Magnitude of Alcohol-Related Mortality and Morbidity among U.S. College Students Ages 18-24

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ABSTRACT. *Objective:* This report estimates the numbers of 18-24 year old United States college students who annually experience alcohol-related deaths, injuries and other health problems. *Method*: We examined traffic and unintentional injury deaths in 1998 reported by the National Highway Traffic Safety Administration and the Centers for Disease Control (CDC). We also examined results of national coroner studies, Department of Education college enrollment data, the National Household Survey on Drug Abuse (NHSDA), the CDC National College Health Risk Behavior Survey and the Harvard School of Public Health College Alcohol Survey (CAS). All survey participants were ages 18-24: 6,930 college and 12,394 noncollege respondents in the NHSDA survey; 3,077 college students in the CDC survey; and 12,217 full-time 4-year college students in the CAS. Based on the number and proportion of 18-24 year olds enrolled in college, data on alcohol involvement in injury deaths among 18-24 year olds and survey responses, we calculated the numbers of 18-24 year old alcohol-related injury deaths and other health problems. *Results*: We estimate that over 1,400 students aged 18-24 and enrolled in 2- and 4-year colleges died in 1998 from alcohol-related unintentional injuries, including motor vehicle crashes. According to surveys conducted in 1999, in the preceding year, over 2 million of the 8 million college students in the United States drove under the influence of alcohol and over 3 million rode with a drinking driver. Over 500,000 full-time 4-year college students were unintentionally injured under the influence of alcohol and over 600,000 were hit or assaulted by another student who had been drinking. *Conclusions*: There is an urgent need for expanding prevention and treatment programs, to reduce alcohol-related harm among U.S. college students and other young adults. (*J. Stud. Alcohol* **63:** 136-144, 2002)

NATIONAL SURVEYS of college-student drinking practices 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 heavy episodic or "binge" drinking among college students. This was defined, for male student drinkers, as the consumption of five or more drinks in a single drinking session and, for female students, as four or more drinks (Wechsler et al., 1994, 1998, 2000). 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 year prior to the survey, a percentage that has not changed since 1993 (Wechsler et al., 2000). About one fourth (23%) drank in this way frequently (three or more times in the past 2 weeks), up from 20% in 1993. Frequent heavy episodic drinkers were 21 times more likely than were other drinkers to experience five or more of 12 alcohol-related problems asked about in the survey. The National Monitoring the Future Survey (Johnston et al., 2000) produced similar results. Of the 1,440 full-time 2- and 4-year college students surveyed in 1999, 40% reported consuming five 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%).

These surveys have determined that a large proportion of college students drinks heavily, an even larger proportion than that of persons of the same age not in college. The exact numbers of college students nationwide who are fatally injured or experience specific health problems each year as a result of this heavy alcohol consumption have not been determined, however. Documenting the magnitude of alcohol-related mortality and health problems among college students can help stimulate and target efforts by the institutions to reduce these problems, and can serve as a baseline against which to measure potential progress in achieving this goal. Colleges and universities may be in an opportune position to address these problems because of the control they can exercise over programs and policies offered to their students.

In 1998, the National Advisory Council of the National Institute on Alcohol Abuse and Alcoholism (NIAAA) created a commission to review the research literature on college drinking in order to advise administrators on implementing and evaluating campus programs, as well as advis-

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ing NIAAA on future research directions. During this 3-year process more than two dozen college presidents and scientists reviewed epidemiologic data, as well as individual and community programs, to evaluate the current state of knowledge about the problem and the effectiveness of interventions. This article, one of 24 papers written for that commission, many of which are published in a recent supplement of this *Journal*, estimates the numbers of college students harmed by alcohol annually.

Method

There were two major tasks pursued in this report: (1) determining the number of alcohol-related traffic and other unintentional injury deaths in 1998 among 18-24 year old part-time and full-time college students; and (2) estimating the numbers of 18-24 year old college students who engaged in a variety of related behaviors that pose health risks. The methods used to approach these issues are described below.

Calculation of alcohol-related traffic and unintentional injury deaths

This article estimates the annual number of traffic and other unintentional injury deaths among 18-24 year olds in the U.S. who are full- or part-time college students attending either 2- or 4-year colleges. To derive these figures, it was necessary to examine multiple data sources because whether or not persons who die in motor vehicle crashes are college students is not routinely recorded in the Department of Transportation Fatality Analysis Reporting System (FARS; NHTSA, 1999). In addition, people who die from other types of other unintentional injuries are not systematically tested for blood alcohol concentrations (BACs). To our knowledge, this is the first time that estimates have been made based on these multiple datasets. The sources of data are described below.

First, the Centers for Disease Control and Prevention's National Center for Injury Prevention and Control annually records the numbers of unintentional injury deaths and the ages of the fatally injured persons (Centers for Disease Control and Prevention [CDC], 2000). Second, a recent meta-analysis of 331 medical examiner studies (Smith et al., 1999) from 1975-1995 revealed that 84% of unintentional nontraffic fatalities were tested for BACs. Of those tested, 38% had positive blood alcohol content, and 31% had BACs of 0.10% or higher, a level that would make them legally intoxicated in any state in the United States (Smith et al., 1999).

A third measure of deaths comes from the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS), which records all motor vehicle crash deaths in the United States (NHTSA, 1999) and calculates the proportion that are alcohol related and involved either a driver or pedestrian with a positive BAC. The ages of the 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 unavailable. The National Highway Traffic Safety Administration has used a linear discriminant model to estimate the probability that a driver or nonoccupant has a BAC in grams per deciliter (g/dl) of 0.00, 0.01 to 0.09, and 0.10 and greater. These estimates are generated only for drivers and nonoccupants (e.g., pedestrians or pedalcyclists) for whom alcohol test results were not reported. The model projects the likelihood of alcohol involvement based on characteristics of fatal traffic crashes and drivers most likely to involve alcohol (e.g., whether the crash involved a single vehicle or occurred on a weekend or at night, the driver's age, gender, lack of restraint use, and history of traffic violations). The approach was validated by comparing estimates to actual alcohol test results in states with the most comprehensive testing of persons in fatal crashes. State Annual state projections and actual test results have produced very similar estimates of the proportion of fatal crashes and persons in fatal crashes who were alcohol positive (Klein 1986). National estimates of alcohol involvement in fatal crashes using this method have been reported since 1982, and state and national estimates of alcohol traffic crash involvement have been used in numerous National Highway Traffic Safety Administration reports and scientific articles.

Calculation of numbers of college students aged 18-24

Data on the numbers of undergraduate college students in the United States ages 18-24 have been tabulated by the Department of Education's National Center for Education Statistics: Integrated Post Secondary Education Data System (National Center for Education Statistics, 1999). In 1997, of the 25,470,210 18-24 year olds living in the United States (Department of Commerce, 2000), 31% (8,000,106) were enrolled as full- or part-time students in either 2- or 4-year colleges: 21% (n = 5,320,295) in 4-year colleges and 10% (n = 2,679,811) in 2-year colleges. A majority (60%) of students enrolled in 4-year colleges were aged 18-24; nearly half (48%) of those enrolled in 2-year colleges fell in that age group.

The National Household Survey of Drug Abuse (NHSDA; described below) surveyed 18-24 year olds whether or not they were college students. The 18-24 year old 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. Based on those survey results, we projected that the proportions of traffic

and other unintentional injury nontraffic deaths positive for alcohol would be at least as high among college as among noncollege 18-24 year olds.

Because college students constitute 31% of 18-24 year olds in the United States, we estimate that 18-24 year old college students experience 31% of the traffic and other unintentional injury deaths experienced by the 18-24 year old U.S. population.

Calculation of students at risk

Based on the results of three national surveys and data on the numbers of 18-24 year old college students in the U.S., we estimated the numbers of college students that age who annually drive under the influence of alcohol and are unintentionally injured as a result of consuming alcohol. Three national surveys have explored patterns of drinking and risky behaviors that college students engage in after drinking: the National Household Survey on Drug Abuse (NHSDA; Department of Health and Human Services [DHHS], 2000); the CDC National College Health Risk Behavior Survey (NCHRBS; CDC, 1997); and the Harvard School of Public Health College Alcohol Survey (CAS; Wechsler et al., 2000).

The National Household Survey of Drug Abuse (NHSDA; SAMHSA, 2000) is the primary source of statistical information on the use of illegal drugs by the U.S. population. Sponsored by the Substance Abuse and Mental Health Services Administration (SAMHSA), the survey consists of computer-assisted interviews 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 NHSDA used an independent multistage area probability sample for each of the 50 states and the District of Columbia. Youths and young adults were oversampled so that each state's sample was approximately equally distributed among people aged 12-17, 18-25 and 26 and older. Across the United States, 169,166 addresses 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 aged 18-24, of whom 19,324 responded to the questions of interest. Of the latter, 6,930 (36%) were enrolled in college: 5,796 (30%) as full-time students and 1,134 (6%) as part-time students.

Respondents were asked how often they drank five or more alcoholic drinks on the same occasion in the past 30 days. They were also asked, "During the past 12 months . . . has your use of alcohol caused you to have any health problems? . . . have you driven a vehicle under the influence of alcohol? . . . have you received treatment or counseling for your use of alcohol?"

It should be noted that the NHSDA examines both full- and part-time students at both 2- and 4-year colleges, and represents students who live in dormitories, other college housing, fraternities and sororities. Results from this survey that are specific to college students have not been published previously.

The CDC National College Health Risk Behavior Survey United States 1995, a two-stage cluster sample design, produced a nationally representative sample of full- and part-time undergraduate college students ages 18 and older (CDC, 1997). From a list of 2- and 4-year colleges nationwide, 4-year (n = 74) and 2-year (n = 74) colleges were selected from 16 strata formed on the basis of the relative percentage of black and Hispanic students in the institutions. The schools were selected with probability proportional to undergraduate enrollment size. Of the 148 schools, 136 (92%) participated. Students at participating schools were randomly selected, and 65% (n = 4,838) of 7,442 eligible students completed mailed self-administered surveys. The overall response rate was 60%. The sample included 3,077 students ages 18 through 24 (63.6% of respondents). Respondents were asked whether, in the 30 days prior to the survey, they had ridden with a driver who had been drinking alcohol; drunk alcohol and driven a car or vehicle; or drunk alcohol while boating or swimming.

The Harvard School of Public Health College Alcohol Survey (*CAS*) began in 1993 with a sample of 140 colleges selected from a list of 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, another survey was conducted of students from 128 of the 140 original 4-year colleges. The inability of 10 colleges in 1997 and two 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 from 40 states, were surveyed; nearly half of these lived in dormitories, college housing, fraternities or sororities (response rate: 60%; Wechsler et al., 2000). 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

All three surveys (NHSDA, NCHRBS and CAS) presented weighted results that took into account their respective sample 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 (Shah, 1996). 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 appropriately account for sampling design.

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

Results

Alcohol-related unintentional injury deaths

As explained below, we estimate that in 1998 there were approximately 1,400 unintentional, alcohol-related fatal injuries among college students ages 18-24: approximately 1,100 traffic and 300 nontraffic unintentional, alcohol-related fatal injuries (Table 1).

TABLE 1. 1998 estimated U.S. 18-24 year old college student alcohol-related injury deaths

Alcohol-related motor vehicle crash deaths	
18-24 year-old alcohol-related motor vehicle crash deaths[a]	3,674
Percentage of 18-24 year olds who are college students[b]	31%
Number of 18-24 year old college student alcohol-related motor vehicle crash deaths	1,138
Alcohol-related unintentional, nontraffic deaths	
Number of 18-24 year old unintentional injury deaths[c]	10,052
Number of 18-24 year old motor vehicle crash deaths[d]	7,444
Percentage of unintentional nontraffic injury deaths that are alcohol related[d]	38%
Percentage of 18-24 year olds who are college students[b]	31%
Number of 18-24 year old college student alcohol-related unintentional injuries	307
Total	1,445

[a] NHTSA (1999), Fatal Analysis Reporting System (FARS) data. [b]National Center for Education Statistics (1999). [c]CDC Unintentional Injury Fatalities (2000). [d]Based on meta-analysis of 331 medical examiner studies.

Motor vehicle crash deaths

The NHSDA survey 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 five or more drinks on a single occasion in the past month (41.7% vs 36.5%) and drove under the influence of alcohol (26.5% vs 19.8%) (Table 2). Similar proportions of college students living in dormitories and other congregate residences (e.g., fraternities) reported driving under the influence of alcohol, relative to those not living in dormitories.

In 1998, in the United States, there were 3,674 alcohol-related traffic deaths among those aged 18-24 years (49% of 7,444 traffic fatalities in that age group). Based on the assumption that college students (31% of the U.S. population ages 18-24) experienced alcohol-related traffic deaths at the same rate as the entire 18-24 population, 1,138 (31%) of the 3,674 alcohol-related traffic deaths in that age group would have been college students.

Unintentional nontraffic deaths

In the NHSDA survey, 18-24 year old college students and same age noncollege students were equally likely to experience alcohol-related health problems (1.9% vs 2.0%) (Table 2). Furthermore, in the Harvard Survey (CAS), college students living in dormitories, sororities, fraternities and college residences were also as likely as other college students to have been injured while or after drinking. Only 1.4% of 18-24 year old college students were arrested in the past year for an alcohol-related offense and only 1.2% received alcohol or drug treatment. Among same age noncollege students, these percentages were 2.4% and 2.8%, respectively (Table 2).

According to the CDC, there were 10,052 unintentional injury deaths of persons ages 18-24 in 1998 (CDC, 2000). Subtracting traffic deaths (n = 7,444), there were 2,608 unintentional injury deaths from other causes (e.g., falls, drowning, burns, suffocation and unintentional gunshot wounds). If 38% were alcohol-related, as reported in national analyses of coroner studies (Smith et al., 1999), 991 persons ages 18-24 died from unintentional alcohol-related nontraffic injuries. In addition, if 31% of those fatal injuries occurred among college students, we can conclude that 307 college students died that year from alcohol-related nontraffic unintentional injury deaths.

Heavy episodic drinking

Table 3 summarizes the proportions and numbers of full- and part-time college students ages 18-24 in the NHSDA who had five or more drinks on an occasion at least once in the last 30 days. Approximately 42% (95% CI:

TABLE 2. Heavy episodic drinking and alcohol-related problems of 18-24 year olds in the 1999 NHSDA, according to whether or not they were in college

	College student 18-24 year olds (n = 6,930)				Noncollege student 18-24 year olds[a] (n = 12,394)			
Past year	Survey percent	95% CI	Projected number	95% CI	Survey percent	95% CI	Projected number	95% CI
Past month drank 5 or more drinks on a single occasion	41.7	39.7-43.6	3,319,893	3,160,656-3,471,159	36.5	35.6-37.3	6,376,587	6,228,514-6,524,662
Past year drove under the influence of alcohol	26.5	25.0-27.9	2,106,988	1,986,546-2,227,441	19.8	19.1-20.5	3,459,081	3,336,516-3,581,645
Past year arrested for alcohol-related offense	1.4	1.1-1.7	112,000	89,871-134,132	2.4	2.1-2.7	419,282	372,209-466,356
Past year received alcohol or drug treatment	1.2	0.9-1.6	98,584	71,067-126,101	2.8	2.5-3.1	489,163	438,422-539,904
Past year health problem related to alcohol	1.9	1.4-2.4	152,128	115,039-189,217	2.0	1.8-2.2	349,102	306,342-392,462

[a]This category includes 10,838 18-24 year olds who were definitely not enrolled in any college at the time of the survey and 1,556 18-24 year olds who did not answer questions related to their educational status.

39.7-43.6) of these students reported having five or more drinks on an occasion in the past 30 days, indicating that over 3.3 million of the 8 million college students ages 18-24 nationwide engaged in this behavior during the past 30 days.

Driving while intoxicated

Consistent with the alcohol-related mortality data, the most common alcohol-related health risks reported by college students in national surveys were riding with a drinking driver and driving after drinking. Table 4 provides results from the CDC National College Risk Behavior Survey (CDC, 2000). In the CDC survey, 38.9% (95% CI: 36.2-41.6) of college students ages 18-24 reported riding with a drinking driver during the previous month. Projected to the 8 million 2- and 4-year college students that age in the United States, an estimated 3.1 million students engage in this behavior each month. Nearly 28% (95% CI: 25.4-30.2) of college students this age in the CDC survey reported

TABLE 3. NHSDA heavy episodic (binge) drinking and alcohol-related problems among full- and part-time college students

	Survey percent[a]	95% CI	Projected number[b]	95% CI
Past month drank 5 or more drinks on a single occasion				
Full-time college	42.6	40.5-44.7	2,644,276	2,525,699-2,774,628
Part-time college	37.4	33.5-41.6	659,665	590,877-733,745
Total	41.7	39.7-43.6	3,319,893	3,160,666-3,471,159
Received alcohol or drug counseling treatment				
Full-time college	1.1	0.8-1.5	68,599	49,890-93,544
Part-time college	1.7	1.0-2.9	29,985	17,638-51,151
Total	1.2	0.9-1.6	98,584	71,067-126,101
Past year health problems because of alcohol				
Full-time college	2.1	1.6-2.7	130,962	99,781-168,380
Part-time college	1.2	0.6-2.2	21,166	10,583-38,804
Total	1.9	1.4-2.4	152,128	115,039-189,217
Past year drove under the influence of alcohol				
Full-time college	26.8	25.2-28.5	1,671,327	1,571,546-1,777,344
Part-time college	24.7	21.4-28.5	435,661	377,456-502,686
Total	26.5	25.0-27.9	2,106,988	1,986,536-2,227,441

[a]NHSDA college students 18-24 years old, n = 6,930. [b]U.S. college population 18-24 years old, n = 8,000,106.

TABLE 4. CDC National College Health Risk Behavior Survey: Alcohol-related risky behaviors

Past month	Survey percent[a]	95% CI	Projected number[b]	95% CI
Rode with a driver who had been drinking	38.9	36.2-41.6	3,112,041	2,896,038-3,328,044
Drank alcohol and drove a car or other vehicle	27.8	25.4-30.2	2,224,029	2,032,026-2,416,032
Drank alcohol while swimming or boating	21.7	19.7-23.6	1,736,023	1,576,020-1,888,025

[a]CDC college students 18-24 years old, n = 3,077. [b]U.S. college population 18-24 years old, n= 8,000,106.

driving after drinking in the month prior to the survey (i.e., an estimated 2.2 million college students ages 18-24).

In the NHSDA survey (SAMHSA, 2000), 26.5% reported driving under the influence of alcohol in the past year (95% CI: 25.0-27.9): an estimated 2.1 million college students (Table 2). Note that the different wording of the questions in the CDC and NHSDA surveys may account for the similarity in responses even though the time periods asked about were different.

Other alcohol-related problems

Table 3 provides percentages of college students ages 18-24 who reported in the NHSDA (SAMHSA, 2000) other alcohol-related social and health problems during the year prior to the 1999 survey. Just under 2% (1.9%) reported a health problem in the past year (95% CI: 1.4-2.4), representing 150,000 college students.

Table 5 reports alcohol-related health and social problems of full-time 4-year college students based on the CAS survey. In the Harvard CAS survey, 10.6% (95% CI: 10.1-11.1) reported being hurt or injured because of their drinking. Of the 5,320,295 4-year college students in the U.S., 4,758,636 are full-time students. Thus, we estimate just over 500,000 full-time 4-year college students were hurt or injured annually because of their drinking. Table 5 also lists problems that full-time students at 4-year colleges experienced in the past year because of other students' drinking. An estimated 630,000 students nationwide were assaulted or hit, a problem reported by 13.3% of respondents (95% CI: 12.7-13.9). In the CAS, 8.4% reported having unprotected sex because of drinking alcohol (95% CI: 7.9-8.9). This means that, in that year, nearly 400,000 full-time students nationwide may have had unprotected sex as a result of drinking. Over 70,000 were victims of a sexual assault or date rape, a problem reported by 1.5% of respondents (95% CI: 1.3-1.7)

Discussion

Methodologic issues

Whereas a small number of alcohol overdose deaths have drawn attention to college drinking problems, the number of unintentional alcohol-related injury deaths among 18-24 year-olds attending 2- and 4-year colleges probably exceeds 1,400 annually. In addition, the number of 4-year college students that are unintentionally hurt or injured under the influence each year may reach 500,000, and the number hit or assaulted by drinking college students is over 600,000.

TABLE 5. 1999 Harvard School of Public Health College Alcohol Survey (CAS): Full-time 4-year college students ages 18-24

	College percent[a]	95% CI	Projected number[b]	95% CI
SELECTED HEALTH AND SOCIAL PROBLEMS RELATED TO ALCOHOL				
Since the beginning of the school year has alcohol caused you to				
Be hurt or injured	10.6	10.1-11.1	504,415	480,622-528,209
Have unprotected sex	8.4	7.9-8.9	399,725	375,932-423,518
Have sexual intercourse when you were so intoxicated you were unable to consent	2.3	2.0-2.5	109,448	95,172-118,966
SELECTED HEALTH AND SOCIAL PROBLEMS EXPERIENCED BECAUSE OF OTHER STUDENTS' DRINKING				
Since the beginning of the school year have you experienced any of the following because of other students' drinking				
Been assaulted, pushed or hit	13.3	12.7-13.9	632,899	604,346-661,450
Been a victim of a sexual assault, date rape	1.5	1.3-1.7	71,379	61,862-80,987

[a]CAS full-time college students 18-24 years old, n = 12,317. [b]U.S. full-time 4-year college population 18-24 years old, n = 4,758,636.

These numbers are disturbingly high; however, for several reasons we believe our estimates are conservative.

First, the NHSDA rates of heavy episodic drinking and driving under the influence of alcohol were greater for college students than for same age noncollege students. Among college students, those living in dormitories reported driving under the influence in similar proportions to those who lived elsewhere. As a consequence, our projection that college and noncollege 18-24 year olds experience traffic injury deaths at the same rate per population was intended to be a conservative estimate for college students. The amount and circumstances of driving and driving after drinking by college students relative to same age noncollege students has not been studied; such research could help us test the validity of our assumption. The National Highway Traffic Safety Administration collects data in 22 states regarding the occupational and/or student status of persons fatally injured in traffic crashes. The results of such alcohol testing showed the same percentage of traffic fatalities for 18-24 year old college students and their noncollege counterparts.

Second, the meta-analyses of coroner studies (Smith et al., 1999) did not provide age-specific estimates of alcohol involvement in nontraffic unintentional injury deaths. Persons ages 18-24 are known to drink more than older adults. Also, in the 18-24 year old population a higher proportion of traffic fatalities are alcohol-related (49%) than among all age groups (38%). It is therefore possible that our estimate of the numbers of unintentional alcohol-related nontraffic injury deaths among 18-24 year old college students is also conservative.

Third, responses to survey questions may be subject to social desirability biases. Respondents may underreport some behaviors, particularly illegal behaviors (e.g., driving under the influence of alcohol or being arrested after drinking). If such is the case, the estimates of the magnitude of these problems among college students ages 18-24 may have been deflated.

Fourth, for consistency we calculated estimates and confidence intervals of the numbers of college students with alcohol-related problems for all three surveys, including NHSDA, based on the percentage of college respondents in each survey reporting a problem and on the numbers of college students 18-24 in the U.S. as recorded by the Department of Education. Using this approach, the numbers of students that we estimate had alcohol problems are lower than if we had used NHSDA population estimates.

Fifth, response rates for the NHSDA, the NCHRBS and the CAS were low. Thus, the students surveyed may under- or overrepresent the problems associated with alcohol. In order to examine the potential bias introduced by nonresponse in the CAS, a short form of the questionnaire was sent to nonresponding students in 1999. There was no significant difference in rates of past-year alcohol use for those who answered the short survey compared with those that responded to the entire questionnaire. Moreover, the rates of heavy episodic drinking and other substance use observed by the CAS were consistent with those obtained by other major national surveys (e.g., the Monitoring the Future Survey; Johnston et al., 2000). Comparisons between respondents and nonrespondents on the CAS were not made, however, on other variables (e.g., unprotected sex or injury after driving). Compared to the CDC-sponsored NCHRBS, the NHSDA produces lower estimates of substance use. These lower estimates are probably due to the fact that the NHSDA respondents are most often surveyed in the home, closer to parents or family members, compared with NCHRBS respondents who are surveyed in classrooms.

Sixth, this analysis focused only on college students ages 18-24. Because only 60% of 4-year college students and 48% of students at either 2- or 4-year colleges are ages 18-24, these estimates do not reflect all college students, but rather those in the age group at highest risk of alcohol-related problems. We have calculated estimates for all college students based on responses to the NHSDA study; they are available upon request.

We should note that none of the surveys that record students' consumption of five or more drinks on an occasion specifically asks the duration of those drinking occasions. The number of hours during which drinking occurred could influence respondents' blood alcohol content.

Implications

The magnitude of problems posed by excess college student drinking should stimulate both efforts to improve our measurement of these problems and interventions to reduce them. First, without consistent recording of blood alcohol concentrations and college-student status of people who die from motor vehicle and other unintentional injuries, the number of alcohol-related unintentional injury deaths involving college students can only be estimated based on examination of multiple data sources and acceptance of some underlying assumptions. No matter how cautious the assumptions used, it would be preferable to have direct systematic alcohol test results and consistent information on student status. Data systems must be improved to more accurately count and monitor over time the exact numbers of college students who die from unintentional and intentional injury deaths annually. Existing mortality data sets (e.g., the Department of Transportation's Fatality Analysis Reporting System [FARS] and the 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. Second, all motor vehicle and other unnatural deaths should be tested for alcohol (and other drugs if possible). In some states, this type of testing is done frequently; however, consistency of testing varies from state to state and even within the same state over time.

The most comprehensive testing is found among fatally injured drivers in traffic crashes. In 1999, 62% of fatally injured drivers had known alcohol test results and 21 states tested over 80% of driver fatalities. In contrast, only 25% of drivers who survived fatal crashes were tested and only two states tested 80% or more of surviving drivers in fatal crashes. Of the 56,352 drivers involved in fatal crashes nationwide in 1999, 31,142 (55%) survived the crash.

The testing rates are high enough in some states that statistical models based on crash factors, vehicle factors and person factors have been used to estimate overall alcohol involvement in fatal crashes in all states (Klein, 1986). This has proven invaluable to researchers seeking to study the effects of state level legislative interventions to reduce alcohol-related fatalities.

Testing needs to be increased in all types of injury and unnatural deaths so that similar types of analyses can be undertaken to explore policies and programs to reduce these and other types of alcohol-related deaths.

Interventions to reduce college drinking and related problems must also be strengthened. Individually oriented prevention and treatment strategies (Cronin, 1996, Darkes and Goldman, 1993, 1998; Fleming et al., 1997, 2000; Garvin et al., 1990; Gentilello et al., 1999; Marlatt et al., 1998; Monti et al., 1999), environmental alcohol regulations (Gruenewald et al., 1996; Kenkel and Manning, 1996; O'Malley and Wagenaar, 1991; Toomey et al., 1996), a variety of drunk-driving laws (Hingson et al., 1999; Voas et al., 2000), social norms marketing campaigns (DeJong and Linkenbach, 1999; Haines 1998) and comprehensive community campus interventions (Hingson et al., 1996; Holder et al., 2000; Wagenaar et al., 2000) appear to have reduced alcohol-related problems and traffic deaths among college-age populations. These initiatives should be expanded. Of college students with drinking problems, only a small minority recognizes problems, asks for treatment or is exposed to individually oriented programs shown in experimental studies to reduce drinking problems. Colleges and their surrounding communities nationwide should also consider (1) regulations to increase prices and reduce availability of alcohol, (2) a variety of drunk-driving laws and (3) comprehensive community interventions, all of which have been demonstrated to reduce alcohol consumption and related health problems among college-age students.

It is important that colleges and their surrounding communities collaborate in these efforts. College restrictions regarding on-campus drinking absent parallel community support may simply push problematic drinking off campus. Community crackdowns, if not supported by colleges, similarly can drive drinking problems back onto the campus. Although a higher percentage of college students than same age noncollege students report heavy episodic drinking and driving under the influence of alcohol, the absolute numbers of 18-24 year-olds who engage in these behaviors are greater among noncollege students because only 31% of persons that age attend college. Whereas 3.3 million 18-24 year old college students engage in episodic heavy drinking each month, 6.4 million same age noncollege students engage in that behavior. Whereas 2.1 million 18-24 year old college students drove under the influence of alcohol in the past year, so, too, did 3.3 million noncollege 18-24 year-olds. Whereas over 1,400 18-24 year old college students died in 1998 from alcohol-related unintentional and motor vehicle injuries, more than 3,200 18-24 year olds not in college died from the same causes. It is to be hoped that heightened attention to problems posed by excessive alcohol consumption will stimulate initiatives and policy changes to protect all 18-24 year old young adults from these consequences. Moreover, it would be most useful to involve college students and other young adults in campus/community collaborations. If college students and other young adults are represented in these efforts, they may be less likely to regard the policies and programs developed and implemented as authoritarian and more likely to accept new programs and policies to reduce college drinking problems.

Dedication

This article is dedicated to the memory of Jonathan Levy and Dr. Margaret Moore, student and faculty member, respectively, of Radford College in Virginia, who died on October 31, 1997, in separate vehicles involved in a crash caused by a college student alleged to have been driving while intoxicated. Travis Steadman, also a college student at the time, survived the crash despite sustaining severe injuries.

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