

# Magnitude and Trends in Heavy Episodic Drinking, Alcohol-Impaired Driving, and Alcohol-Related Mortality and Overdose Hospitalizations Among Emerging Adults of College Ages 18–24 in the United States, 1998–2014

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**ABSTRACT. Objective:** This article estimates percentages of U.S. emerging adults ages 18–24 engaging in past-month heavy episodic drinking and past-year alcohol-impaired driving, and numbers experiencing alcohol-related unintentional injury deaths and overdose hospitalizations between 1998 and 2014. **Method:** We analyzed national injury mortality data from coroner, census, and college enrollment statistics, the National Survey on Drug Use and Health, and the Nationwide Inpatient Sample. **Results:** From 1999 to 2005, percentages of emerging adults ages 18–24 reporting past-month heavy episodic drinking rose from 37.1% to 43.1% and then declined to 38.8% in 2014. Alcohol-impaired driving rose from 24% to 25.5% and then declined to 16.0%. Alcohol-related unintentional injury deaths increased from 4,807 in 1998 to 5,531 in 2005 and then declined to 4,105 in 2014, a reduction of 29% per 100,000 since 1998. Alcohol-related traffic deaths increased from 3,783

in 1998 to 4,114 in 2005 and then declined to 2,614 in 2014, down 43% per 100,000 since 1998. Alcohol-related overdose deaths increased from 207 in 1998 to 891 in 2014, a 254% increase per 100,000. Other types of nontraffic unintentional injury deaths declined. Alcohol-overdose hospitalizations rose 26% per 100,000 from 1998 to 2014, especially from increases in alcohol/other drug overdoses, up 61% (alcohol/opioid overdoses up 197%). **Conclusions:** Among emerging adults, a trend toward increased alcohol-related unintentional injury deaths, heavy episodic drinking, and alcohol-impaired driving between 1998 and 2005 was reversed by 2014. Persistent high levels of heavy episodic drinking and related problems among emerging adults underscore a need to expand individually oriented interventions, college/community collaborative programs, and evidence-supported policies to reduce their drinking and related problems. (*J. Stud. Alcohol Drugs*, 78, 540–548, 2017)

IN 2002, A TASK FORCE CONVENED BY the National Advisory Council of the National Institute on Alcohol Abuse and Alcoholism (NIAAA) released a report titled *A Call to Action: Changing the Culture of Drinking on U.S. College Campuses* (NIAAA, 2002). An article (Hingson et al., 2002) commissioned by the task force estimated that more than 1,400 students ages 18–24 enrolled in 2- and 4-year colleges died in 1998 from alcohol-related unintentional injuries, including traffic crashes. Of the 8 million U.S. college students in that year, 3.8 million consumed five or more drinks on an occasion in the past month and more than 2 million drove under alcohol's influence. College students were more likely than same-age nonstudents to engage in heavy episodic drinking (five or more alcoholic drinks on any occasion in the past 30 days) and drive under alcohol's influence. However, because most 18- to 24-year-olds were not in college, they accounted for more alcohol-related deaths. Among all 18- to 24-year-olds, there were 4,808 alcohol-related unintentional injury deaths.

In an update, Hingson et al. (2009) estimated that, from 1998 to 2005, alcohol-related unintentional injury deaths per

100,000 college students ages 18–24 increased 3%, to 1,825. The percentage of 18- to 24-year-old college students reporting driving under alcohol's influence increased from 26.5% to 28%, and the proportion reporting consumption of five or more drinks on an occasion in the past month increased from 41.7% to 44.7%. Because many more 18- to 24-year-olds were not in college, the total number of alcohol-related unintentional injury deaths for the entire 18–24 age group was 5,534. This underscores the need to examine trends in the magnitude of alcohol-related unintentional injury deaths among all 18- to 24-year-olds, not just college students.

This report assesses potential changes in heavy episodic drinking, driving under alcohol's influence, and alcohol-related mortality and overdose hospitalizations among U.S. college students and other emerging adults ages 18–24, extending the analysis to 2014, the most recent year of available data.

## Method

To estimate the number of alcohol-related traffic and other unintentional injury deaths in 1998, 2001, 2005, 2008, 2011, and 2014 among 18- to 24-year-olds in the United States, including full- and part-time students attending 2- and 4-year colleges, it was necessary to integrate information from multiple data sets. This is because the National High-

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way Traffic Safety Administration's (2016) Fatality Analysis Reporting System (FARS) does not routinely record whether persons who die in alcohol-related traffic crashes are college students. In addition, people who die from other types of unintentional injuries are not systematically tested for blood alcohol concentrations (BACs), and college student status is not recorded. The following data sources were examined.

First, the Centers for Disease Control and Prevention's Web-Based Injury Statistics Query and Reporting System (2016) annually records the number and ages of unintentional injury deaths, but not whether these deaths are alcohol related.

Second, a meta-analysis (Smith et al., 1999) of 331 medical examiner studies from 1975 to 1995 indicated that 84% of unintentional nontraffic injury deaths were tested for BAC. This meta-analysis provides the best-available estimates for alcohol involvement in injury deaths (other than traffic crash deaths), but it does not provide information on annual changes in the proportions of those deaths that are alcohol related. Of those tested by medical examiners, 38% had BACs of .01% or higher. The proportions of unintentional injury decedents who tested positive for alcohol at a BAC of .01% or higher varied by injury types: 37.9% for burns/fires; 90.0% for cold/hypothermia; 49.2% for drowning; 63.3% for falls; 48.7% for gunshots; 26.6% for poisoning by solid, liquid, or gas; and 38.5% for all other unintentional nontraffic injury deaths. These percentages were used to estimate these specific types of alcohol-related nontraffic injury deaths in 1998, 2001, 2005, 2008, 2011, and 2014.

Third, FARS (National Highway Traffic Safety Administration, 2016) records all traffic crash deaths in the United States and estimates the proportion that are alcohol related, defined as involving a driver or pedestrian with a BAC of .01% or higher. Decedent ages and BACs are recorded. An imputational formula estimated alcohol involvement in those crashes for which test results were not available (Subramanian, 2002).

Fourth, according to the U.S. Census Bureau (U.S. Department of Commerce, 2016), the numbers of 18- to 24-year-olds living in the United States were 26,055,861 in 1998; 27,992,652 in 2001; 29,441,546 in 2005; 30,194,274 in 2008; 30,094,473 in 2011; and 31,464,158 in 2014, a 21% proportionate increase since 1998. The U.S. Department of Education (2016) estimated that, in those same years, the numbers and percentages enrolled as full- or part-time college students in 2- or 4-year colleges were, respectively, 8,224,909 (32%); 9,262,206 (33%); 10,120,702 (34%); 10,905,315 (36%); 12,017,624 (40%); and 11,758,664 (37%), a 43% proportional increase from 1998 to 2014.

Of the students enrolled as undergraduates in 1998, 2001, 2005, 2008, 2011, and 2014, 62%, 58%, 54%, 57%, 57%, and 61%, respectively, were ages 18–24.

Fifth, data from the Nationwide Inpatient Sample (Agen-

cy for Healthcare Research and Quality, 2016) estimated the number of 18- to 24-year-olds hospitalized for alcohol overdoses alone and in combination with other drugs between 1998 and 2014 using methods outlined in White et al. (2011). NIS is the largest inpatient data set in the United States, containing data on approximately 8 million discharges each year.

NIS approximates a 20% sample of U.S. community hospitals, as defined by the American Hospital Association. Sampling strata were U.S. region, urban or rural location, teaching status, ownership and control, and bed size. With sampling weights, NIS estimates national statistics on hospitalizations. The unit of NIS was individual discharge records, and the procedures for case selection were the same as those used in White et al. (2011).

Sixth, we analyzed the Substance Abuse and Mental Health Services Administration's (SAMHSA) National Survey on Drug Use and Health (NSDUH) in 1999, 2001, 2005, 2008, 2011, and 2014 (SAMHSA, 2000, 2002, 2006, 2009, 2012, 2015, 2016). These surveys are the primary U.S. source for statistical information on illegal drug use. Computer-assisted interviews were conducted with representative U.S. population samples age 12 and older, including residents of households and noninstitutional group quarters (e.g., shelters, rooming houses, and dormitories) and civilians living on military bases. Each survey used independent, multi-area probability samples for each of the 50 states and the District of Columbia (SAMHSA, 2015). Youths and young adults were oversampled so that each state's sample was approximately equally distributed among persons ages 12–17, 18–25, and 26 and older.

In the NSDUH of 1999, 169,166 mailing addresses nationwide were screened, and 66,706 persons interviewed. The weighted response rates for households screened and interviewed were 89.6% and 68.6%. The sample included 19,463 respondents ages 18–24, of whom 6,930 (36%) were college students. In 2005, 68,308 persons from 134,055 household units were interviewed. The in-person and household response rates were 82% and 91%. In 2008, 68,736 persons were interviewed, with in-person and household response rates of 74.4% and 89%. In 2011, 70,109 respondents from 156,048 houses were interviewed, with in-person and household response rates of 87% and 74.4%. In 2014, 67,901 respondents from 127,605 houses were interviewed, with in-person and household response rates of 81.9% and 71.2%.

In each NSDUH, respondents were asked how often they engaged in heavy episodic drinking and if they drove a vehicle in the previous year under alcohol's influence. Because, in all the NSDUHs, 18- to 24-year-old college students were more likely than noncollege counterparts to report driving under alcohol's influence, we conservatively projected that the proportions of traffic and other unintentional injury deaths testing positive for alcohol would be proportionate to the percentage of 18- to 24-year-olds in college and not in college.

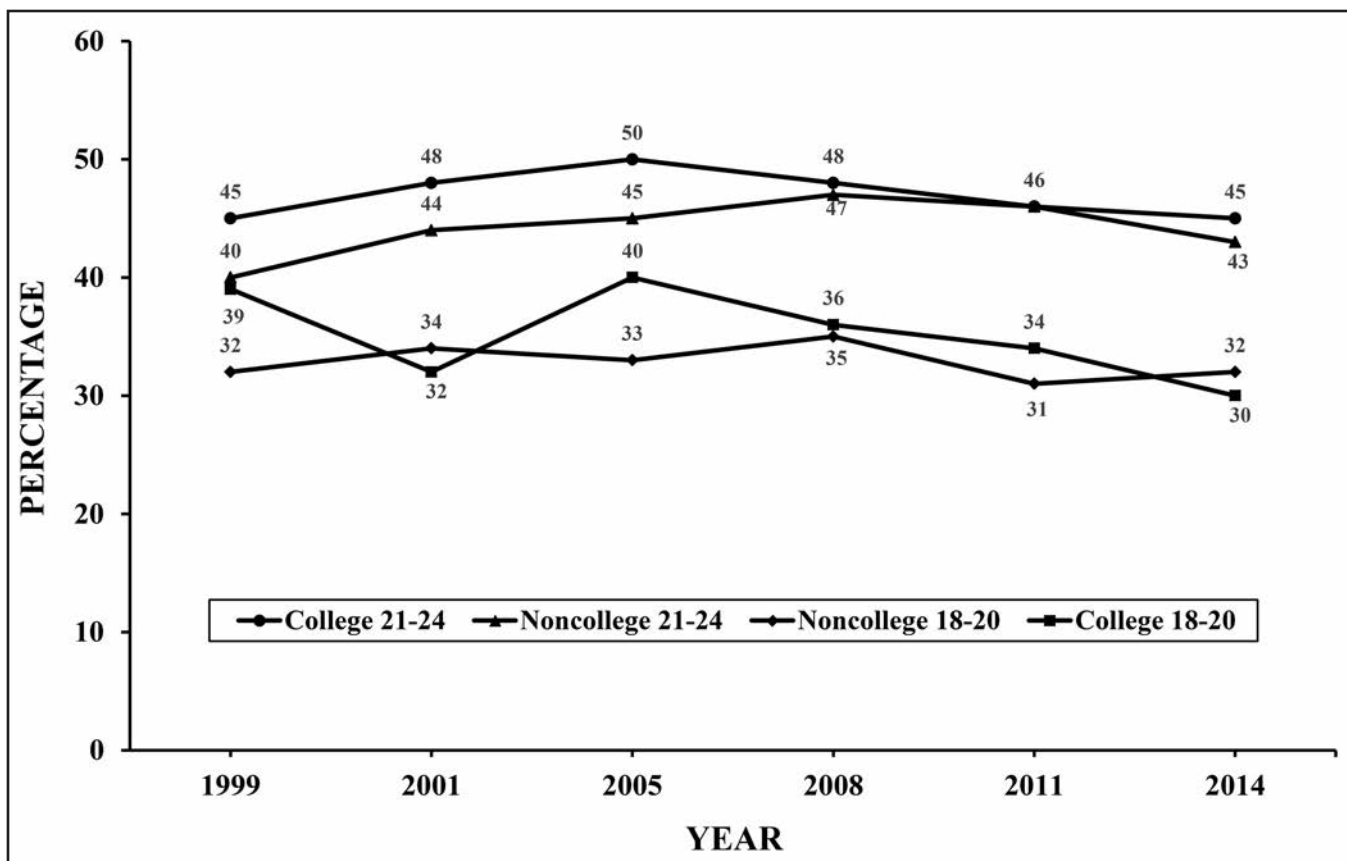


FIGURE 1. Past month heavy episodic drinking among those ages 18–20 versus 21–24 and college versus not in college. Source: National Survey on Drug Use and Health (Substance Abuse and Mental Health Services Administration, 2000, 2002, 2006, 2009, 2012, 2015, 2016).

### Statistical analyses of surveys

For the NSDUHs, statistical estimates for the surveys were conducted using the SUDAAN (Research Triangle Institute, 2014) statistical package to account for each survey's design, response rates, and sampling weights.

We identified percentages of 18- to 24-year-olds in 2- and 4-year colleges and not in college who reported heavy episodic drinking as well as driving under alcohol's influence. To estimate the numbers of 18- to 24-year-olds and college and noncollege respondents who engaged in these behaviors, we then multiplied those percentages by the appropriate population count from census and Department of Education data of students enrolling in U.S. colleges (U.S. Department of Commerce, 2016; U.S. Department of Education, 2016).

## Results

### Heavy episodic drinking/driving under alcohol's influence

Based on the NSDUHs, from 1999 to 2005 proportions of 18- to 24-year-olds who engaged in past-month heavy episodic drinking increased from 37.1% in 1999 to 43.1% ( $p$

$= .03$ ) in 2005 but then declined to 38.8% in 2014 (not significant from 2005 to 2014). Figure 1 indicates that persons ages 21–24, above the legal drinking age, were more likely to report heavy episodic drinking than those ages 18–20. A higher percentage of 21- to 24-year-olds in college reported this behavior than persons that age not in college. For most years, those ages 18–20 in college were more likely to report heavy episodic drinking than noncollege counterparts.

In 1999 and 2005, a greater percentage of 18- to 24-year-old college versus noncollege respondents engaged in past-month heavy episodic drinking (41.7% vs. 36.2%,  $p = .03$ , in 1999 and 44.7% vs. 41.9%,  $p = .03$ , in 2005). In 2008, 2011, and 2014, greater percentages of noncollege than college student 18- to 24-year-olds engaged in heavy episodic drinking (43% vs. 41%,  $p = .01$ ; 41.4% vs. 39.8%,  $p = .01$ ; and 40% vs. 37.4%,  $p = .02$ , respectively). Because noncollege 18- to 24-year-olds greatly exceeded those in college, the number who engaged in heavy episodic drinking also exceeded the numbers of college students who did so in each year we examined. For example, the number of noncollege versus college heavy episodic drinkers ages 18–24 was 6,454,805 versus 3,429,787 in 1999 and 7,862,063 versus 4,397,866 in 2014.

From 1999 to 2005, the proportion of 18- to 24-year-olds

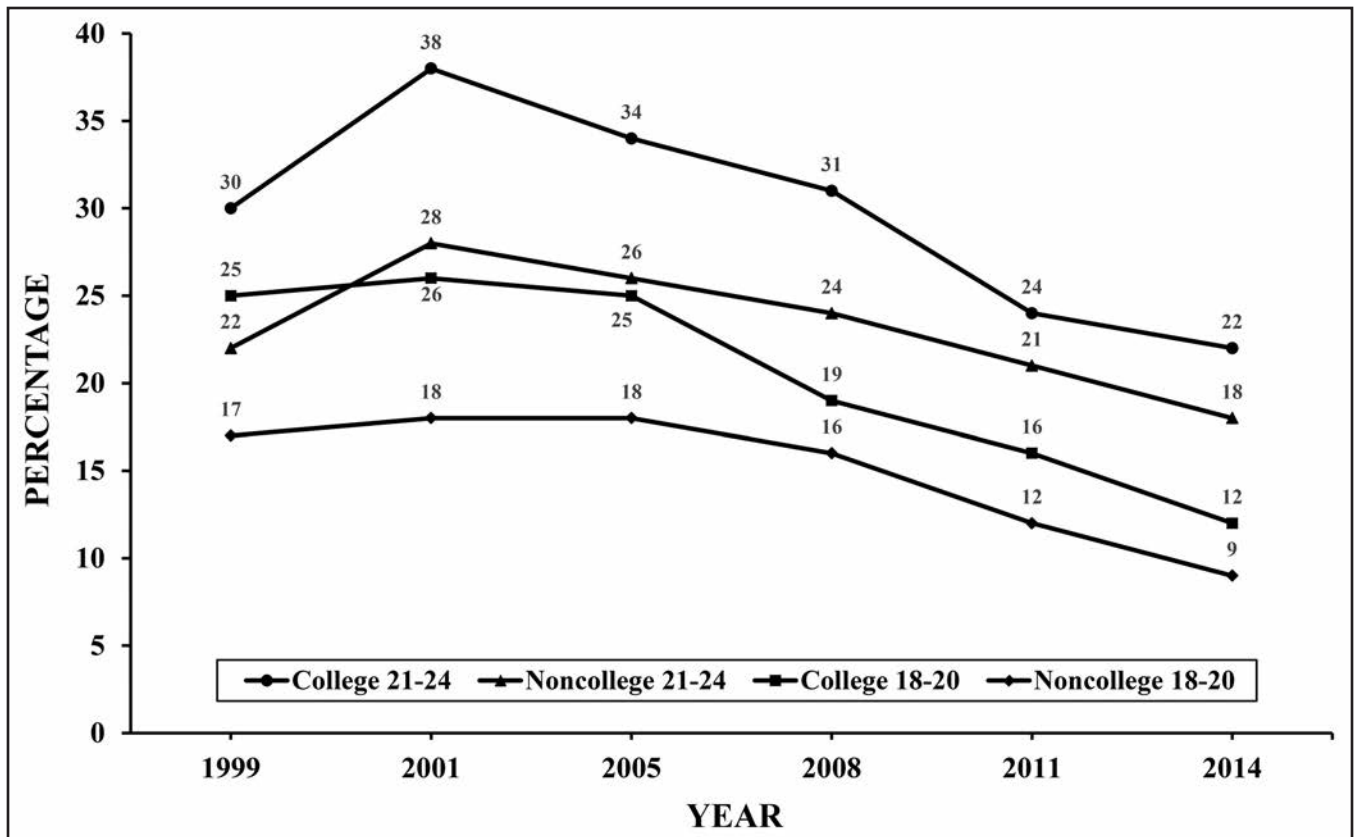


Figure 2. Past-year drove under the influence of alcohol, ages 18-20 versus 21-24 and college versus not in college. Source: National Survey on Drug Use and Health (Substance Abuse and Mental Health Services Administration, 2000, 2002, 2006, 2009, 2012, 2015, 2016).

who drove under alcohol’s influence increased significantly from 24% to 25.5%, a 6% proportional increase ( $p = .03$ ). In 2008, 2011, and 2014, the percentages declined to 23.2%, 19.1%, and 16%, respectively, a 37% proportional decline since 2005 ( $p < .01$ ). Similar patterns were observed among college and noncollege 18- to 24-year-olds.

From 1999 to 2005, there were significant proportional increases among college and noncollege 18- to 24-year-olds who drove under alcohol’s influence. However, differences in the rate of increase were not significant (7% vs. 10%,  $p = .21$ ). The numbers of 18- to 24-year-old alcohol-impaired drivers were 2,212,501 in 1999 and 2,924,966 in 2005, whereas the numbers of noncollege persons that age in those years were 3,494,868 and 4,405,084, respectively. By 2008, 2011, and 2014, the numbers of college respondents who drove under the influence declined to 2,557,191, 2,441,736, and 1,951,994, respectively, and the numbers of noncollege respondents who did so were 4,345,240, 3,471,058, and 3,054,299.

Figures 1 and 2 identify significantly greater increases from 1999 to 2005 in heavy episodic drinking as well as driving under alcohol’s influence among respondents ages 21–24 than 18–20 for both college and noncollege groups (all  $ps < .01$ ). Each year, a greater percentage of 21-

24-year-olds than 18- to 20-year-olds engaged in these behaviors ( $p < .05$ ). Among both 21- to 24-year-olds and 18- to 20-year-olds, college students were more likely than noncollege respondents to report these behaviors. In 2008, 2011, and 2014, there were greater declines in heavy episodic drinking as well as driving under alcohol’s influence among 18- to 20- and 21- to 24-year-old college students than those not in college ( $p = .04$ ).

*Total alcohol-related unintentional injury deaths*

Among 18- to 24-year-olds, we estimate that the total number of alcohol-related unintentional deaths, including traffic and other unintentional injuries, increased 2% per 100,000 from 4,807 in 1998 to 5,531 in 2005, then declined to 4,984, 4,404, and 4,105 in 2008, 2011, and 2014, a 29% decline per 100,000 since 1998.

Among 18- to 24-year-old college students, we estimate that deaths from all alcohol-related unintentional injuries, including traffic and other unintentional injuries, increased from 1,538 in 1998 to 1,881 in 2005, a 1% decrease per 100,000 (Table 1), and then declined to 1,794, 1,762, and 1,519 in 2008, 2011, and 2014, respectively, a 31% decline per 100,000 college students since 1998.

TABLE 1. Estimated number of alcohol-related injury deaths and rates per 100,000, United States, 18- to 24-year-olds in college and not in college: 1998–2014

Variable	1998	2001	2005	2008	2011	2014	Rate per 100,000			% change in rate per 100,000	
							1998	2005	2014	1998–2005	1998–2014
							1998	2005	2014	2005	2014
Population of 18- to 24-year-olds											
Total	26,055,861	27,992,652	29,441,546	30,194,274	30,094,473	31,464,158	–	–	–	–	–
In college	8,224,909	9,262,206	10,120,702	10,905,315	12,017,624	11,758,664	–	–	–	–	–
Not in college	17,830,952	18,730,446	19,320,844	19,288,959	18,076,849	19,705,494	–	–	–	–	–
% of 18- to 24-year-olds in college	32%	33%	34%	36%	40%	37%	–	–	–	–	–
No. of unintentional injury deaths (motor vehicle crash and nontraffic injury deaths)											
Total	9,962	11,102	12,503	11,530	10,380	10,087	38.23	42.47	32.06	+11%	-16%
Total: Alcohol related	4,807	5,307	5,531	4,984	4,404	4,105	18.45	18.79	13.05	+2%	-29%
College: Alcohol related	1,538	1,751	1,881	1,794	1,762	1,519	18.70	18.58	12.92	-1%	-31%
Not in college: Alcohol related	3,269	3,556	3,651	3,190	2,642	2,586	18.33	18.89	13.12	+3%	-28%
No. of motor vehicle crash deaths											
Total	7,452	8,253	8,510	7,159	5,789	5,489	28.60	28.90	17.45	+1%	-39%
Total: Alcohol related	3,783	4,219	4,114	3,518	2,884	2,614	14.52	13.97	8.31	-4%	-43%
College: Alcohol related	1,211	1,392	1,399	1,266	1,154	967	14.72	13.82	8.23	-6%	-44%
Not in college: Alcohol related	2,572	2,827	2,715	2,252	1,730	1,647	14.43	14.05	8.36	-3%	-42%
No. of unintentional nontraffic injury deaths											
Total	2,510	2,849	3,993	4,371	4,591	4,598	9.63	13.56	14.61	+41%	+52%
Total: Alcohol related	1,024	1,088	1,417	1,466	1,520	1,491	3.93	4.81	4.74	+22%	+21%
College: Alcohol related	328	359	482	528	608	552	3.98	4.76	4.69	+20%	+18%
Not in college: Alcohol related	696	729	935	938	912	939	3.91	4.84	4.77	+24%	+22%

Note: No. = number. Sources: U.S. Department of Commerce (2016), U.S. Department of Education (2016), National Highway Traffic Safety Administration (2016), Centers for Disease Control and Prevention (2016).

### Alcohol-related traffic deaths

From 1998 to 2014, alcohol-related traffic deaths per 100,000 among 18- to 24-year-olds declined 43%. Similar trends appeared among college and noncollege 18- to 24-year-olds. Among 18- to 24-year-olds, 51%, 48%, 49%, 50%, and 48% of traffic deaths were alcohol related in 1998, 2005, 2008, 2011, and 2014, respectively (Table 1).

Based on the deliberately conservative assumption (see the Method section) that college students (32% of the U.S. population of 18- to 24-year-olds in 1998 and 34% in 2005) experienced alcohol-related traffic fatalities at the same rate as the entire 18- to 24-year-old population, we estimate that, of the alcohol-related traffic deaths in that population, 1,211 in 1998 and 1,399 in 2005 were college students. In 2008, 2011, and 2014, 36%, 40%, and 37%, respectively, of 18- to 24-year-olds were college students, and we estimate that 1,266, 1,154, and 967 college students that age in those years died in alcohol-related traffic crashes.

### Alcohol-related unintentional nontraffic deaths

Table 1 indicates that the numbers of unintentional nontraffic injury deaths among 18- to 24-year-olds were 2,510 in 1998 and 3,993 in 2005. Those numbers increased to 4,371, 4,591, and 4,598 in 2008, 2011, and 2014, respectively. Compared with the 1998 data, the rates per 100,000 of

alcohol-related unintentional nontraffic injury deaths among 18- to 24-year-olds increased by 21% by 2014.

Table 2 estimates that the numbers of alcohol-related nontraffic injury deaths were 1,024, 1,417, 1,466, 1,520, and 1,491 in 1998, 2005, 2008, 2011, and 2014, respectively. If 32% of those deaths were among college students in 1998, 34% in 2005, 36% in 2008, 40% in 2011, and 37% in 2014, then the numbers of 18- to 24-year-old college students who died from alcohol-related unintentional nontraffic injuries was 328, 482, 528, 608, and 552 in 1998, 2005, 2008, 2011, and 2014, respectively. Relative to other unintentional injury deaths, alcohol-related poisoning deaths increased much more sharply—from 207 to 891—among 18- to 24-year-olds between 1998 and 2014, representing a 254% increase per 100,000. Alcohol-related unintentional injury deaths other than poisonings actually declined 40%.

### Alcohol-related overdose hospitalizations

Between 1998 and 2014 among 18- to 24-year-olds, hospitalizations for overdoses involving alcohol, including alcohol only and combined alcohol and other drugs, rose from 32,872 to 50,050, a 26% increase per 100,000, with a greater proportional increase involving alcohol and other drugs in combination (61%), particularly combined alcohol and opioids (197%) and combined alcohol and sedatives (241%) compared with alcohol only (1%). If college students

TABLE 2. Estimated number of total and alcohol-related unintentional injury deaths and rates per 100,000, United States, ages 18–24: 1998–2014

Variable	% alcohol related	1998		2001		2005		2008		2011		2014		Rate per 100,000		% change in rate per 100,000: Alcohol related 1998–2014
		Total	Alcohol related	Total	Alcohol related	Total	Alcohol related	Total	Alcohol related	Total	Alcohol related	Total	Alcohol related	1998	2014	
Burn/fire <sup>a</sup>	37.9	276	105	308	117	253	96	224	85	203	77	156	59	0.40	0.19	-53%
Cold/hypothermia	90.0	54	49	45	41	72	65	56	50	81	73	54	49	0.19	0.15	-21%
Drowning	49.2	568	279	418	206	480	236	425	209	417	205	391	192	1.07	0.61	-43%
Fall	63.3	185	117	222	141	202	128	206	130	170	108	155	98	0.45	0.31	-31%
Gunshot	48.7	174	85	153	75	151	74	96	47	102	50	124	60	0.33	0.19	-42%
Poisoning	26.6	779	207	1,220	325	2,290	609	2,949	784	3,240	862	3,351	891	0.80	2.83	+254%
Other	38.5	474	182	483	186	545	210	415	160	378	146	367	141	0.70	0.45	-36%
Total	–	2,510	1,024	2,849	1,088	3,993	1,417	4,371	1,466	4,591	1,520	4,598	1,491	3.93	4.74	+21%

Notes: <sup>a</sup>Includes residential fire/flame. Sources: Smith et al., 1999; Centers for Disease Control and Prevention (2016).

were hospitalized for alcohol overdoses according to their proportion of the 18- to 24-year-old population in 2014, then 22,219 college students were hospitalized for an alcohol overdose.

If people have co-occurring alcohol and other drug problems, their judgment may be impaired, contributing to consumption of greater and potentially more dangerous levels of both alcohol and other drugs, particularly combined alcohol and opioids and combined alcohol and sedatives. Further, alcohol can pharmacologically potentiate the effects of other drugs, especially sedatives and pain killers (White et al., 2011).

**Discussion**

Among 18- to 24-year-olds, from 1999 to 2005, the percentages of college students reporting heavy episodic drinking as well as driving under the influence proportionally increased 7%. Among noncollege respondents, the proportional increases were 10%. From 2005 to 2014, college student heavy episodic drinking declined from 45% to 37%, representing a 18% proportional decline, and driving under the influence declined from 29% to 17%, representing a 41% proportional decline. Among noncollege respondents between 1999 and 2014, heavy episodic drinking increased from 36% to 40%, representing an 11% proportional increase, whereas alcohol-impaired driving declined from 20% to 16%, representing a 20% proportional decline (SAMHSA, 2000, 2006, 2016). In parallel, 18- to 24-year-old alcohol-related crash deaths rose from 3,783 in 1998 to 4,114 in 2005, and then declined to 2,614, a 43% decline per 100,000 since 1998. Total alcohol-related unintentional injury deaths among 18- to 24-year-olds rose from 4,807 in 1998 to 5,531 in 2005 and then declined to 4,105 by 2014, 29% lower than 1998. Alcohol-related nontraffic deaths increased 21% per 100,000 from 1998 to 2014, primarily because alcohol poisoning deaths more than doubled.

Overdose hospitalization data suggest that combined alcohol and other drug overdoses, particularly opioids, contributed to the increase.

Several factors may help explain these trends. Nelson et al. (2010) reported that a national college dean survey revealed 80% were aware of NIAAA’s report titled *A Call to Action: Changing the Culture of Drinking at U.S. Colleges* (2002). However, only half had implemented evidence-supported interventions to reduce college student alcohol problems. Most implemented interventions were individually oriented, primarily screening and counseling the small percentages of students with alcohol or disciplinary infractions. Very few focused on environmental policies, such as minimum legal drinking age enforcement. Given the initial slow response to NIAAA’s report, it is not surprising that heavy episodic drinking, driving after drinking, and alcohol-related unintentional injury deaths continued to increase through 2005.

After 2005, evidence concerning the effectiveness of screening and brief counseling interventions grew. Scott-Sheldon et al.’s (2014) review of 62 brief college individual screening and counseling interventions indicated that evidence of effectiveness was so strong that every incoming college student should be screened for risky alcohol use, possibly motivating more colleges to expand the numbers and ranges of students offered these interventions. Also, new research indicated that multi-component college community interventions could achieve population decreases in episodes of heavy episodic drinking (Saltz et al., 2010) and reductions in college drinking problems and problems posed to other students because of drinking (Wolfson et al., 2012). NIAAA’s *CollegeAIM Alcohol Intervention Matrix* (2015) identified 60 interventions reported in scientific literature that reduced college drinking and related problems. Both individually oriented interventions and environmental policy interventions were identified. Possibly, as the intervention evidence accumulated and was disseminated, more colleges

expanded the reach and repertoire of their interventions. Of note, after 2005, estimates of college student heavy episodic drinking and alcohol-related unintentional injury deaths declined. During the same period, heavy episodic drinking among noncollege 18- to 24-year-olds increased. The body of literature about effective noncollege alcohol interventions is sparse and has not kept pace with college drinking-prevention research.

Numerous studies have shown that lowering legal BACs to .08% is associated with declines in alcohol-related traffic deaths (U.S. Department of Health and Human Services, 2016). After 2000, when Congress passed legislation that would withhold federal highway construction funds from states without .08% per se legislation, the number of states with such laws grew from 17 to 50.

The steep economic recession that began in 2008 may have also contributed to the declines in heavy episodic drinking, driving under the influence, and numbers of alcohol-related unintentional injury deaths. During a recession, people have less discretionary income to spend on alcohol and travel. Both alcohol- and non-alcohol-related traffic deaths declined among 18- to 24-year-olds. As the economy revives, it will be important to monitor college student heavy episodic drinking, driving under alcohol's influence, and alcohol-related unintentional injury death rates.

A disturbing development that began in the adult population in the early 1980s is the increase in drug overdose deaths, which by 2008 surpassed traffic deaths as the leading cause of injury deaths (White et al., 2011). This issue of alcohol and other drug overdose increases will require focused prevention research going forward to identify effective interventions, such as preventive education, screening and brief intervention counseling for both alcohol and other drug use (which have been found to reduce both alcohol and other drug use among emerging adults) (Tanner-Smith et al., 2015), and prescription drug monitoring.

### *Limitations*

As we noted in the Method section, the fatality data provided for 18- to 24-year-olds in college versus not in college are estimates. Most fatally injured drivers are tested for alcohol, permitting reliable estimates of alcohol-related traffic fatalities among 18- to 24-year-olds. However, it is not recorded whether those who died were college students. Our estimates of these deaths among college students are based on the conservative assumption that college students die in these traffic crashes at rates proportional to the percentage of college students in the population, even though considerably higher percentages of students report driving under the influence. For the most accurate counts, it would be preferable to have the college student status of these persons recorded in FARS. We also believe that all unintentional injury deaths should be tested for alcohol. Without consistent testing over

time, we can only estimate the numbers of alcohol-related injury deaths, and projected changes in these deaths over time should be interpreted cautiously.

A limitation of the method used to estimate alcohol involvement in nontraffic unintentional injury deaths is that we assumed that the proportion of each type of death that involved alcohol has not changed over time. This assumption may or may not be correct.

As we have noted, the rate per 100,000 of alcohol-related poisoning deaths among 18- to 24-year-olds more than doubled from 1998 to 2014. There have not been increases in other types of unintentional nontraffic injury deaths. However, when other substances are listed as the primary cause of a poisoning death, it is unknown whether the decedent may also have been drinking. The Sober Truth on Preventing Underage Drinking (STOP) Act, which Congress passed in 2006, and the *Surgeon General's Call to Action to Prevent and Reduce Underage Drinking* (U.S. Department of Health and Human Services, 2007) both recommend all injury deaths under age 21 be tested for alcohol. This would provide more accurate data on alcohol involvement in nontraffic injury deaths in that age group of the U.S. population.

We previously discussed limitations in our methods for estimating alcohol-related mortality among college students (Hingson et al., 2002, 2009; White & Hingson, 2014). We believe that our estimates of college student alcohol-related injury deaths in 1998, 2001, 2005, 2008, 2011, and 2014 are conservative for the following reasons: (a) we focused on college students ages 18–24, who comprise less than two thirds of all college students; (b) we did not include alcohol-related homicide and suicide deaths; (c) we estimated that nontraffic injury deaths among 18- to 24-year-olds are as likely to involve alcohol as those injury deaths among persons of all ages, although the prevalence of heavy episodic drinking is much higher among college students than the general adult population (in 2014, 53% of traffic deaths among 18- to 24-year-olds were alcohol related, compared with 33% in all other age groups); (d) we estimated that alcohol-related traffic deaths among 18- to 24-year-old college students occur at rates proportional to their percentage of the 18- to 24-year-old population, although a higher percentage of college students reported driving under alcohol's influence than 18- to 24-year-olds not in college; and (e) we estimated that nontraffic alcohol injury deaths among 18- to 24-year-old college students occur at a rate proportional to their percentage of the 18- to 24-year-old population, although a higher percentage of 18- to 24-year-old college students reported heavy episodic drinking than noncollege counterparts from 1998 to 2005.

### *Conclusion*

Despite limitations of our methods estimating alcohol-related mortality, since 2005, particularly among college

students, the rates of heavy episodic drinking, driving under the influence, and alcohol-related unintentional injury mortality have declined. Alcohol-related traffic deaths declined 45% per 100,000 from 2005 to 2014, and the numbers of alcohol-related unintentional deaths declined 34% per 100,000. Similar declines occurred among noncollege 18- to 24-year-olds.

However, for every 18- to 24-year-old in college, there are nearly two not in college. Furthermore, research has found that alcohol problems often begin before college. The younger students were when they first drank to intoxication, the greater the likelihood that, while in college, they will experience alcohol dependence, drive after drinking, ride with drinking drivers, and have alcohol-related injuries (Hingson et al., 2003a, 2003b).

A growing body of evidence indicates that a variety of individually oriented screening and counseling approaches, environmental alcohol policies and their enforcement, and comprehensive community/college cooperative interventions can reduce drinking and alcohol-related problems among college-age individuals and college students (Carey et al., 2007; Cronce & Larimer, 2011; DeJong & Blanchette, 2014; Fell et al., 2016; Hingson et al., 2005, 2014; Kilmer et al., 2014; Larimer & Cronce, 2007; NIAAA, 2002, 2007, 2015; Scott-Sheldon et al., 2014; Tanner-Smith & Lipsey, 2015; Toomey & Lenk, 2011; Toomey et al., 2007). Colleges and their surrounding communities must collaborate to expand implementation of these programs and policies to change the culture of drinking in emerging adults to optimize declines in alcohol-related problems.

## References

- Agency for Healthcare Research and Quality (Healthcare Cost and Utilization Project). (2016). *Nationwide Inpatient Sample*. Retrieved from <https://www.hcup-us.ahrq.gov/nisoverview.jsp>
- Carey, K. B., Scott-Sheldon, L. A. J., Carey, M. P., & DeMartini, K. S. (2007). Individual-level interventions to reduce college student drinking: A meta-analytic review. *Addictive Behaviors, 32*, 2469–2494. doi:10.1016/j.addbeh.2007.05.004
- Centers for Disease Control and Prevention. (2016, February 2). *Web-Based Injury Statistics Query and Reporting System*. Atlanta, GA: Author. Retrieved from <https://webappa.cdc.gov/sasweb/ncipc/mortrate.html>
- Cronce, J. M., & Larimer, M. E. (2011). Individual-focused approaches to the prevention of college student drinking. *Alcohol Research & Health, 34*, 210–221.
- DeJong, W., & Blanchette, J. (2014). Case closed: Research evidence on the positive public health impact of the age 21 minimum legal drinking age in the United States. *Journal of Studies on Alcohol and Drugs, Supplement 17*, 108–115. doi:10.15288/jsads.2014.s17.108
- Fell, J. C., Scherer, M., Thomas, S., & Voas, R. B. (2016). Assessing the impact of twenty underage drinking laws. *Journal of Studies on Alcohol and Drugs, 77*, 249–260. doi:10.15288/jsad.2016.77.249
- Hingson, R., Heeren, T., Winter, M. R., & Wechsler, H. (2003a). Early age of first drunkenness as a factor in college students' unplanned and unprotected sex attributable to drinking. *Pediatrics, 111*, 34–41. doi:10.1542/peds.111.1.34
- Hingson, R., Heeren, T., Winter, M., & Wechsler, H. (2005). Magnitude of alcohol-related mortality and morbidity among U.S. college students ages 18–24: Changes from 1998 to 2001. *Annual Review of Public Health, 26*, 259–279. doi:10.1146/annurev.publhealth.26.021304.144652
- Hingson, R. W., Heeren, T., Zakocs, R. C., Kopstein, A., & Wechsler, H. (2002). Magnitude of alcohol-related mortality and morbidity among U.S. college students ages 18–24. *Journal of Studies on Alcohol, 63*, 136–144. doi:10.15288/jsa.2002.63.136
- Hingson, R., Heeren, T., Zakocs, R., Winter, M., & Wechsler, H. (2003b). Age of first intoxication, heavy drinking, driving after drinking and risk of unintentional injury among U.S. college students. *Journal of Studies on Alcohol, 64*, 23–31. doi:10.15288/jsa.2003.64.23
- Hingson, R., & White, A. (2014). New research findings since the 2007 Surgeon General's Call to Action to Prevent and Reduce Underage Drinking: A review. *Journal of Studies on Alcohol and Drugs, 75*, 158–169.
- Hingson, R. W., Zha, W., & Weitzman, E. R. (2009). Magnitude of and trends in alcohol-related mortality and morbidity among U.S. college students ages 18–24, 1998–2005. *Journal of Studies on Alcohol and Drugs, Supplement 16*, 12–20. doi:10.15288/jsads.2009.s16.12
- Kilmer, J. R., Cronce, J. M., & Larimer, M. E. (2014). College student drinking research from the 1940s to the future: where we have been and where we are going. *Journal of Studies on Alcohol and Drugs, Supplement 17*, 26–35. doi:10.15288/jsads.2014.s17.26
- Larimer, M. E., & Cronce, J. M. (2007). Identification, prevention, and treatment revisited: Individual-focused college drinking prevention strategies 1999–2006. *Addictive Behaviors, 32*, 2439–2468. doi:10.1016/j.addbeh.2007.05.006
- National Highway Traffic Safety Administration. (2016). *Fatality Analysis Reporting System (FARS)*. Retrieved from <http://www.nhtsa.gov/FARS>
- National Institute on Alcohol Abuse and Alcoholism. (2002). *A call to action: Changing the culture of drinking at U.S. colleges*. NIH Publication No. 02–5010. Rockville, MD: Author.
- National Institute on Alcohol Abuse and Alcoholism. (2007). *What colleges need to know now: An update on college drinking research*. NIH Publication No. 07–5010. Rockville, MD: Author.
- National Institute on Alcohol Abuse and Alcoholism. (2015). *Planning alcohol interventions using NIAAA's CollegeAIM Intervention Matrix*. NIH Publication No. 15–AA–8017. Rockville, MD: Author.
- Nelson, T. F., Toomey, T. L., Lenk, K. M., Erickson, D. J., & Winters, K. C. (2010). Implementation of NIAAA College Drinking Task Force recommendations: How are colleges doing 6 years later? *Alcoholism: Clinical and Experimental Research, 34*, 1687–1693. doi:10.1111/j.1530-0277.2010.01268.x
- Saltz, R. F., Paschall, M. J., McGaffigan, R. P., & Nygaard, P. M. (2010). Alcohol risk management in college settings: The safer California universities randomized trial. *American Journal of Preventive Medicine, 39*, 491–499. doi:10.1016/j.amepre.2010.08.020
- Scott-Sheldon, L. A., Carey, K. B., Elliott, J. C., Garey, L., & Carey, M. P. (2014). Efficacy of alcohol interventions for first-year college students: A meta-analytic review of randomized controlled trials. *Journal of Consulting and Clinical Psychology, 82*, 177–188. doi:10.1037/a0035192
- Research Triangle Institute. (2014). *SUDAAN Language Manual Release 11.0*. Research Triangle Park, NC: Author.
- Smith, G. S., Branas, C. C., & Miller, T. R. (1999). Fatal non-traffic injuries involving alcohol: A meta-analysis. *Annals of Emergency Medicine, 33*, 659–668.
- Sober Truth on Preventing Underage Drinking (STOP) Act of 2006, Pub. L. 109-422, 120 Stat. 2890, 2891, 2892, 2893, 2894, 2895, 2896, 2897, 2898 and 2899, codified as 20 U.S.C. §1001, 21 U.S.C. §1521, and 42 U.S.C. §§290bb-25b.
- Subramanian, R. (2002). *Transitioning to multiple imputation: A new method to estimate missing blood alcohol concentration (BAC) values in FARS*. Technical Report No. DOT HS 809-403. Washington,

- D.C.: National Highway Traffic Safety Administration, Department of Transportation.
- Substance Abuse and Mental Health Services Administration. (2000). *Summary of findings of the 1999 National Household Survey on Drug Abuse*. DHHS Publication No. SMA 003466. Rockville, MD: Author.
- Substance Abuse and Mental Health Services Administration. (2002). *Results from the 2001 National Household Survey on Drug Abuse: Volume 1. Summary of national findings*. DHHS Publication No. SMA 02-3758. Rockville, MD: Author.
- Substance Abuse and Mental Health Services Administration. (2006). *Results from the 2005 National Survey on Drug Use and Health: National findings*. DHHS Publication No. SMA 06-4194. Rockville, MD: Author.
- Substance Abuse and Mental Health Services Administration. (2009). *Results from the 2008 National Survey on Drug Use and Health: National findings*. NSDUH Series H-36, HHS Publication No. SMA 09-4434. Rockville, MD: Author.
- Substance Abuse and Mental Health Services Administration. (2012). *Results from the 2011 National Survey on Drug Use and Health: Summary of national findings*. NSDUH Series H-44, HHS Publication No. SMA 12-4713. Rockville, MD: Author.
- Substance Abuse and Mental Health Services Administration. (2015). *Behavioral health trends in the United States: Results from the 2014 National Survey on Drug Use and Health*. HHS Publication No. SMA 15-4927, NSDUH Series H-50. Rockville, MD: Author.
- Substance Abuse and Mental Health Services Administration. (2016). Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2002–2005, 2006–2010, 2011–2014 (special data request).
- Tanner-Smith, E. E., Steinka-Fry, K. T., Hennessy, E. A., Lipsey, M. W., Winters K. C. (2015). Can brief alcohol interventions for youth also address concurrent illicit drug use? Results from a meta-analysis. *Journal of Youth Adolescence*, 44, 1011–1023.
- Tanner-Smith, E. E., & Lipsey, M. W. (2015). Brief alcohol interventions for adolescents and young adults: A systematic review and meta-analysis. *Journal of Substance Abuse Treatment*, 51, 1–18.
- Toomey, T. L., & Lenk, K. M. (2011). A review of environmental-based community interventions. *Alcohol Research & Health*, 34, 163–166.
- Toomey, T. L., Lenk, K. M., & Wagenaar, A. C. (2007). Environmental policies to reduce college drinking: An update of research findings. *Journal of Studies on Alcohol*, 68, 208–219. doi:10.15288/jsad.2007.68.208
- U.S. Department of Commerce (Census Bureau). (2016, April 8). Age & sex tables, 1998 through 2014. Retrieved from <https://www.census.gov/topics/population/age-and-sex/data/tables.2015.html>
- U.S. Department of Education (National Center for Education Statistics). (2016, April 8). Integrated Postsecondary Education Data System (IPEDS), “Fall Enrollment Survey” (IPEDS-EF:98-99), and IPEDS Spring 2001 through Spring 2015, Enrollment component (special data request).
- U.S. Department of Health and Human Services (HHS), Office of the Surgeon General. (2016). *Facing addiction in America: The Surgeon General's report on alcohol, drugs, and health*. Washington, DC: Author. Retrieved from <https://addiction.surgeongeneral.gov/surgeon-generals-report.pdf>
- U.S. Department of Health and Human Services. (2007). *The Surgeon General's call to action to prevent and reduce underage drinking*. Rockville, MD: Author. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK44360/>
- White, A., & Hingson, R. (2014). The burden of alcohol use: Excessive alcohol consumption and related consequences among college students. *Alcohol Research: Current Reviews*, 35, 201–218.
- White, A. M., Hingson, R. W., Pan, I.-J., & Yi, H.-Y. (2011). Hospitalizations for alcohol and drug overdoses in young adults ages 18–24 in the United States, 1999–2008: Results from the Nationwide Inpatient Sample. *Journal of Studies on Alcohol and Drugs*, 72, 774–786. doi:10.15288/jsad.2011.72.774
- Wolfson, M., Champion, H., McCoy, T. P., Rhodes, S. D., Ip, E. H., Blocker, J. N., . . . Durant, R. H. (2012) Impact of a randomized campus/community trial to prevent high-risk drinking among college students. *Alcoholism: Clinical and Experimental Research*, 36, 1767–1778. doi:10.1111/j.1530-0277.2012.01786.x