the national Monitoring the Future study (36) reported 40% of 1440 full-time 2- and 4-year college students surveyed in 1999 consumed 5 or more drinks on a single occasion at least once in the previous 2 weeks, a greater proportion than found among same-age noncollege peers (35%) and high school seniors (31%).

In 1998 the National Advisory Council of the National Institute on Alcohol Abuse and Alcoholism (NIAAA), one of the Institutes of the National Institutes of Health, created a task force to review the research on college drinking to advise administrators and the NIAAA on implementing and evaluating college programs and future research directions. This study resulted in a 2002 report: *A Call to Action: Changing the Culture of Drinking on U.S. College Campuses* (57). Background papers appeared in "College Drinking, What Is It and What to Do About It? A Review of the State of the Science" in the *Journal of Studies for Alcohol* (23).

One of the 24 articles commissioned for this panel (30) estimated that in 1998 more than 1400 students ages 18–24 enrolled in 2- and 4-year colleges died from alcohol-related injuries including motor vehicle crashes. Further, of the 8 million college students in the United States more than 2 million drove under the influence of alcohol and over 3 million rode with a drinking driver. More than 500,000 full-time 4-year-college students were unintentionally injured under the influence of alcohol, and more than 600,000 were hit or assaulted by and more than 70,000 experienced a date rape caused by another student who had been drinking.

The purpose of this review is to assess whether the magnitude of alcohol-related morbidity and mortality among U.S. college students ages 18–24 changed from 1998 to 2001. We also outline interventions, identified by rigorous research in the 2002 NIAAA report and the recent *National Academy of Science Report to Congress Preventing Under Age Drinking: A Collective Responsibility*, to reduce college drinking problems (52).

## METHODS: CALCULATING CHANGES IN ALCOHOL-RELATED MORTALITY

This review compares the number of alcohol-related traffic and other unintentional injury deaths in 1998 and 2001 among 18–24-year-olds in the United States who are full- or part-time college students attending either 2- or 4-year colleges. Information was integrated from multiple data sets because the U.S. Department of Transportation Fatality Analysis Reporting System (FARS): NHTSA (56) does not routinely record whether persons who die in motor vehicle crashes are college students. In addition, people who die from other types of unintentional injuries are not systematically tested for blood alcohol concentrations (BACs). The data sources consulted are described below.

First, the Centers for Disease Control and Prevention (CDC) annually records the numbers and ages of unintentional injury deaths (5), but they do not record whether these deaths are alcohol related. Second, a recent meta-analysis of 331 medical examiner studies (65) from 1975 to 1995 revealed that 84% of unintentional nontraffic fatalities were tested for BACs. Of those tested, 38% had positive BACs, and 31% had BACs of 0.10% or higher, exceeding legal limits for intoxication nationwide (65). This analysis provides the best available estimates for alcohol involvement in injury deaths (other than motor vehicle crash deaths), but it does not provide information on annual changes in the proportions of those deaths that are alcohol related.

Third, the National Highway Traffic Safety Administration's (NHTSA) FARS records all motor vehicle crash deaths in the United States (55, 56) and the proportion that are alcohol related, defined as involving a driver or pedestrian with a positive BAC. The ages of decedents are recorded, as are their blood alcohol concentrations. Because BACs are not drawn on all motor vehicle crash deaths, an imputational formula projects the likelihood of alcohol involvement in those crashes for which test results are not available.

Fourth, the Department of Education's National Center for Education Statistics (53) reports the number of undergraduate college students in the United States. In 1998, of the 26,058,760 18–24-year-olds living in the United States (17), 8,670,000 (33%) were enrolled as full- or part-time students in either 2- or 4-year colleges: 24% ( $n = 6,106,000$ ) in 4-year colleges and 10% ( $n = 2,564,000$ ) in 2-year colleges. Of students enrolled in 4-year colleges, 74% were ages 18–24, as were 60% of those enrolled in 2-year colleges. In 2001, of the 27,918,979 18–24-year-olds living in the United States, 8,894,000 (32%) were enrolled as either full- or part-time college students: 23% 6,381,000 (23%) in 4-year colleges and 9% 2,518,000 (9%) in 2-year colleges. Of students enrolled in 4-year colleges 74% were age 18–24, as were 61% of those enrolled in 2-year colleges.

Fifth, the National Household Survey of Drug Abuse in 1999 and 2002 surveyed 18–24-year-olds regardless of whether they were college students (66, 67). In both surveys, college students were more likely than same-age noncollege respondents to report drinking five or more drinks on at least one occasion in the past month and driving under the influence in the past year. On the basis of those survey results, we projected that the proportions of traffic and other unintentional injury decedents testing positive for alcohol would be as high among college 18–24-year-olds as noncollege-year-olds same-age persons. Because college students comprised 33% of the 18–24-year-old population in 1998 and 32% in 2001, we estimated that in 1998 18–24-year-old college students accounted for 33% and in 2001 32% of traffic and other unintentional injury deaths experienced by the 18–24-year-old U.S. population.

## Calculation of other Alcohol-Related Risks

Two national surveys conducted in 1999 and 2002 (66, 67) asked students about their experiences with alcohol in the previous year. Using their responses and data

on the numbers of college students in the United States during those years, we estimated the annual numbers of college students ages 18–24 who drive under the influence of alcohol, were injured because of drinking, and experienced other alcohol-related problems.

The National Household Survey on Drug Abuse (NHSDA) (67) is the primary source of statistical information on illegal drug use in the United States. Sponsored by the Substance Abuse and Mental Health Services Administration (SAMHSA) (66), computer-assisted interviews are conducted with a representative sample of the United States: residents of households and noninstitutional group quarters (e.g., shelters, rooming houses, dormitories) and civilians living on military bases.

The 1999 and 2002 NHSDA used an independent multistage area probability sample for each of the 50 states and the District of Columbia. Youth and young adults were oversampled so that each state's sample was approximately equally distributed among people ages 12–17, 18–25, and 26 and older.

In 1999, 169,166 addresses across the United States were screened, and 66,706 persons were interviewed within screened addresses. Weighted response rates for households screened and interviewed were 89.6% and 68.6%, respectively. The sample included 19,438 respondents ages 18–24, of whom 6930 (36%) were enrolled in college, 5796 (30%) as full-time students and 1134 (6%) as part-time students.

In 2002, 68,126 persons were interviewed within the screened addresses. Weighted response rates for households screened and persons interviewed were 91% and 79%. In the survey 20,478 respondents were ages 18–24, of whom 8041 (39%) were enrolled in college.

Respondents were asked how often they drank 5 or more alcoholic drinks on any one occasion in the past 30 days. They were also asked, reflecting on the previous 12 months, Has your use of alcohol caused you to have any health problems?, Have you driven a vehicle under the influence of alcohol only?, and Have you received treatment or counseling for your use of alcohol?

The Harvard School of Public Health CAS began in 1993 (77) with a sample of 140 colleges selected from a list of all accredited 4-year colleges provided by the American Council on Education, using probability sampling proportionate to the size of undergraduate enrollment at each institution. At each college, a random sample of 225 undergraduates was drawn from the total enrollment of full-time students. In 1999 (79), another survey was conducted with 128 of the original 140 colleges. The inability of 10 colleges in 1997 and 2 colleges in 1999 to provide a random sample of students and their mailing addresses resulted in the attrition of those schools. In 1999, 12,317 full-time students, ages 18–24 and having come from 40 states, were surveyed; nearly half of these students lived in dormitories, college housing, fraternities, or sororities (response rate 60%) (79).

In 2001, 215 full-time students ages 18–24 were randomly selected for the survey from each of 119 colleges and universities that had been part of the 1999 sample, response rate 52% (80). Respondents were asked their frequency and usual quantity of drinking, whether during the current school year they experienced

a variety of health and social problems because of their drinking, and whether the drinking of other college students posed any of a series of social and health problems for them.

## Statistical Analyses of Surveys

For both surveys we present weighted results that consider their respective designs and nonresponse. All statistical estimates of percentages for the survey data were conducted using the SUDAAN statistical package to account for each survey's design (63). The SUDAAN package accounts for sampling weights in calculating both estimates and standard errors, using first-order Taylor series approximations to provide standard errors that approximately account for sampling design.

Using the information above, we identified the percentage of 2- and 4-year college students ages 18–24 who responded affirmatively to the survey questions regarding alcohol problems and then calculated 95% confidence intervals for those responses. To estimate the numbers of 18–24-year-old college students who experienced those problems, we then multiplied those percentages and confidence intervals by the appropriate population count from the Department of Education of students 18–24 years enrolled in 2- and 4-year colleges in the United States. Data from the Department of Education are considered to be true population totals; therefore, our confidence intervals reflect only the sampling variability in the percentage estimates. We also made projections from the CAS responses to the full-time 4-year college population using the same analytic strategy.

Percentages of responses with 95% confidence intervals were calculated from survey data accounting for the sampling design. Changes in numbers of events and rates of events per 100,000 population were described through relative risks, and 95% confidence intervals were calculated using the Poisson model. These percentages and confidence intervals are available on request.

## RESULTS

### Motor Vehicle Crash Deaths

The NHTSA surveys in both 1999 and 2002 revealed that in the year prior to the survey, a significantly greater percentage of 18–24-year-old college students compared with same-age noncollege respondents drank 5 or more drinks on a single occasion in the past month (41.7% versus 36.5% in 1999 and 43.2% versus 39.8% in 2002) and drove under the influence of alcohol in the previous year (26.5% versus 19.8% in 1999 and 31.4% versus 23.7% in 2002). The percentage in both groups of 18–24-year-olds who drank 5 or more drinks in the past 30 days did not significantly increase from 1999 to 2002. However, the percentage of college students who drove under the influence in the past year increased significantly [RR = 1.18 (95% CI 1.13, 1.25)].

In 1998, in the United States, among persons ages 18–24, 3783 (51%) of 7452 traffic deaths were alcohol related. On the basis of a deliberately conservative assumption that college students (33% of the U.S. population ages 18–24 in 1998) experienced alcohol-related fatalities at the same rate as the entire 18–24-year-old population, 1248 (33%) of the alcohol-related traffic deaths in that age group would have been college students. (Note this figure is somewhat higher than reported by Hingson et al. (30) because the Census Bureau revised its estimate of college students in 1998 from 8 million to 8.67 million.)

In 2001, in the United States, among persons ages 18–24, 4216 (51%) of the 8242 traffic deaths were alcohol related. Assuming that college students (32% of the U.S. population ages 18–24 in 2001) experienced alcohol-related fatalities at the same rate as the entire 18–24-year-old population, 1349 (32%) of the alcohol-related traffic deaths in that age group would have been college students (Table 1).

From 1998 to 2001 the U.S. population ages 18–24 increased 7%, whereas alcohol-related traffic deaths increased 11%. Thus the increase in alcohol-related traffic deaths per 18–24-year-old population was 4%. The U.S. college population ages 18–24 increased 3%, but the number of alcohol-related traffic deaths among 18–24-year-old students increased 8%. The 5% increase in the rate of alcohol-related traffic deaths from 14.4 to 15.2 per 100,000 college students approached, but did not reach, statistical significance [RR = 1.05 (95% CI 0.98, 1.14)].

## Unintentional Nontraffic Deaths

In the NHSDA survey, 18–24-year-olds in college and not in college were equally likely to report alcohol-related health problems (1.9% versus 2.0% in 1999 and 2.1% versus 2.3% in 2002). According to the CDC there were 10,052 unintentional injury deaths among 18–24-year-olds in 1998 and 11,272 in 2001 (5). Subtracting 7444 traffic deaths in 1998 from the total unintentional injury deaths among 18–24-year-olds that year and 8242 from the total in 2001 yielded 2608 nontraffic injury unintentional deaths in 1998 and 3030 in 2001. If 38% were alcohol related, as reported in national analyses of coroner studies (64), then 991 persons ages 18–24 in 1998 and 1151 in 2001 died from alcohol-related nontraffic injuries. If 33% of those deaths were among college students in 1998 and 32% in 2001, then 327 students in 1998 and 368 in 2001 died from alcohol-related nontraffic unintentional injuries.

From 1998 to 2001, the rate of these deaths showed a non-significant 10% increase from 3.8 to 4.1 per 100,000 college students, RR = 1.10 (95% CI 0.95, 1.27). Among 18–24-year-old college students, deaths from all alcohol-related unintentional injuries, including traffic and other unintentional injury deaths, increased from 1575 in 1998 to 1717 in 2001, corresponding to an increase in the rates of these deaths from 18.2 to 19.3 per 100,000 students, a 6% increase that approached statistical significance (RR = 1.06, 95% CI 0.99, 1.14). From 1998

**TABLE 1** Estimated U.S. alcohol-related injury deaths among 18–24-year-olds, 1998 and 2001

	1998	2001	Change (95% CI)	Change/ population (95% CI)
<b>Alcohol-related motor vehicle crash deaths</b>				
Number of alcohol-related motor vehicle crash deaths	3783	4216	↑11% (↑7%, ↑16%)	↑4% (↓0.5%, ↑9%)
Percentage who are college students	33%	32%		
Number of college-student alcohol-related motor vehicle crash deaths	1248	1349	↑8% (↑0.1%, ↑16%)	↑6% (↓2%, ↑14%)
<b>Alcohol-related unintentional nontraffic deaths</b>				
Number of unintentional deaths	10,052	11,272	↑12% (↑9%, ↑15%)	↑5% (↑2%, ↑8%)
Number of motor vehicle crash deaths	7452	8242		
Number of unintentional nontraffic injury deaths	2608	3030		
Percentage of nontraffic injury deaths that are alcohol related	38%	38%		
Number of nontraffic injury deaths that are alcohol related	991	1151	↑16% (↑7%, ↑25%)	↑8% (↓0.5%, ↑18%)
Percentage who are college students	33%	32%		
Number of college-student alcohol-related unintentional injury deaths	327	368	↑13% (↓3%, ↑28%)	↑10% (↓5%, ↑27%)
All alcohol-related unintentional deaths	4771	5367	↑12% (↑8%, ↑17%)	↑5% (↑1%, ↑9%)
Total alcohol-related unintentional injury death				
Total alcohol-related unintentional injury deaths among college students	1575	1717	↑9% (↑2%, ↑16%)	↑6% (↓1%, ↑14%)

to 2001 the total population of persons ages 18–24, including college students and others, increased 7%, and alcohol-related unintentional injury deaths increased 12% from 4771 to 5367, a significant 5% increase per population [RR = 1.05 (95% CI 1.01, 1.09)].

### Heavy Episodic Drinking

From 1999 to 2002, the proportion of college students ages 18–24 who drank 5 or more drinks on an occasion in the previous 30 days increased from 41.7% to 43.2%, a nonsignificant increase. The number of college students ages 18–24

**TABLE 2** Interventions demonstrated to reduce college drinking problems

	References
Individually oriented interventions	See Larimer & Cronce 2002 (43)
Brief motivational interventions	Baer et al. 1992 (3), Borsari & Carey 2000 (4), Marlatt et al. 1998 (48)
Mailed graphic feedback	Agostinelli et al. 1995 (1); Aubrey 1998 (2); Dimeff 1997 (18); Monti et al. 1999 (49); Walters et al. 1999, 2000 (75, 76)
Self-monitoring self-assessment	Garvin et al. 1990 (21), Marlatt et al. 1998 (48)
Expectancy challenge	Darkes & Goldman 1993 (14)
Life skills training	Murphy 1986 (50), Rohsenow et al. 1985 (60)
Environmental interventions	D'Amico & Fromme 2000 (13)
Raising the minimum legal drinking age to 21	Shults et al. 2001 (64), Wagenaar & Toomey 2002 (74)
Zero-tolerance laws	Hingson et al. 1994 (28), Wagenaar & Toomey 2002 (74)
Increased price of alcohol	See Wagenaar & Toomey 2002 (74); Chaloupka et al. 2002 (6); Chesson 2000 (9); Coate & Grossman 1988 (10); Cook & Moore 1999 (11); Cook & Tauchen 1982 (12); Dee & Evans 2001 (16); Godfrey 1997 (22); Grossman et al. 1997 (25); Kenkel 1993 (39); Laixuthai & Chaloupka 1993 (42); Manning et al. 1995 (45); Markowitz & Grossman 1998 (46); Natl. Acad. Sci. 2004 (52); Ruhm 1996 (61); Saffer & Grossman 1987 (62); Sutton & Godfrey 1995 (68)
Comprehensive community intervention	Hingson et al. 1996 (34), Hingson & Howland 2002 (32), Holder et al. 2000 (35), Wagenaar et al. 2000 (71, 72), Weitzman et al. 2004 (83)

who consumed at least 5 drinks on an occasion in the previous month increased from 3,615,550 to 3,842,208, a nonsignificant 4% increase per college student population. The increase in the proportion who reported a health problem related to alcohol, from 1.9% to 2.1%, was also not significant. However, the proportion of college students ages 18–24 who in the past year reported driving under the influence of alcohol increased significantly from 26.5% to 31.4%,  $RR = 1.18\%$  (95% CI 1.13, 1.25); the proportion of students who were arrested for an alcohol-related offense or who were receiving treatment for an alcohol or drug problem increased from 1.4% to 2.2%,  $RR = 1.37$  (95% CI 1.22, 2.01). The number of students who drove under the influence of alcohol in the previous year increased from 2,297,550 to 2,792,716, a highly significant 18% increase per college student population.



## Other Alcohol-Related Health Problems

From 1998 to 2001 the number of full-time 4-year college students ages 18–24 in the United States increased 4% from 5,496,000 to 5,709,000. Because the proportion of students who in the CAS reported being hurt or injured or having unprotected sex did not significantly change from 1999 to 2001, the projected number of students with these experiences increased at rates similar to the proportional population increase. In 2001, 599,000 (10.5%) were injured because of drinking and 474,000 (8%) had unprotected sexual intercourse as a result of their drinking. Although in 2001 slightly smaller proportions reported being assaulted or hit by another drinking college student, more than 696,000 (12%) experienced that problem in 2001, and 97,000 (2%) were alcohol-related sexual assault or date rape victims.

## DISCUSSION: ESTIMATES OF THE MAGNITUDE OF COLLEGE DRINKING PROBLEMS

From 1998 to 2001 the nationwide number of alcohol-related deaths among 18–24-year-olds rose at a rate that significantly exceeded that age group's proportional population increase. Whereas the population increased 7% from 26,058,760 to 27,918,979, alcohol-related unintentional injury deaths rose 12% from 4771 to 5367. Thus, alcohol-related deaths per population of 18–24-year-olds rose 5% from 1998 to 2001.

From 1998 to 2001, among college students ages 18–24 the population increased 3% from 8,670,000 to 8,894,000, whereas unintentional alcohol-related injury deaths increased 9% from 1575 to 1717. Thus, similar to the overall 18–24-year-old group, among college students alcohol-related unintentional injury deaths per population rose 6%, an increase that approached statistical significance. In 2001, nearly 600,000 college students were injured because of drinking, and 696,000 were assaulted by another drinking college student.

Although the numbers are disturbingly high, we believe our estimates of alcohol-related college deaths are conservative. First, we focused only on unintentional injury deaths, not homicides and suicides, many of which are also alcohol related. Second, the proportion of 18–24-year-olds who engage in heavy episodic drinking and driving under the influence of alcohol is higher among persons that age who are enrolled in college. Consequently, our projection that college and noncollege 18–24-year-olds experience traffic alcohol-related injury deaths at the same rate per population in each group was intentionally conservative.

Third, the meta-analysis of coroner studies (65) did not provide age-specific estimates of alcohol involvement in nontraffic unintentional injury deaths. We estimated the proportion of nontraffic unintentional injury deaths was the same among 18–24-year-old college students as among adults all ages, even though persons 18–24 are known to drink more than other adults. A higher proportion of traffic fatalities are alcohol related in the 18–24-year-old population (51%)

than among all age groups (38%). It is therefore possible, if not likely, that our estimates of the number of unintentional alcohol-related nontraffic injury deaths among 18–24-year-olds are also conservative.

Fourth, if respondents underreport illegal behaviors like driving under the influence of alcohol, our estimate of the numbers of students who engage in those behaviors may be low.

Fifth, response rates for the NHSDA and CAS were low. Thus, students may under- or overrepresent problems associated with alcohol. In 1999 a short form of the CAS was sent to nonresponding students, and there was no significant difference in rates of previous year alcohol use for those answering the short survey compared with the full questionnaire. Of note, the estimates of heavy episodic drinking reported by college students in the NHSDA and the CAS are very similar to those obtained by other major national surveys that include college students e.g., the Monitoring the Future Survey (36, 37).

Sixth, this analysis focused only on college students ages 18–24. In 1998 only 74% of 4-year college students and 60% of students at 2- or 4-year colleges were ages 18–24. In 2001, 74% of 4-year college students and 61% at 2-year colleges were in that age group. We have calculated the overall numbers of college students all ages who drink heavily and experience alcohol-related health problems. These numbers are larger than those reported here and are available on request.

## IMPLICATIONS

The magnitude of problems posed by excessive drinking among college students should stimulate both improved measurement of these problems and efforts to reduce them. We believe every unnatural death in the United States should be tested for alcohol. The average cost of such testing would be approximately \$50 per deceased person or an annual cost of \$1.1 million if all injury deaths of those under 21 were tested or \$7.2 million for 144,374 unintentional deaths, homicides, and legal intervention and suicide deaths of all ages recorded in 2001. In comparison, the National Academy of Sciences (52) reports \$71.1 million are spent annually to reduce underage drinking. Even though this review used cautious assumption to estimate the numbers of alcohol-related deaths among college students and other 18–24-year-olds, direct systematic alcohol test results would be preferable. Also, mortality data sets (e.g., the Department of Transportation's FARS and CDC's Vital Statistics Mortality File) should include occupation and student status categories so that the absolute number of annual college student deaths can be tabulated.

Progress has been made over the past two decades to reduce alcohol-related crash deaths. This process has occurred in part because a sufficiently high and consistent level of fatally injured drivers in crashes are tested for alcohol that statistical models based on crash factors, vehicle factors, and person factors have been developed and used to estimate the annual numbers of alcohol-involved fatal crashes in all states (40). The data on the numbers of alcohol-related fatal crashes

annually in each state has proven invaluable to researchers seeking to study the effects of state-level legislative interventions to reduce alcohol-related traffic deaths.

Unfortunately, without comprehensive testing for alcohol and determination of college student status of all persons who die from unnatural deaths, we lack the most dependable yardstick by which to measure the magnitude of alcohol-related injury death among college students, and whether this figure is changing over time.

## INTERVENTIONS TO REDUCE COLLEGE DRINKING

The increase in the past 3 years in alcohol-related traffic and other unintentional injury deaths among 18–24-year-olds both in college and not in college underscores the need for colleges and their surrounding communities to expand and strengthen interventions demonstrated to reduce excessive drinking among college students and their same-age noncollege counterparts.

Of note, heavy-drinking college students not only place their own health at risk, but also they jeopardize the well-being of others. As many as 46% of the 4553 people killed in 2001 in crashes involving 18–24-year-old drinking drivers are persons other than the drinking driver, and the total deceased has increased 33% from 3425 to 4553 between 1998 and 2001. Further, surveys both in 1999 and again in 2001 indicate annually over 600,000 college students nationwide were hit or assaulted by a drinking college student, and in 2001 97,000 students were the victim of a date rape or assault perpetrated by a drinking college student. Colleges and surrounding communities have an obligation to protect people from potential harm contributed by excess college drinking.

The recent report on college drinking (57) and its background reports (23) and the National Academy of Sciences Report on Underage Drinking (52) identified numerous individually oriented counseling approaches, environmental interventions, and comprehensive community interventions that can reduce drinking and related problems among college students and the college age population. These documents summarize scientifically valid approaches for effective prevention, and some believe they establish a new legal standard by which the adequacy of any college or university's efforts can be judged (44). See Table 2.

### Individually Oriented Interventions

Larimer & Cronce (43) reviewed individually oriented strategies to reduce problematic alcohol consumption by college students from 1984 to 1999. Studies were included in this review if they had a control or comparison group and had at least one change in drinking or alcohol consequences outcome. A total of 34 separate studies were identified. The reviewers found little evidence for the effectiveness of information-based and values-clarification programs. Several skills-based interventions (13, 50, 60) resulted in decreases in alcohol consumption, including self-monitoring/self-assessment (21, 48) as well as expectancy-challenge procedures (14) involving alcohol/placebo administration. Brief motivational interventions

had demonstrated effectiveness in a variety of contexts including selected high-risk freshmen, high school classrooms, fraternity organizations, outpatient counseling centers, and emergency rooms. Mailed graphic feedback alone in three studies (1, 75, 76) resulted in reductions in alcohol consumption equivalent or superior to skills-based interventions with combined feedback.

## Environmental Interventions: Legal Drinking Age of 21

The most powerful environmental intervention to reduce drinking among college students is the minimum legal drinking age of 21. In 1984, when 25 states had a legal drinking age of 21, the U.S. Congress passed legislation that would withhold highway construction funds from states that did not make it illegal to sell alcohol to people younger than 21. By 1988, all states adopted this law. A review of more than 49 studies of legal drinking age changes revealed that in the 1970s and 1980s, when many states lowered the drinking age, alcohol-related traffic crashes increased 10%. In contrast, when states increased the legal drinking age to 21, alcohol-related crashes among people younger than 21 decreased an average of 16% (64). Wagenaar & Toomey (74) reviewed more than 48 studies of the effects of drinking age changes on drinking and 57 studies on traffic crashes. They concluded that increases in the age of legal alcohol purchase and consumption have been the most successful intervention to date in reducing drinking- and alcohol-related crashes among persons under 21. One national study of laws raising the drinking age to 21 indicated that persons who grew up in states with a drinking age of 21 relative to those with lower legal drinking ages drank less not only when they were younger than 21, but also when they were ages 21–25 (58). NHTSA (54) estimates that a legal drinking age of 21 saves 700–1000 lives annually, and that more than 21,000 traffic deaths have been prevented by such laws since 1976.

Zero tolerance laws, which make it illegal in every state for persons under 21 to drive after any drinking, have also contributed to declines in alcohol-related traffic deaths among people younger than 21. A comparison of the first 8 states to adopt zero tolerance laws with nearby states without such laws revealed a 21% greater decline in zero tolerance law states in the proportion of fatal crashes among drivers younger than 21 that were of the type most likely to involve alcohol (i.e., single-vehicle fatal crashes at night) (28). Wagenaar et al. (73) found that in the first 30 states to adopt zero tolerance laws, relative to the rest of the nation, there was a 19% decline in the proportion of people younger than 21 who drove after any drinking and a 23% decline in the proportion who drove after 5 or more drinks.

Unfortunately, despite their demonstrated benefits, legal drinking age and zero tolerance laws generally have not been vigorously enforced (38). Young drivers are substantially underrepresented in the driving while intoxicated (DWI) arrest population relative to their contributions to the alcohol crash problem (59, 70). Younger drivers may be more likely to drink at locations where DWI enforcement resources are less likely to be deployed. Young drivers with high BACs also are more likely to be missed by police at sobriety checkpoints (82).

Stepped-up enforcement of alcohol purchase laws aimed at sellers and buyers can be effective (59, 69, 72) if resources are made available for this purpose. Enforcement of zero tolerance laws is hindered in some states because their implied consent laws require either an arrest for DWI or probable cause for a DWI arrest before the evidentiary test can be done to prove a zero tolerance violation (19). Thus in practice zero tolerance laws often are not enforced independently of DWI. In states such as New Mexico, where this situation exists, most teenagers are unaware that there is a zero tolerance law (20).

## Price of Alcohol

The National Academy of Sciences (52) reviewed the literature on price of alcohol and alcohol-related problems and recommended that Congress and state legislators raise excise taxes to reduce underage alcohol consumption and to raise additional revenues to reduce underage drinking problems.

With rare exceptions (8, 15) research since the early 1980s generally has concluded that increases in the price of alcohol beverages lead to reductions in drinking and heavy drinking, as well as reductions in the adverse consequences of alcohol use and abuse (6). Higher alcohol prices have also been found to reduce alcohol-related problems such as motor vehicle fatalities (16, 39, 62), robberies, rapes, liver cirrhosis deaths (11, 12, 61), sexually transmitted diseases (9), and child abuse (46, 47). Among moderate drinkers, investigators have estimated that a 1% price increase results in a 1.19% decrease in consumption (45). Younger, heavier drinkers tend to be more affected by price than older, heavier drinkers (7, 22, 39, 68), perhaps because younger drinkers have less discretionary income. Laixuthai & Chaloupka (42), Grossman et al. (25), and Coate & Grossman (10) all found increasing the price of alcohol reduces the percent of youths who drink infrequently and produces even greater percentage declines in youths who drink frequently.

Research taking into account the addictive nature of alcohol shows that the long-term price elasticity is well above short-term elasticity (24). Kenkel (39) reported a 10% increase in the price of alcohol would reduce DWI 7% among men and 8% among women, and among persons under 21 this action would produce a 13% decrease among men and a 21% decrease among women.

If, as recommended by the National Academy of Sciences Report (52), revenues generated by alcohol tax increases to raise beverage prices are in turn earmarked for programs and enforcement of policies known to reduce underage drinking, reductions in underage drinking problems could exceed deductions associated with alcohol price increases alone.

## Other Environmental Interventions

Alcohol outlet density has been associated with alcohol-related problems (26) and reducing outlet density may in turn reduce drinking-related problems. Wechsler et al. (81) found that students who attend colleges in states that have more restrictions on underage drinking, high volume consumption, and sales of alcohol

beverages and which devote more resources to enforce drunk-driving laws, report less drinking and driving. Laws in these states included prohibitions against using a false identification, restrictions on attempting to buy or consume for those under the legal drinking age, enforcement of a clerk age minimum, and maintenance of minimum mandatory postings of warning signs in retailers to potential underage buyers. Laws pertaining to volume alcohol sales were keg registration, a statewide 0.08 g/dl per se BAC law, and restrictions on happy hours, open alcohol containers, beer sold in a pitcher, and billboards and advertising. The availability of large volumes of alcohol (24- and 30-can cases of beer, kegs, party balls), low sale prices, and frequent promotions and advertisements at both on- and off-premise establishments were also associated with higher binge drinking rates on the college campuses (41).

Shults (64) also reviewed 19 studies of states lowering legal blood alcohol limits for persons above 21 to 0.08% and reported that this law cut alcohol-related fatalities on average by 7% and concluded that there is strong evidence in favor of such a change.

## Comprehensive Community Interventions

Several carefully conducted community-based initiatives have had particular success in reducing drinking- and/or alcohol-related problems among young people (32). These programs typically coordinate efforts of city officials from multiple departments of city government, school, health, police, alcohol beverage control, etc.; concerned private citizens and their organizations; students; parents; and merchants who sell alcohol. Often multiple intervention strategies are incorporated into the programs, including school-based programs involving students, peer leaders, and parents; media advocacy; community organizing and mobilization; environmental policy change to reduce alcohol availability to youth; and heightened enforcement of laws regulating sales and distribution of alcohol and laws to reduce alcohol-related traffic injuries and deaths.

Three comprehensive community programs in particular have shown reduction in alcohol problems among college-age youth: the Communities Mobilizing for Change Program (71, 72), the Community Trials Program (35), and the Saving Lives Program (34). Two programs (35, 71, 72) concentrated program efforts on underage alcohol purchase attempt surveys with feedback to alcohol sales merchants and the community about the proportion of attempts that resulted in sales and penalties for continued violations. Two programs (34, 35) focused on publicized police enforcement of drinking driver laws and alcohol service laws, and one (34) targeted risky motorist behaviors—such as speeding, running red lights, failing to wear safety belts, and yielding to pedestrians in crosswalks—engaged in disproportionately by drinking drivers.

Relative to the comparison communities, the Communities Mobilizing for Change communities achieved a 17% increase in outlets checking the age identification of youthful-looking alcohol purchasers, a 24% decline in sales by bars

and restaurants to potential underage purchasers, a 25% decrease in the proportion of 18–20-year-olds seeking to buy alcohol, a 17% decline in the proportion of older teens who provided alcohol to younger teens, and a 7% decrease in the percentage of respondents younger than 21 who drank in the previous 30 days (71). Further, drinking and driving arrests declined significantly among 18–20-year-olds, and disorderly conduct violators declined among 15–17-year-olds (72).

In the Community Trials Program, single-vehicle crashes at night, a measure of alcohol-related crashes, declined 11% more in program than in comparison communities. Alcohol-related trauma visits to emergency departments declined 43% (35).

In the Saving Lives Program (34) the proportion of drivers younger than 20 who reported in telephone surveys driving after drinking declined from 19% to 9% over the course of the program. The proportion of vehicles observed speeding through use of radar was cut in half, and there was a 7% increase in safety belt use. Minimal change in these outcomes occurred in comparison areas. Fatal crashes declined from 178 during the 5 preprogram years to 120 during the 5 program years, a 25% greater reduction than in the rest of Massachusetts. Fatal crashes involving alcohol declined 42%, and the number of fatally injured drivers with positive BACs declined 47%, relative to the rest of Massachusetts. Visible injuries per 100 crashes declined 5% more in Saving Lives cities than in the rest of the state during the program period. The fatal crash declines were greater in all six program cities relative to comparison areas, particularly among drivers ages 15–25.

Weitzman et al. (83) recently evaluated the impact of college/community partnerships implementing environmentally based interventions to reduce drinking and related problems specifically among college students. Interventions included in the A Matter of Degree (AMOD) program included keg registration, mandatory responsible beverage service, increased enforcement of community police collaboration or wild party enforcement, substance-free residence halls, and a variety of alcohol bars advertising environment with change. Of the ten AMOD programs, the five that most vigorously implemented these interventions achieved significant reductions in binge and frequent binge drinking, frequent intoxication, driving after drinking, alcohol-related injury, and a variety of other alcohol-related problems. Relative to control colleges, significant reductions were observed also in the proportion of students who reported being assaulted by another drinking college student.

## CONCLUSIONS

Binge drinking and particularly DWI among college students and others in the 18–24 age group has increased since 1998, and alcohol-related deaths have increased significantly more than the population totals for that age. Colleges and the communities in which they are located have an obligation to control the harms to others posed by college-age drinkers, regardless of whether these drinkers are college students. Although a high percentage of 18–24-year-old college students drink

heavily and engage in behaviors, such as driving a motor vehicle after drinking, that pose risk to themselves and others, there are so many more 18–24-year-olds not in college that this population actually accounts for more heavy drinkers, drinking drivers, and alcohol-related deaths. In 2001, while 3.8 million college students ages 18–24 engaged in heavy (5+ drinks) drinking episodes, so too did 7.6 million 18–24-year-olds who were not in college. While 2.8 million college students this age drove under the influence of alcohol, so too did 4.5 million persons that age who were not in college. While in 2001 nearly 1349 18–24-year-old college students died in alcohol-related motor vehicle crashes, among all 18–24-year-olds, there were 4216 of these deaths in 2001. While more than 300 college students ages 18–24 died from other unintentional alcohol-related injuries, among all 18–24-year-olds, 1151 individuals died from alcohol-related nontraffic unintentional injuries in 2001.

Moreover, while young adults ages 18–24 have the highest rates of binge drinking (5+ drinks at a time) than do other adults, persons over age 26 account for two thirds of all binge drinking episodes (51). Also, while the highest rates of alcohol-related traffic deaths are among 18–24-year-olds, they accounted for only 24% of alcohol-related traffic deaths and 9% of all other alcohol-related unintentional deaths in 2001; this fact suggests that efforts are needed to reduce alcohol-related traffic and unintentional injury deaths among persons of all ages, including college students.

Further, new research indicates that persons who drink to excess even before they enter college are more likely to experience alcohol-related problems both in high school and in college (33). According to the CDC National Youth Risk Behavior Survey, in 2001 47% of high school students (over 7 million) drank alcohol in the previous 30 days and 34% (over 5 million) drank at least 5 drinks within a 2-hour period at least once in the previous 30 days. Thirteen percent or 1.9 million individuals drove after drinking in the previous 30 days, and 31% (4.6 million) rode with a drinking driver (27). Further, the average age of starting to drink is declining (66). In 2001, 29% of high school students reported that they began drinking before age 13 (27). Analyses of the 1999 CAS among college students 19 and older revealed that the younger college students were when they first drank to intoxication (got drunk), the more likely they were to experience alcohol dependence in college, to engage in frequent heavy episodic drinking, to drive after drinking and heavy (5+ drinks) drinking, to ride with drunk drivers, to be injured under the influence of alcohol (31), and to have unplanned and unprotected sex after drinking (29). Community alcohol policy enforcement targeting high school students may have carryover effects in college years.

Because increased efforts to enforce underage drinking laws at the community level have reduced underage drinking, alcohol-related assault, emergency department visits, and alcohol-related fatal crashes involving people of college age (34, 35, 71, 72), it is important that colleges and their surrounding communities collaborate in these efforts. These efforts can include individually oriented screening and counseling strategies of proven efficiency among college and adolescent



populations as well as environmental interventions such as alcohol tax increases, heightened education, and enforcement of minimum legal drinking age and zero tolerance laws. College crackdowns on campus drinking absent community support may drive problematic drinking off campus. Community crackdowns without college support may similarly drive drinking problems back onto campus. Moreover, community efforts to reduce underage drinking are needed to prevent the development of unsafe underage drinking practices before they spill over into the college setting.

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**ERRATA**

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