

# Driving After Drug or Alcohol Use by US High School Seniors, 2001–2011

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Motor vehicle crashes are a leading cause of mortality and morbidity among American youths.<sup>1</sup> Alcohol is often a factor in these crashes, and alcohol-impaired driving has long been a focus of attention. In recent years, rates of driving under the influence of alcohol among American youths have declined, but are still unacceptably high.<sup>2</sup> Impaired driving caused by use of substances other than alcohol has become an issue of increased concern. The National Institute on Drug Abuse commissioned a white paper on drugged-driving research,<sup>3</sup> and a recent National Drug Control Strategy includes a goal of reducing drugged driving in the United States by 10% by the year 2015.<sup>4</sup> Specifically, the Office of National Drug Control Policy aims to make preventing drugged driving a national priority on par with preventing drunk driving.<sup>5</sup>

The issue of drugs and driving has been of interest to the federal government for some time. The National Highway Traffic Safety Administration commissioned *Drug Use and Highway Safety*, a 101-page report published in 1971.<sup>6</sup> In 1977, the National Institute on Drug Abuse issued its 11th research monograph, *Drugs and Driving*.<sup>7</sup> The institute addressed the role of marijuana in driving in a 1980 research monograph.<sup>8</sup>

The National Highway Traffic Safety Administration conducted national roadside surveys of alcohol use by drivers in 1973, 1986, 1996, and 2007, but the 2007 survey was the first to include assessment of drug use.<sup>9</sup> The 2007 survey found a dramatic decline in the percentage of nighttime drivers with blood alcohol concentrations above the legal limit of 0.08% to 2.2%, down from 7.5% in 1973.<sup>10</sup> Among nighttime drivers, 16.3% tested positive for drugs, most often marijuana (8.6%). In another study by the traffic safety agency, data from the Fatal Accident Reporting System showed a rise in drug involvement in motor vehicle crashes.<sup>11</sup> A recent systematic review and meta-analysis of the role of a

**Objectives.** We examined prevalence, trends, and correlates of driving or riding after use of drugs or alcohol among US high school seniors from 2001 to 2011.

**Methods.** Data come from Monitoring the Future, an annual survey of nationally representative samples of high school seniors. We used logistic regressions with data from more than 22 000 respondents to examine multivariate associations with demographic and lifestyle factors.

**Results.** Large numbers of US high school seniors put themselves and others at great risk of harm by driving after using marijuana or other illicit drugs or drinking alcohol or by riding in a vehicle whose driver had used marijuana, other illicit drugs, or alcohol. Driving after drinking has declined in recent years, but driving after use of marijuana has increased. A higher percentage of students reported driving after using marijuana than after having 5 or more alcoholic drinks. Risky driving and riding behaviors differed little between demographic subgroups but considerably according to lifestyle factors.

**Conclusions.** Stronger efforts are needed to combat adolescent driving under the influence of illicit drugs. (*Am J Public Health.* 2013;103:2027–2034. doi:10.2105/AJPH.2013.301246)

comprehensive list of illicit or prescribed drugs in motor vehicle crashes found that most of the drugs were associated with increased risk.<sup>12</sup> Other studies have reported on the role of marijuana in crashes.<sup>13,14</sup> A recent systematic review of the association between marijuana use and risk of motor vehicle collision concluded that “acute cannabis consumption is associated with an increased risk of a motor vehicle crash, especially for fatal collisions.”<sup>15(p1)</sup>

Young drivers are particularly likely to be involved in motor vehicle crashes, so it is important to monitor their drug, drinking, and driving behaviors. We previously studied prevalence and trends in these behaviors among American high school seniors from 2001 to 2006 and concluded that impaired driving by youths remained a problem needing serious attention despite some modest progress in recent years.<sup>16</sup>

We analyzed data from 2001 through 2011 to answer the following questions about high school seniors:

- What changes are taking place in the percentage who drive after using marijuana,

using other illicit drugs, drinking any alcohol, or having 5 or more drinks?

- What changes are taking place in the percentage who ride in a vehicle whose driver has used marijuana, used other illicit drugs, drunk any alcohol, or had 5 or more drinks?
- What demographic and psychosocial characteristics are associated with these behaviors?
- What percentage of individuals who report driving after using marijuana also report driving after heavy drinking?
- What percentage of individuals who report driving after using marijuana are involved in accidents?

## METHODS

Our data came from the Monitoring the Future project, which has conducted annual surveys of nationally representative samples of American high school seniors since 1975. Survey procedures are described in detail elsewhere.<sup>17</sup> Nationally representative samples of about 17 000 12th-grade students, located in

about 135 schools, were selected each year through a multistage scientific sampling procedure. Confidential, self-completed questionnaires were administered during school hours, usually in a regularly scheduled class period, by professional interviewers employed by the University of Michigan. The questions on driving or riding after drinking or using drugs were included on only 1 of 6 forms, distributed in a random sequence within the classroom, so responses to these questions came from a random one sixth of the total sample of students. Questions on driving or riding in a motor vehicle after use of marijuana or other illicit drugs were added to the study in 2001, so we analyzed data from 2001 to 2011. Student response rates averaged 82% (range = 79%–85%); the great majority of nonresponse was attributable to absenteeism.

Driving and riding behaviors were assessed by the following questions:

During the last two weeks, how many times have you driven a car, truck, or motorcycle after . . . drinking alcohol? . . . having five or more drinks in a row? . . . smoking marijuana? . . . using other illicit drugs?

A second set of questions asked:

During the last two weeks, how many times (if any) have you been a passenger in a car . . . when the driver had been drinking? . . . when you think the driver had 5 or more drinks? . . . when the driver had been smoking marijuana? . . . when the driver had been using other illicit drugs?

Response categories were none, once, twice, 3 to 5 times, 6 to 9 times, and 10 or more times. We collapsed these into binary values (0 = none; 1 ≥ once). The questions did not assume that behaviors were mutually exclusive. For example, an individual could have driven after smoking marijuana and drinking heavily on the same occasion.

Two items asked about tickets or warnings for moving violations and being in an accident while driving:

Within the LAST 12 MONTHS how many times, if any, have you received a ticket (OR been stopped and warned) for moving violations, such as speeding, running a stop light, or improper passing?

During the LAST 12 MONTHS, how many accidents have you had while you were driving (whether or not you were responsible)?

Respondents were instructed not to include bumps or scratches in parking lots.

All demographic and lifestyle measures except geographic region and population density were obtained by self-report. Number of parents in the household indicated whether the respondent lived with zero, 1, or 2 parents or guardians. Parental education, a proxy for socioeconomic position (SEP), was derived from an average of 2 items (1 missing response allowed) about the amount of education achieved by parents (responses were completed grade school or less, some high school, completed high school, some college, completed college, and graduate or professional school after college). Religious commitment (high, medium, or low) was an average of 2 items (1 missing response allowed) assessing the importance of religion (responses were not important, a little important, pretty important, and very important) and frequency of attendance at religious services (never, rarely, 1–2 times/month, or ≥ 1 time/week). These 2 items were not asked of students in schools located in California, because of state regulations; thus we assigned all California students as missing data on this measure and treated this as a separate category.

Grade point average was the average during high school. Truancy was an average (categorized as none, low, medium, or high) of the frequency of skipping classes or whole days of school during the past 4 weeks. Evenings out was the number of evenings out for fun and recreation in a typical week (responses were < 1, 1, 2, 3, 4–5, and 6–7; we collapsed these into ≤ 1, 2, 3, ≥ 4). Hours worked was the average number of hours worked per week on a job during the school year (we categorized responses as 0, 1–15, 16–30, and > 30). Miles driven was the number of miles the respondent reported driving a car, truck, or motorcycle in an average week (we categorized responses as 0, 1–50, 51–100, and > 100). All of these measures of lifestyle factors have been used extensively in other studies. More details on their psychometric properties, particularly construct validity, are provided elsewhere.<sup>18</sup> We assigned geographic region according to US Census classifications of states into 4 regions: Northeast, Midwest, South, and West. We categorized population density according to US Census

statistical areas: large metropolitan, other metropolitan, and nonmetropolitan.

We chose all of these variables because of their inherent interest (e.g., gender) or because they have demonstrated associations with drug or alcohol use.<sup>19,20</sup> We weighted the data to adjust for differential probabilities of sample selection. We conducted logistic regressions for the multivariate analyses; these regressions took appropriate account of the complex sample design. For interpretation of trends over time, we ran logistic regressions with linear and quadratic terms for year.

## RESULTS

Table 1 provides the prevalence in 2001 to 2011 of various measures of driving after use of marijuana, other illicit drugs, and alcohol, as well as riding in a car when the driver had used marijuana, other illicit drugs, or alcohol.

The trend for driving after using marijuana was curvilinear, decreasing in the early years, then increasing in recent years; these results are consistent with trends in use of marijuana.<sup>21</sup> The trend for driving after using illicit drugs other than marijuana was essentially flat. The trend for driving after drinking any alcohol or 5 or more drinks was downward, again consistent with overall trends in those behaviors. The final measure, which combined use of illicit drugs and heavy drinking, reflected all these trends. The trends for being a passenger in a car with a driver who had used drugs or drunk alcohol followed similar patterns, as did the combination of driving and riding data.

Some of the percentages were disturbingly large: for example, more than a quarter (28%) of the class of 2011 reported that at least once in the past 2 weeks they were the driver or a passenger in a car when the driver had used marijuana or another illicit drug or had had 5 or more drinks. This measure had an even higher value in the class of 2001 (32%; difference significant at  $P < .05$ ). It is noteworthy that students in 2011 were distinctly (and significantly, by a test of differences in proportions) more likely to report driving (or riding) after using marijuana than after having 5 or more drinks. We observed these significant differences in 2001, but the differences had increased by 2011.

**TABLE 1—Trends in the Percentage of High School Seniors Who Reported Driving After Alcohol or Drug Use or Riding After Alcohol or Drug Use by the Driver: Monitoring the Future Survey, United States, 2001–2011**

Driver Substance Use	2001, %	2002, %	2003, %	2004, %	2005, %	2006, %	2007, %	2008, %	2009, %	2010, %	2011, % (95% CI)
Respondent driver after using:											
Marijuana	14.6	12.1	11.0	12.7	12.2	10.6	11.8	10.4	10.8	11.9	12.4 (10.4, 14.4)
Illicit drug <sup>a</sup>	3.1	3.2	2.3	3.3	2.1	2.3	3.2	2.3	1.9	3.0	2.4 (1.6, 3.1)
Alcohol	15.5	16.0	13.3	13.2	13.1	12.4	13.2	10.7	9.4	9.2	8.7 (7.5, 10.0)
Alcohol, ≥ 5 drinks	9.4	10.4	8.3	8.9	7.4	8.0	8.2	6.3	5.9	5.9	6.3 (5.1, 7.4)
Marijuana, illicit drugs, or ≥ 5 drinks	19.5	18.0	16.7	17.2	16.2	15.4	15.8	13.4	14.0	14.9	16.0 (14.1, 17.9)
Respondent passenger of driver who had used:											
Marijuana	21.7	19.9	17.1	17.9	17.2	17.8	17.5	15.7	16.7	19.2	20.4 (18.2, 22.6)
Illicit drug <sup>a</sup>	4.5	4.3	4.0	4.0	4.1	4.0	3.7	3.0	3.2	3.6	3.7 (2.7, 4.6)
Alcohol	23.7	21.8	20.5	18.3	19.4	19.5	18.0	16.6	15.6	16.7	15.2 (13.5, 16.8)
Alcohol, ≥ 5 drinks	14.6	13.0	10.8	10.4	10.5	9.7	9.9	7.5	8.3	8.4	7.2 (6.0, 8.4)
Marijuana, illicit drugs, or ≥ 5 drinks	26.7	25.4	23.0	21.9	21.9	21.8	21.6	19.4	20.4	22.3	23.3 (21.0, 25.5)
Respondent driver or passenger when driver had used:											
Marijuana	25.3	22.8	19.8	20.9	20.4	20.3	20.5	18.1	19.5	21.8	23.4 (21.0, 25.8)
Illicit drug <sup>a</sup>	5.6	5.4	4.9	5.3	4.9	4.8	4.9	3.8	3.9	5.1	4.6 (3.6, 5.7)
Alcohol	28.7	27.7	25.6	23.5	25.4	24.4	23.6	21.1	19.7	20.5	19.2 (17.4, 21.0)
Alcohol, ≥ 5 drinks	18.7	17.1	14.2	14.3	13.9	13.7	13.5	10.7	10.9	11.5	10.5 (8.9, 12.0)
Marijuana, illicit drugs, or ≥ 5 drinks	32.3	29.2	28.1	26.9	26.5	26.5	26.3	23.1	24.3	26.1	28.1 (25.7, 30.4)

Note. CI = confidence interval. Number of respondents averaged approximately 2000 per year.

<sup>a</sup>Other than marijuana.

### Demographic and Lifestyle Factors

Table 2 shows associations between various demographic and lifestyle factors and the measures of driving after using marijuana and driving after having 5 or more drinks for the years 2009 to 2011 combined (to increase the numbers of cases in subgroups). We treated all the independent variables as categorical to allow presentation of the percentages of each category reporting the behavior. Unadjusted and adjusted odds ratios (ORs) are shown; the former are from regressions with only the indicated variable and the latter are from regressions with all independent variables.

Young men were much more likely than young women to report driving after smoking marijuana at least once in the past 2 weeks (15% vs 9%;  $P < .001$ ). Having 2 parents in the home appeared to be protective, with rates of driving after smoking marijuana significantly higher for respondents with 1 or no parents in the home. Average parental education (or SEP), on the other hand, did not relate to driving after smoking marijuana. Race/ethnicity also did not relate significantly bivariate (unadjusted); however, in the multivariate

model, African American students were significantly more likely than White students to report this behavior (adjusted OR [AOR] = 1.8;  $P < .01$ ). Rates of driving after marijuana use did not vary significantly by region or population density. Overall, demographic factors were not very strongly associated with driving after marijuana, indicating that the behavior was fairly widespread throughout society.

By contrast with demographic factors, lifestyle factors were strongly associated with driving after marijuana use. Grades, truancy, evenings out, religious commitment, hours worked, and miles driven all had significant unadjusted ORs, with associations in the direction that would be expected with deviant or risky behavior. Most of the associations remained significant in the multivariate analyses, with the exception of hours worked per week, which became nonsignificant.

The associations between demographic and lifestyle factors and driving after heavy drinking were generally similar to those for driving after marijuana use. One exception was that the AOR for African Americans was not significant; that is, African American students

were significantly more likely than White students to report driving after smoking marijuana but not after having 5 or more drinks. The associations for religious commitment and grade point average were in the same direction for driving after both marijuana use and heavy drinking but were distinctly stronger for marijuana. Associations for driving after using other illicit drugs were generally similar in pattern to those for driving after smoking marijuana, although with fewer AORs reaching statistical significance (data not shown).

Table 3 shows associations between demographic and lifestyle factors and 2 other measures of risky vehicle behaviors: (1) driving after using marijuana or any other illicit drug or riding after the driver used marijuana or any other illicit drug and (2) driving after using marijuana or any other illicit drug or after having 5 or more drinks or riding after the driver had used marijuana or any other illicit drug or had 5 or more drinks. The table shows 2-week prevalence measures. After adjustment for other demographic and lifestyle factors, gender was not significantly associated with these measures. Average

**TABLE 2—Odds Ratios Predicting Driving After Marijuana Use and After Heavy Drinking Among High School Seniors: Monitoring the Future Survey, United States, 2009–2011**

Variable	Driving After Marijuana Use (n = 6161)			Driving After Heavy Drinking <sup>d</sup> (n = 6155)		
	%	OR <sup>b</sup> (95% CI)	AOR <sup>c</sup> (95% CI)	%	OR <sup>b</sup> (95% CI)	AOR <sup>c</sup> (95% CI)
<b>Gender</b>						
Female (Ref)	8.6	1.0	1.0	3.5	1.0	1.0
Male	14.5	1.8*** (1.5, 2.1)	1.3** (1.1, 1.6)	8.3	2.5*** (1.9, 3.3)	1.9*** (1.4, 2.5)
<b>Parents in household</b>						
2 (Ref)	10.4	1.0	1.0	5.6	1.0	1.0
1	13.3	1.3** (1.1, 1.6)	1.2 (0.9, 1.5)	5.4	1.0 (0.7, 1.3)	1.0 (0.7, 1.3)
0	17.1	1.8** (1.3, 2.5)	1.7* (1.1, 2.7)	11.7	2.2*** (1.5, 3.2)	2.1** (1.2, 3.5)
<b>Parental education, average</b>						
≤ grade school (Ref)	9.4	1.0	1.0	7.6	1.0	1.0
Some high school	12.2	1.3 (0.9, 1.9)	1.2 (0.7, 1.9)	6.1	0.8 (0.5, 1.2)	0.7 (0.4, 1.2)
Completed high school	12.0	1.3 (0.9, 1.9)	1.2 (0.7, 1.9)	5.5	0.7 (0.5, 1.1)	0.7 (0.4, 1.3)
Some college	12.4	1.4 (1.0, 1.9)	1.6 (1.0, 2.5)	5.9	0.8 (0.5, 1.1)	0.9 (0.5, 1.5)
≥ college	10.7	1.2 (0.8, 1.7)	1.3 (0.8, 2.3)	5.9	0.8 (0.5, 1.3)	0.9 (0.5, 1.7)
<b>Race/ethnicity</b>						
White (Ref)	11.8	1.0	1.0	6.5	1.0	1.0
African American	14.3	1.2 (0.9, 1.7)	1.8** (1.2, 2.7)	4.3	0.6* (0.4, 1.0)	0.6 (0.3, 1.1)
Hispanic	9.7	0.8 (0.6, 1.1)	0.9 (0.6, 1.3)	6.6	1.0 (0.7, 1.4)	1.0 (0.6, 1.7)
Other	11.6	1.0 (0.7, 1.3)	0.9 (0.6, 1.3)	4.5	0.7* (0.5, 1.0)	0.6* (0.4, 1.0)
<b>Region</b>						
West (Ref)	11.0	1.0	1.0	5.0	1.0	1.0
Northeast	11.0	1.0 (0.7, 1.4)	1.0 (0.7, 1.5)	4.4	0.9 (0.5, 1.5)	1.0 (0.5, 1.9)
Midwest	12.4	1.1 (0.9, 1.5)	1.2 (0.8, 1.7)	7.1	1.5* (1.0, 2.1)	1.7* (1.0, 3.0)
South	12.1	1.1 (0.8, 1.5)	1.2 (0.9, 1.8)	6.7	1.4 (1.0, 2.0)	1.7 (1.0, 3.0)
<b>Urbanicity</b>						
Large MSA (Ref)	11.9	1.0	1.0	6.0	1.0	1.0
Other MSA	11.8	1.0 (0.8, 1.2)	1.0 (0.8, 1.3)	5.8	1.0 (0.7, 1.3)	1.0 (0.7, 1.4)
Non-MSA	11.3	0.9 (0.7, 1.3)	1.1 (0.7, 1.5)	6.6	1.1 (0.8, 1.5)	1.1 (0.7, 1.7)
<b>Religious commitment</b>						
High (Ref)	6.5	1.0	1.0	3.8	1.0	1.0
Medium	12.7	2.1*** (1.6, 2.8)	1.9*** (1.4, 2.7)	7.0	1.9** (1.3, 2.9)	1.5 (1.0, 2.5)
Low	15.3	2.6*** (2.0, 3.4)	2.6*** (1.9, 3.7)	7.1	1.9*** (1.4, 2.8)	1.8** (1.2, 2.7)
Missing data <sup>d</sup>	10.4	1.7** (1.1, 2.4)	2.9*** (1.7, 4.8)	5.1	1.4 (0.8, 2.2)	1.9 (0.8, 4.3)
<b>Grade point average</b>						
A or A- (Ref)	7.5	1.0	1.0	4.6	1.0	1.0
B+ or B	11.0	1.5*** (1.2, 1.9)	1.9 (1.4, 2.7)	4.9	1.1 (0.7, 1.5)	0.9 (0.6, 1.3)
≤ B-	17.6	2.6*** (2.1, 3.3)	2.1*** (1.6, 2.7)	9.0	2.1*** (1.5, 2.9)	1.3 (0.9, 1.9)
<b>Truancy</b>						
None (Ref)	6.2	1.0	1.0	3.0	1.0	1.0
Low	12.4	2.2*** (1.6, 3.0)	1.9*** (1.4, 2.8)	5.1	1.7* (1.2, 2.6)	1.7* (1.1, 2.8)
Medium	19.3	3.6*** (2.7, 4.8)	3.0*** (2.2, 4.1)	9.1	3.3*** (2.3, 4.7)	2.7*** (1.8, 4.1)
High	27.8	5.8*** (4.4, 7.7)	4.2*** (3.0, 6.1)	17.4	6.9*** (4.9, 9.5)	5.1*** (3.3, 7.8)

Continued

TABLE 2—Continued

Evenings out, no./wk						
≤ 1 (Ref)	5.2	1.0	1.0	2.8	1.0	1.0
2	6.9	1.3 (1.0, 1.8)	1.2 (0.9, 1.7)	3.8	1.4 (0.9, 2.1)	1.4 (0.8, 2.2)
3	14.1	3.0*** (2.2, 4.0)	2.4*** (1.7, 3.3)	7.4	2.8*** (1.8, 4.2)	2.3** (1.4, 3.8)
≥ 4	23.0	5.4*** (4.1, 7.1)	3.5*** (2.6, 4.9)	10.8	4.2*** (2.9, 6.1)	2.6*** (1.7, 4.2)
Work, h/wk						
0 (Ref)	9.3	1.0	1.0	4.1	1.0	1.0
1–15	11.4	1.2 (1.0, 1.6)	1.2 (0.9, 1.6)	5.9	1.5* (1.1, 2.0)	1.3 (0.9, 1.9)
16–30	14.3	1.6*** (1.2, 2.1)	1.1 (0.8, 1.6)	7.4	1.9*** (1.4, 2.5)	1.3 (0.9, 2.0)
> 30	18.4	2.2*** (1.5, 3.2)	1.2 (0.8, 1.9)	12.6	3.4*** (2.0, 5.6)	1.7 (0.9, 3.0)
Driving, miles/wk						
0 (Ref)	4.6	1.0	1.0	2.7	1.0	1.0
1–50	9.4	2.1*** (1.6, 3.0)	2.8*** (1.9, 4.1)	4.1	1.5 (1.0, 2.4)	1.8* (1.1, 3.0)
51–100	14.0	3.4*** (2.4, 4.7)	3.6*** (2.4, 5.3)	6.7	2.6*** (1.8, 3.8)	2.3*** (1.4, 3.6)
> 100	19.6	5.1*** (3.7, 7.0)	4.7*** (3.2, 6.9)	11.4	4.6*** (3.1, 6.9)	3.3*** (2.0, 5.5)

Note. AOR = adjusted odds ratio; CI = confidence interval; MSA = metropolitan statistical area; OR = odds ratio. Results are for 2009 to 2011 data combined.

<sup>a</sup>Defined as ≥ 5 drinks.

<sup>b</sup>Unadjusted, bivariate result with 1 predictor.

<sup>c</sup>Multivariate result with all predictors.

<sup>d</sup>Data not collected in California because of state regulation.

\* $P < .05$ ; \*\* $P < .01$ ; \*\*\* $P < .001$ .

parental education had a somewhat curvilinear association. Number of parents was related: students living with neither of their parents were more likely to report both behaviors. African American students were more likely to report both behaviors, but the difference was significant only for drug and not for drug or alcohol use. Lifestyle factors related similarly to the behaviors reported in Table 2, generally significantly. (We selected the 2 measures shown in Table 3 as being of most interest; other possible measures, e.g., driving after using marijuana or other illicit drugs, are not shown because of space limitations.)

### Consequences of Dangerous Behaviors

Table 4 shows the percentages of students who drove after using marijuana or drinking heavily. Of the 15% who reported at least 1 of these behaviors, 59% reported driving after using marijuana but not after heavy drinking, 20% drove after heavy drinking but not after using marijuana, and 21% did both.

Table 4 also shows whether respondents who drove after using marijuana or drinking heavily, did both, or did neither received a ticket or warning in the past 12 months and whether they had been in an accident in the past 12 months. Students who reported driving

after smoking marijuana, drinking heavily, or both were significantly more likely than students who did neither to have received a ticket or warning for a moving infraction in the past 12 months and were significantly more likely to have been in an accident. However, the 3 groups did not differ significantly among themselves; 42% to 44% received a ticket or warning, and 27% to 32% had been in an accident. In other words, those who reported driving after smoking marijuana but not after heavy drinking were not significantly less likely to have received a ticket or warning or to have been in an accident than those who drove after drinking but not after using marijuana. The likelihood of being in an accident did not differ between these 2 groups even when we combined all data from 2001 to 2011.

### DISCUSSION

Perhaps our most important finding was that substantial numbers of America's high school seniors continue to put themselves and others at risk for harm. More than a quarter (28%) reported driving under the influence or riding in a vehicle with a driver who had used drugs or alcohol in just the past 2 weeks. The 2011 figure of 28% was down significantly

from 2001, when it was 32%. Alcohol use also decreased in this interval, and that may account for the decline in driving after substance use and riding with drivers who had used alcohol or drugs. Driving or riding after marijuana use was slightly lower in 2011 (23%) than in 2001 (25%), but this behavior increased in each of the last 3 years of the study period. Similarly, driving after smoking marijuana increased in each of the last 3 years in our data, from 10% in 2008 to 12% in 2011. This increase is particularly concerning, in light of evidence that marijuana has been implicated in dangerous driving.<sup>11,22–24</sup> A recent meta-analysis of 9 studies that met criteria suggested that driving under the influence of marijuana was associated with a significantly increased risk of a motor vehicle crash.<sup>15</sup>

The data in Tables 2 and 3 show that these risky behaviors are quite pervasive, occurring in all sociodemographic groups. Another indication that the behaviors are pervasive is that the intraclass correlations by school for driving after using alcohol or drugs were all between 2% and 3% (for 2011); in other words, 97% or more of the variation in the behaviors was within schools, and 3% or less was between schools, indicating that this behavior was not found in only a few schools.

**TABLE 3—Odds Ratios Predicting Driving After Alcohol or Drug Use or Riding With a Driver Who Had Used Alcohol or Drugs Among High School Seniors: Monitoring the Future Survey, United States, 2009–2011**

Variable	Driving After Drug Use or Riding With Driver Who Had Used Drugs <sup>a</sup> (n = 6111)			Driving After Drug or Alcohol Use or Riding With Driver Who Had Used Drugs or Alcohol <sup>b</sup> (n = 6107)		
	%	OR <sup>c</sup> (95% CI)	AOR <sup>d</sup> (95% CI)	%	OR <sup>c</sup> (95% CI)	AOR <sup>d</sup> (95% CI)
<b>Gender</b>						
Female (Ref)	18.8	1.0	1.0	21.9	1.0	1.0
Male	25.1	1.5*** (1.3, 1.7)	1.1 (1.0, 1.3)	29.8	1.5*** (1.3, 1.7)	1.2 (1.0, 1.4)
<b>Parents in household</b>						
2 (Ref)	19.6	1.0	1.0	23.6	1.0	1.0
1	25.4	1.4*** (1.2, 1.6)	1.2 (0.9, 1.4)	29.1	1.3*** (1.1, 1.5)	1.1 (0.9, 1.4)
0	33.3	2.0*** (1.5, 2.7)	2.1*** (1.4, 3.0)	37.8	2.0*** (1.5, 2.6)	2.0*** (1.4, 2.9)
<b>Parental education, average</b>						
≤ grade school (Ref)	19.8	1.0	1.0	24.2	1.0	1.0
Some high school	22.9	1.2 (0.9, 1.6)	1.2 (0.9, 1.6)	27.9	1.2 (0.9, 1.6)	1.2 (0.9, 1.6)
Completed high school	24.3	1.3* (1.0, 1.7)	1.4* (1.0, 1.8)	28.2	1.2 (1.0, 1.5)	1.3* (1.0, 1.7)
Some college	20.3	1.0 (0.8, 1.4)	1.3 (0.9, 1.8)	23.6	1.0 (0.8, 1.2)	1.2 (0.9, 1.7)
≥ college	20.4	1.0 (0.7, 1.5)	1.4 (1.0, 2.0)	23.5	1.0 (0.7, 1.3)	1.4 (1.0, 1.9)
<b>Race/ethnicity</b>						
White (Ref)	21.8	1.0	1.0	26.0	1.0	1.0
African American	26.5	1.3* (1.0, 1.7)	1.5* (1.1, 2.1)	27.8	1.1 (0.9, 1.4)	1.2 (0.9, 1.7)
Hispanic	21.4	1.0 (0.8, 1.3)	0.9 (0.7, 1.2)	27.1	1.1 (0.8, 1.3)	1.0 (0.8, 1.3)
Other	22.0	1.0 (0.8, 1.3)	0.8 (0.6, 1.1)	25.1	1.0 (0.8, 1.2)	0.8 (0.6, 1.1)
<b>Region</b>						
West (Ref)	22.8	1.0	1.0	26.5	1.0	1.0
Northeast	24.1	1.1 (0.8, 1.4)	1.1 (0.8, 1.7)	26.1	1.0 (0.8, 1.3)	1.0 (0.7, 1.5)
Midwest	21.5	0.9 (0.7, 1.2)	1.1 (0.8, 1.5)	26.3	1.0 (0.8, 1.3)	1.2 (0.8, 1.6)
South	21.7	0.9 (0.7, 1.2)	1.1 (0.8, 1.5)	26.0	1.0 (0.8, 1.2)	1.1 (0.8, 1.5)
<b>Urbanicity</b>						
Large MSA (Ref)	23.0	1.0	1.0	26.6	1.0	1.0
Other MSA	22.9	1.0 (0.8, 1.2)	1.0 (0.8, 1.3)	26.7	1.0 (0.8, 1.2)	1.0 (0.8, 1.3)
Non-MSA	19.9	0.8 (0.7, 1.0)	1.0 (0.8, 1.3)	24.7	0.9 (0.7, 1.1)	1.1 (0.8, 1.4)
<b>Religious commitment</b>						
High (Ref)	12.7	1.0	1.0	15.3	1.0	1.0
Medium	23.7	2.1*** (1.7, 2.7)	1.8*** (1.4, 2.4)	28.6	2.2*** (1.8, 2.7)	1.9*** (1.5, 2.4)
Low	27.4	2.6*** (2.1, 3.2)	2.4*** (1.8, 3.0)	31.6	2.5*** (2.1, 3.1)	2.4*** (1.9, 2.9)
Missing data <sup>e</sup>	23.9	2.2*** (1.6, 3.0)	2.7*** (1.9, 4.0)	27.8	2.1*** (1.6, 2.8)	2.6*** (1.8, 3.8)
<b>Grade point average</b>						
A or A- (Ref)	14.6	1.0	1.0	17.4	1.0	1.0
B+ or B	22.3	1.7*** (1.4, 2.0)	1.4*** (1.2, 1.7)	26.7	1.7*** (1.5, 2.1)	1.5*** (1.2, 1.8)
≤ B-	31.8	2.7*** (2.3, 3.3)	2.0*** (1.6, 2.4)	36.6	2.7*** (2.3, 3.3)	2.0*** (1.6, 2.4)
<b>Truancy</b>						
None (Ref)	12.6	1.0	1.0	15.7	1.0	1.0
Low	24.8	2.3*** (1.8, 2.9)	2.0*** (1.5, 2.6)	29.3	2.2*** (1.8, 2.8)	2.0*** (1.5, 2.6)
Medium	35.7	3.9*** (3.1, 4.8)	3.1*** (2.4, 3.9)	41.2	3.7*** (3.0, 4.6)	2.9*** (2.3, 3.7)
High	48.4	6.5*** (5.1, 8.3)	4.8*** (3.6, 6.4)	47.2	6.0*** (4.7, 7.5)	4.3*** (3.3, 5.7)

Continued

TABLE 3—Continued

Evenings out, no./wk						
≤ 1 (Ref)	11.8	1.0	1.0	14.4	1.0	1.0
2	16.8	1.5*** (1.2, 1.9)	1.4** (1.1, 1.8)	20.9	1.6*** (1.3, 2.0)	1.5*** (1.2, 1.9)
3	24.6	2.4*** (1.9, 3.1)	2.3*** (1.8, 3.0)	29.1	2.4*** (2.0, 3.0)	2.3*** (1.8, 3.0)
≥ 4	39.2	4.8*** (3.9, 6.0)	4.0*** (3.0, 5.2)	43.9	4.6*** (3.8, 5.7)	3.8*** (2.9, 4.9)
Work, h/wk						
0 (Ref)	19.2	1.0	1.0	22.0	1.0	1.0
1–15	22.1	1.2* (1.0, 1.4)	1.3* (1.0, 1.5)	25.7	1.2* (1.0, 1.4)	1.3** (1.1, 1.5)
16–30	25.6	1.4*** (1.2, 1.8)	1.2 (0.9, 1.5)	31.2	1.6*** (1.4, 1.9)	1.3* (1.0, 1.6)
> 30	28.5	1.7*** (1.2, 2.3)	1.0 (0.7, 1.5)	35.1	1.9*** (1.5, 2.5)	1.2 (0.9, 1.7)
Driving, miles/wk						
0 (Ref)	18.5	1.0	1.0	21.2	1.0	1.0
1–50	19.4	1.1 (0.8, 1.3)	1.2 (0.9, 1.5)	22.4	1.1 (0.9, 1.3)	1.2 (0.9, 1.5)
51–100	22.3	1.3* (1.0, 1.6)	1.2 (0.9, 1.5)	26.5	1.3** (1.1, 1.6)	1.2 (1.0, 1.6)
> 100	29.7	1.9*** (1.5, 2.3)	1.5** (1.1, 1.9)	35.9	2.1*** (1.7, 2.6)	1.7*** (1.3, 2.3)

Note. AOR = adjusted odds ratio; CI = confidence interval; MSA = metropolitan statistical area; OR = odds ratio. Results are for 2009 to 2011 data combined.

<sup>a</sup>Marijuana or other illicit drugs.

<sup>b</sup>Marijuana or other illicit drugs or ≥ 5 alcoholic drinks.

<sup>c</sup>Unadjusted, bivariate result with 1 predictor.

<sup>d</sup>Multivariate result with all predictors.

<sup>e</sup>Data not collected in California because of state regulation.

\**P* < .05; \*\**P* < .01; \*\*\**P* < .001.

Male students were much more likely than female students to report driving after smoking marijuana or drinking heavily, but we observed no significant differences by gender in driving or riding after use of marijuana or other illicit drugs or after a driver smoked marijuana, used other illicit drugs, or consumed 5 or more alcoholic drinks. This presumably is attributable to the likelihood that young women ride as passengers in male-driven vehicles. Both genders are putting themselves at a similar risk of harm.

Driving after marijuana use or heavy drinking did not vary much by levels of SEP, as

indicated by parental education, but we found some slight curvilinear association between SEP and driving or riding after substance use: students with low and high SEPs had lower rates. The relatively few students (7%) who reported living with neither a father nor a mother were significantly more likely to report all 4 behaviors.

After we controlled for all other demographic and lifestyle factors, African American students were significantly more likely to report driving after smoking marijuana. The factors that revealed this association were

religious commitment and miles driven. African Americans reported higher-than-average religious commitment and lower mileage; adjustment for these variables produced a significant association with driving after marijuana use.

Although demographic factors generally did not relate strongly to driving under the influence of drugs, lifestyle factors certainly did. Students with strong religious commitment and good grades were much less likely than average to drive after using drugs or drinking alcohol. Students who engaged in more than an average amount of truancy, spent more evenings out for fun and recreation, worked more hours per week, or drove more miles were all more likely than average to report driving after drugs or alcohol.

### Limitations

Our data were cross-sectional, precluding causal interpretations. The data were derived from self-reports of behaviors, many of which were illegal or deviant, which could cause over- or underreporting. However, the Monitoring the Future procedures were designed to provide optimal conditions to maximize valid reporting.<sup>25</sup> Respondents were assured of complete confidentiality. Questionnaires were

TABLE 4—Percentage of High School Seniors Who Received Tickets or Were Involved in Accidents When Driving After Marijuana Use and After Heavy Drinking: Monitoring the Future Survey, United States, 2009–2011

Substance Use Before Driving	%	Ticket or Warning, %	Accident, %
Marijuana, not heavy drinking <sup>a</sup>	8.6	42.1	26.9
Heavy drinking, <sup>a</sup> not marijuana	2.9	43.2	30.2
Both <sup>b</sup>	3.1	43.8	32.0
Neither	85.4	20.2	16.3
Total	100.0	23.4	18.0

Note. Results are for 2009 to 2011 data combined.

<sup>a</sup>Defined as ≥ 5 alcoholic drinks.

<sup>b</sup>Not necessarily on the same occasion.

administered in group settings in school by University of Michigan representatives who had no affiliation with the school. All responses were to close-ended questions with pencils provided by the administrators, who followed elaborate procedures to convey to respondents that their data would be well protected. Students absent on the day of the survey administration were not included; such students would likely have higher rates of driving or riding after drug use or drinking.<sup>17</sup>(Appendix A) Thus, the rates we reported were likely to be underestimates of the entire population of high school seniors.

It would have been interesting to ascertain the degree of impairment that drivers had, but the survey asked only whether they drove after using drugs or drinking alcohol. It would also have been of interest to ascertain the extent to which students used alcohol and drugs in combination. The relative risk of serious injury or death has been found to be increased in the presence of combinations of alcohol and drugs.<sup>26</sup>

## Conclusions

Despite some considerable progress in reducing driving under the influence of alcohol or riding with a driver who has been drinking, driving or riding after marijuana use is on the rise. It is also ubiquitous throughout society, socioeconomically and geographically. We hope that our presentation of timely and valid data on the extent of this problem will help focus attention on finding solutions. ■

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## Contributors

P. M. O'Malley conducted the analyses and wrote the first draft of the article. L. D. Johnston helped interpret the findings and write the article.

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## Human Participant Protection

All procedures were reviewed and approved by the University of Michigan's institutional review board.

## References

- National Center for Statistics and Analysis. *Traffic Safety Facts 2009: A Compilation of Motor Vehicle Crash Data From the Fatality Analysis Reporting System and the General Estimates System*. Washington, DC: National Highway Traffic Safety Administration; 2011. DOT HS 811 402.
- Centers for Disease Control and Prevention. Vital signs: drinking and driving among high school students aged  $\geq 16$  years—United States, 1991–2011. *MMWR Morb Mortal Wkly Rep*. 2012;61(39):796–800.
- DuPont RL. *Drugged Driving Research: A White Paper*. Rockville, MD: National Institute on Drug Abuse, Institute for Behavior and Health; 2011.
- Office of National Drug Control Policy. 2013 National drug control strategy. Available at: <http://www.whitehouse.gov/ondcp/2013-national-drug-control-strategy>. Accessed April 24, 2013.
- Office of National Drug Control Policy. Drugged driving. 2013. Available at: <http://www.whitehouse.gov/ondcp/drugged-driving>. Accessed April 24, 2013.
- Nichols JL. *Drug Use and Highway Safety: A Review of the Literature*. Washington, DC: National Highway Traffic Safety Administration; 1971.
- Willette RE, ed. *Drugs and Driving*. Washington, DC: National Institute on Drug Abuse; 1977. NIDA Research Monograph 11.
- McBay AJ, Owens SM. Marijuana and driving. In: Harris LS, ed. *Problems of Drug Dependence, 1980*. Washington DC: National Institute on Drug Abuse; 1981:257–263. NIDA Research Monograph 34.
- Lacey JH, Kelley-Baker T, Voas RB, et al. Alcohol- and drug-involved driving in the United States. *Eval Rev*. 2011;35(4):319–353.
- Compton R, Berning A. *Traffic Safety Facts: Results of the 2007 National Roadside Survey of Alcohol and Drug Use by Drivers*. Washington, DC: National Highway Traffic Safety Administration; 2008.
- National Center for Statistics and Analysis. *Drug Involvement of Fatally Injured Drivers*. Washington, DC: National Highway Traffic Safety Administration; 2010.
- Elvik R. Risk of road accident associated with the use of drugs: a systematic review and meta-analysis of evidence from epidemiological studies. *Accid Anal Prev*. Epub ahead of print July 9, 2012.
- Fergusson DM, Horwood LJ, Boden JM. Is driving under the influence of cannabis becoming a greater risk to driver safety than drink driving? Findings from a longitudinal study. *Accid Anal Prev*. 2008;40(4):1345–1350.
- Li M-C, Brady JE, DiMaggio CJ, Lusardi AR, Tzong KY, Li G. Marijuana use and motor vehicle crashes. *Epidemiol Rev*. 2012;34(1):65–72.
- Asbridge M, Hayden JA, Cartwright JL. Acute cannabis consumption and motor vehicle collision risk: systematic review of observational studies and meta-analysis. *BMJ*. 2012;344:e536.
- O'Malley PM, Johnston LD. Drugs and driving by American high school seniors, 2001–2006. *J Stud Alcohol Drugs*. 2007;68(6):834–842.
- Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE. *Monitoring the Future National Survey Results on Drug Use, 1975–2009. Secondary School Students*. Vol 1. Bethesda, MD: National Institute on Drug Abuse; 2010.
- Bachman JG, O'Malley PM, Johnston LD. *Correlates of Drug Use: Part 1. Selected Measures of Background, Recent Experiences, and Lifestyle Orientations*. Ann Arbor, MI: Institute for Social Research; 1980. Occasional paper 8.
- Brown TN, Schulenberg JE, Bachman JG, O'Malley PM, Johnston LD. *Consistency and change in correlates of youth substance use, 1976–1997*. Ann Arbor, MI: Institute for Social Research; 2001. Occasional paper 49.
- Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE. *Monitoring the Future National Results on Adolescent Drug Use: Overview of Key Findings, 2010*. Ann Arbor, MI: Institute for Social Research; 2011.
- Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE. *Monitoring the Future National Results on Adolescent Drug Use: Overview of Key Findings, 2011*. Ann Arbor, MI: Institute for Social Research; 2012.
- Mura P, Kintz P, Ludes B, et al. Comparison of the prevalence of alcohol, cannabis and other drugs between 900 injured drivers and 900 control subjects: results of a French collaborative study. *Forensic Sci Int*. 2003;133(1–2):79–85.
- Romano E, Voas RB. Drug and alcohol involvement in four types of fatal crashes. *J Stud Alcohol Drugs*. 2011;72(4):567–576.
- Mura P, Chatelain C, Dumestre V, et al. Use of drugs of abuse in less than 30-year-old drivers killed in a road crash in France: a spectacular increase for cannabis, cocaine and amphetamines. *Forensic Sci Int*. 2006;160(2–3):168–172.
- Johnston LD, O'Malley PM. Issues of validity and population coverage in student surveys of drug use. In: Rouse BA, Kozel NJ, Richards LG, eds. *Self-Report Methods of Estimating Drug Use: Meeting Current Challenges to Validity*. Rockville, MD: National Institute on Drug Abuse; 1985:31–54.
- Schulze H, Schumacher M, Urmeew R, Auerbach K. *Driving Under Influence of Drugs, Alcohol, and Medicines: Final Report*. Bergisch Gladbach, Germany: Federal Highway Research Institute; 2012.