

# Alcohol and Marijuana Use Patterns Associated With Unsafe Driving Among U.S. High School Seniors: High Use Frequency, Concurrent Use, and Simultaneous Use

YVONNE M. TERRY-McELRATH, M.S.A.,<sup>a,\*</sup> PATRICK M. O'MALLEY, PH.D.,<sup>a</sup> AND LLOYD D. JOHNSTON, PH.D.<sup>a</sup>

<sup>a</sup>*Institute for Social Research, University of Michigan, Ann Arbor, Michigan*

**ABSTRACT. Objective:** This article examines noncausal associations between high school seniors' alcohol and marijuana use status and rates of self-reported unsafe driving in the past 12 months. **Method:** Analyses used data from 72,053 students collected through annual surveys of nationally representative cross-sectional samples of U.S. 12th-grade students from 1976 to 2011. Two aspects of past-12-month alcohol and marijuana use were examined: (a) use frequency and (b) status as a non-user, single substance user, concurrent user, or simultaneous user. Measures of past-12-month unsafe driving included any tickets/warnings or accidents, as well as tickets/warnings or accidents following alcohol or marijuana use. Analyses explored whether an individual's substance use frequency and simultaneous use status had differential associations with their rate of unsafe driving. **Results:** Higher substance use frequency

(primarily alcohol use frequency) was significantly and positively associated with unsafe driving. The rate of engaging in any unsafe driving was also significantly and positively associated with simultaneous use status, with the highest rate associated with simultaneous use, followed by concurrent use, followed by use of alcohol alone. Individuals who reported simultaneous use most or every time they used marijuana had the highest likelihood of reporting unsafe driving following either alcohol or marijuana use. **Conclusions:** This article expands the knowledge on individual risk factors associated with unsafe driving among teens. Efforts to educate U.S. high school students (especially substance users), parents, and individuals involved in prevention programming and driver's education about the increased risks associated with various forms of drug use status may be useful. (*J. Stud. Alcohol Drugs*, 75, 378–389, 2014)

MOTOR VEHICLE CRASH RISK is higher among adolescents ages 16–19 years than among any other U.S. age group (Centers for Disease Control and Prevention [CDC], 2012b). Per mile driven, these adolescents are four times more likely than older drivers to be in a fatal crash (Insurance Institute for Highway Safety, 2012). American adolescents are at high risk for unsafe driving because of factors such as driving under the influence, speeding, tailgating, low seatbelt use, underestimating dangerous situations, and distracted driving (CDC, 2012b; U.S. Department of Transportation [USDOT], 2010, 2012b). In 2009, individuals younger than 20 years of age comprised 5% of all licensed drivers (Federal Highway Administration, 2011) yet accounted for 10% of drivers involved in fatal crashes and 14% of drivers involved in police-reported crashes (USDOT, 2012b).

As noted, substance use plays a key role in adolescent unsafe driving, most notably via psychopharmacological impairment. In 2006, 18% of high school seniors reported driving after drinking alcohol or using illicit drugs at least

once in the prior 2 weeks (O'Malley and Johnston, 2007). In 2010, alcohol-impaired driving fatalities accounted for almost one third of total U.S. motor vehicle fatalities (USDOT, 2012a); of all drivers with blood alcohol concentration levels of .08 or higher in fatal crashes, 18% were ages 16–20 years (USDOT, 2012a). Research indicates that marijuana use also is associated with significant driving impairment and increased motor vehicle collisions, injuries, and fatalities (Asbridge et al., 2012; Calabria et al., 2010; Hall and Degenhardt, 2009; Kelly et al., 2004; Li et al., 2012; Ramaekers et al., 2004; Sewell et al., 2009). Cannabinoids have been found in more than 40% of fatally injured drivers younger than age 24 years who tested positive for illicit substances (Office of National Drug Control Policy, 2012). Studies indicate simultaneous alcohol and marijuana (SAM) use (i.e., use of both substances in combination at the same time; Collins et al., 1998; Earleywine and Newcomb, 1997) results in greater driving impairment than using either substance alone (Kelly et al., 2004; Ramaekers et al., 2004; Sewell et al., 2009). Specifically, SAM use has been associated with “severe impairment of cognitive, psychomotor, and actual driving performance in experimental studies and sharply increased the crash risk in epidemiological analyses” (Ramaekers et al., 2004, p. 109). American adolescents are at high risk for SAM use; in 2011, 23% of high school seniors reported past-12-month SAM use (Terry-McElrath et al., 2013).

Substance use is a risk factor associated with a higher likelihood of unsafe driving in general. Marijuana use frequency in 10th grade significantly predicted later rates of se-

Received: May 30, 2013. Revision: September 17, 2013.

The Monitoring the Future study (Lloyd Johnston, principal investigator) is supported by National Institute on Drug Abuse Grant DA01411. The study sponsor had no role in (a) study design; (b) the collection, analysis, and interpretation of data; (c) the writing of the report; or (d) the decision to submit the manuscript for publication. The views expressed in this article are those of the authors and do not necessarily reflect the views of the sponsor.

\*Correspondence may be sent to Yvonne M. Terry-McElrath at the Institute for Social Research, University of Michigan, P.O. Box 1248, Ann Arbor, MI 48106-1248, or via email at: yterry@umich.edu.

rious driving offenses among a sample in southeast Michigan (Shope et al., 2001); follow-up surveys found that individuals with higher alcohol misuse and marijuana use frequency exhibited the most risky young-adult driving behaviors and higher substance use associated with a higher crash likelihood during both teen and young-adult years (Bingham and Shope, 2004, 2005). Data from the 2007 National Annenberg Survey of Youth (Dunlop and Romer, 2010) found that the tendency to use multiple substances is more strongly associated with increased crash risk than use frequency of alcohol, marijuana, or cigarettes among a combined older adolescent/young-adult sample ages 16–22 years. However, among 16- to 18-year-olds, alcohol use frequency is more strongly associated with crash risk than the likelihood to use multiple substances. Dunlop and Romer's conclusion that the use of multiple substances may more strongly associate with unsafe driving risk than specific substance use leads to a logical question: Does an individual's status as a single drug user, a concurrent user (someone who reports using various drugs on separate occasions within a given period; Earleywine and Newcomb, 1997; Martin et al., 1992), or a simultaneous user differently associate with their likelihood of unsafe driving above and beyond substance use frequency? Research indicates that adolescent SAM use occurs across the use frequency spectrum of both alcohol and marijuana and is associated with the desire for a unique "high" specific to simultaneous use (Terry-McElrath et al., 2013). Thus, SAM use does not appear to be a simple by-product of heavy use and may associate with unsafe driving independently of use frequency. Further, SAM use is strongly associated with social substance use situations and use in a car or while driving (Pakula et al., 2009; Terry-McElrath et al., 2013), raising the likelihood of increased unsafe driving risk.

This article examines rates of self-reported unsafe driving in the past 12 months among U.S. high school seniors from 1976 to 2011 and explores evidence for differential rates of unsafe driving based on an individual's substance use frequency and SAM use status over the same period without regard to the temporal order of the behaviors (i.e., substance use frequency, SAM use status, and unsafe driving were not necessarily linked in time). Three research questions guide the analyses: (a) How have self-reported unsafe driving rates (both driving in general and after substance use) changed over time? (b) Is there evidence that substance use frequency and SAM use status have differential associations with unsafe driving rates? (c) Do observed associations hold over time?

## Method

### Sample

Analyses used 12th-grade student data from the Monitoring the Future study; details on design and procedures are available elsewhere (Bachman et al., 2011; Johnston et al.,

2012). A nationally representative sample of approximately 15,000 12th-grade students from about 130 schools is surveyed annually. To reduce respondent burden but still obtain a wide variety of measures, Monitoring the Future uses six different questionnaire forms (randomly distributed within classroom); SAM use items are included on only one form. Surveys were administered in classrooms by University of Michigan personnel. Students self-completed the questionnaires, usually during a normal class period. Student response rates averaged 83% from 1976 to 2011 (range: 77%–86%). Absenteeism was the primary reason for missing data; less than 1% of students refused to participate. Appropriate consent procedures were used, and the University of Michigan Behavioral Sciences Institutional Review Board approved the study.

### Measures

*Past-12-month substance use frequency.* Students self-reported past-12-month alcohol, marijuana, and hashish use as 0 occasions, 1–2, 3–5, 6–9, 10–19, 20–39, and 40 or more occasions (coded in the analysis as 0, 1.5, 4, 7.5, 15, 30, and 40, respectively). Responses for marijuana and hashish were combined into a single measure, hereafter referred to as *marijuana*.

*Simultaneous use status.* Students reporting any past-12-month marijuana use were asked, "How many of the times when you used marijuana or hashish during the last year did you use it along with alcohol—that is, so that their effects overlapped?" Responses included *not at all* (1), *a few of the times* (2), *some of the times* (3), *most of the time* (4), and *every time* (5). To obtain estimates of SAM use among all students, respondents reporting no past-12-month marijuana use were coded *not at all* for SAM use. A six-category measure combining past-12-month substance use prevalence and SAM use was coded as follows: *no alcohol or marijuana use* (1), *alcohol use only* (2), *marijuana use only* (3), *concurrent alcohol and marijuana use* (i.e., some degree of use of both substances, but no reported simultaneous use) (4), *SAM use a few of the times/some of the times marijuana was used* (5), and *SAM use most/every time marijuana was used* (6).

*Unsafe driving: Tickets/warnings and accidents.* Students were asked, "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?" Responses included none, once, twice, three times, four or more times. If at least one moving violation was reported, respondents were asked, "How many of these tickets or warnings occurred after you were . . . (a) drinking alcoholic beverages? (b) smoking marijuana or hashish?" The same response scale was used for items indicating tickets/warnings occurring after substance use (ranging from *none* to *four or more times*). For accidents, students were asked, "We are interested in any ac-

cidents which occurred while you were driving a car, truck, or motorcycle. ("Accidents" means a collision involving property damage or personal injury—not bumps or scratches in parking lots.) During the LAST 12 MONTHS, how many accidents have you had while you were driving (whether or not you were responsible)?" If at least one accident was reported, respondents were asked, "How many of these accidents occurred after you were . . . (a) drinking alcoholic beverages? (b) smoking marijuana or hashish?" The same response scale was used for accident outcomes that was used for ticket/warning outcomes (ranging from *none* to *four or more times*). Any/none dichotomies were coded for each unsafe driving measure.

*Control variables.* Analyses sought to examine if both substance use frequency and SAM use status were independently associated with a higher likelihood of unsafe driving. To ascertain specific associations related to these behaviors (vs. factors known to associate with both unsafe driving and substance use), a range of sociodemographic and lifestyle factors were included as covariates in multivariate models.

Sociodemographic measures included self-reported gender, race/ethnicity, number of parents in the home, parental education, college plans, and grades. Non-self-report measures included population density and region. Race/ethnicity was coded as African American, Hispanic, White, or other. Parental education was a proxy for family socioeconomic

TABLE 1. Descriptive statistics for all measures

Variable	Range	<i>M</i>	( <i>SE</i> )
Past-12-month tickets/warnings <sup>a</sup>			
Any overall tickets/warnings ( <i>n</i> = 71,510)	0, 1	0.265	(0.003)
Tickets/warnings after:			
Alcohol use ( <i>n</i> = 18,802)	0, 1	0.104	(0.003)
Marijuana use ( <i>n</i> = 18,693)	0, 1	0.045	(0.002)
Past-12-month accidents <sup>b</sup>			
Any overall accidents ( <i>n</i> = 70,969)	0, 1	0.223	(0.002)
Accidents after:			
Alcohol use ( <i>n</i> = 15,908)	0, 1	0.066	(0.002)
Marijuana use ( <i>n</i> = 15,792)	0, 1	0.031	(0.002)
Past-12-month substance use ( <i>n</i> = 72,053)			
Substance use frequency			
Alcohol use frequency	0–40	11.913	(0.122)
Marijuana use frequency	0–40	5.534	(0.082)
Simultaneous <sup>c</sup> alcohol and marijuana (SAM) use status			
No alcohol or marijuana use	0, 1	0.215	(0.003)
Alcohol use only	0, 1	0.441	(0.003)
Marijuana use only	0, 1	0.005	(0.000)
Concurrent <sup>d</sup> alcohol and marijuana use	0, 1	0.103	(0.001)
SAM use a few of the times/some of the time	0, 1	0.175	(0.002)
SAM use most of the time/every time	0, 1	0.061	(0.001)
Control measures ( <i>n</i> = 72,053)			
Miles driven per week	0–200	70.947	(0.526)
Male	0, 1	0.471	(0.003)
Race/ethnicity			
African American	0, 1	0.097	(0.004)
Hispanic	0, 1	0.069	(0.003)
Other	0, 1	0.080	(0.002)
White	0, 1	0.754	(0.006)
Two-parent household	0, 1	0.750	(0.003)
Average parental education	1–6	3.760	(0.014)
Probably/definitely will graduate from 4-year college	0, 1	0.728	(0.004)
Grade point average	1–9	6.187	(0.015)
Evenings out for fun/recreation	0.5–6.5	2.640	(0.009)
Truancy	1–5	1.610	(0.007)
Population density			
Large metropolitan statistical area (MSA)	0, 1	0.461	(0.010)
Other MSA	0, 1	0.259	(0.009)
Non-MSA	0, 1	0.280	(0.007)
Region			
Midwest	0, 1	0.288	(0.007)
Northeast	0, 1	0.192	(0.006)
West	0, 1	0.187	(0.006)
South	0, 1	0.333	(0.007)

<sup>a</sup>Tickets/warnings for moving violations such as speeding, running a stop light, or improper passing;

<sup>b</sup>accidents for collisions involving property damage or personal injury—not bumps or scratches in parking lots; <sup>c</sup>simultaneous use indicates use of marijuana along with alcohol so that the effects overlapped;

<sup>d</sup>concurrent use indicates use of marijuana and alcohol during the same period (past 12 months), but not simultaneous use.

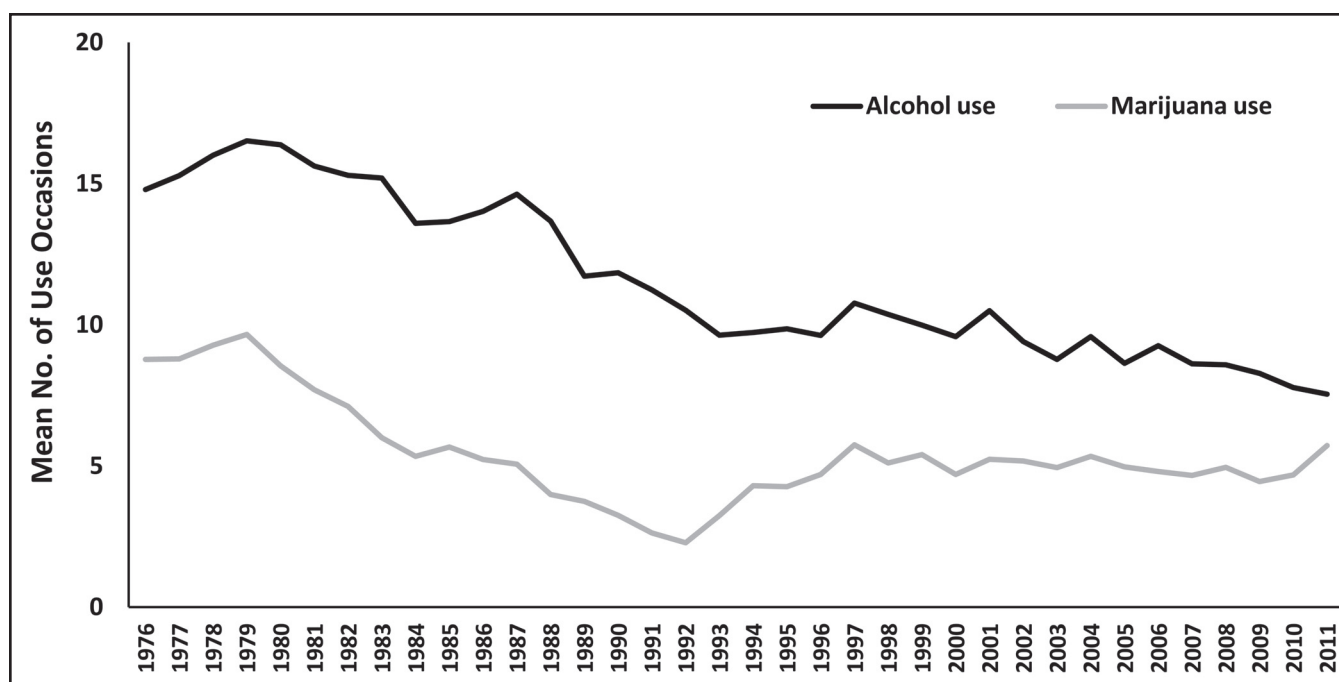


FIGURE 1. Trends in past-12-month alcohol and marijuana use frequency among U.S. high school seniors, 1976–2011. Notes: Respondents self-reported past-12-month use as 0 occasions, 1–2, 3–5, 6–9, 10–19, 20–39, and  $\geq 40$  occasions (coded here and in analysis as 0, 1.5, 4, 7.5, 15, 30, 40). Standard error ranges (across years): for alcohol use frequency, 0.38–0.57; for marijuana use frequency, 0.21–0.50.

status and was coded on an 11-point scale representing student-reported average parental educational attainment (missing data for one parent allowed). College plans was a dichotomy indicating plans to probably/definitely graduate from a 4-year college program. Grades were self-reported average high school grades ranging from *D* (1) to *A* (9). Population density included large metropolitan statistical area (MSA), other MSA, and non-MSA. Regions included the Northeast, Midwest, South, and West.

Lifestyle factors included self-reported miles driven in an average week, number of evenings out during the week for recreation, and truancy. Students reported miles driven by answering the following question: “During an average week, how much do you usually drive a car, truck, or motorcycle?” Responses included *not at all* (coded as 0), *1–10 miles* (5), *11–50 miles* (30), *51–100 miles* (75), *100–200 miles* (150), or *more than 200 miles* (200). Evenings out per week for fun/recreation was coded on a 6-point scale from *less than one* (0.5) to *six or seven* (6.5). Truancy was a mean of the frequency of skipping classes or whole days of school during the past 4 weeks.

#### Data analysis

Survey commands (surveymeans, surveylogistic) in SAS version 9.2 (SAS Institute Inc., Cary, NC) were used for all analyses to account for the complex Monitoring

the Future survey sampling design. Analyses included weights to adjust for differential probability of selection. In multivariate models, dummy terms for each year were included.

#### Results

A total of 103,129 unweighted cases were available from 1976 to 2011 from the questionnaire form including the SAM use measure. Ninety percent (93,036) had valid data for past-12-month marijuana and alcohol use as well as SAM use status. Of these cases, 88% (82,003) had valid data for tickets/warnings or accidents as well as miles driven. After limiting the cases to only those with valid data on all control measures, 72,053 remained. Multivariate models examining any overall tickets/warnings and any tickets/warnings after alcohol use were run in Mplus using full information maximum likelihood to address missingness. Results did not differ substantively from complete case analysis; analyses presented are for complete case models. Table 1 reports descriptive statistics on all measures.

#### *Substance use frequency and simultaneous alcohol and marijuana use status*

From 1976 to 2011, the number of past-12-month substance use occasions averaged 11.9 for alcohol and 5.5 for

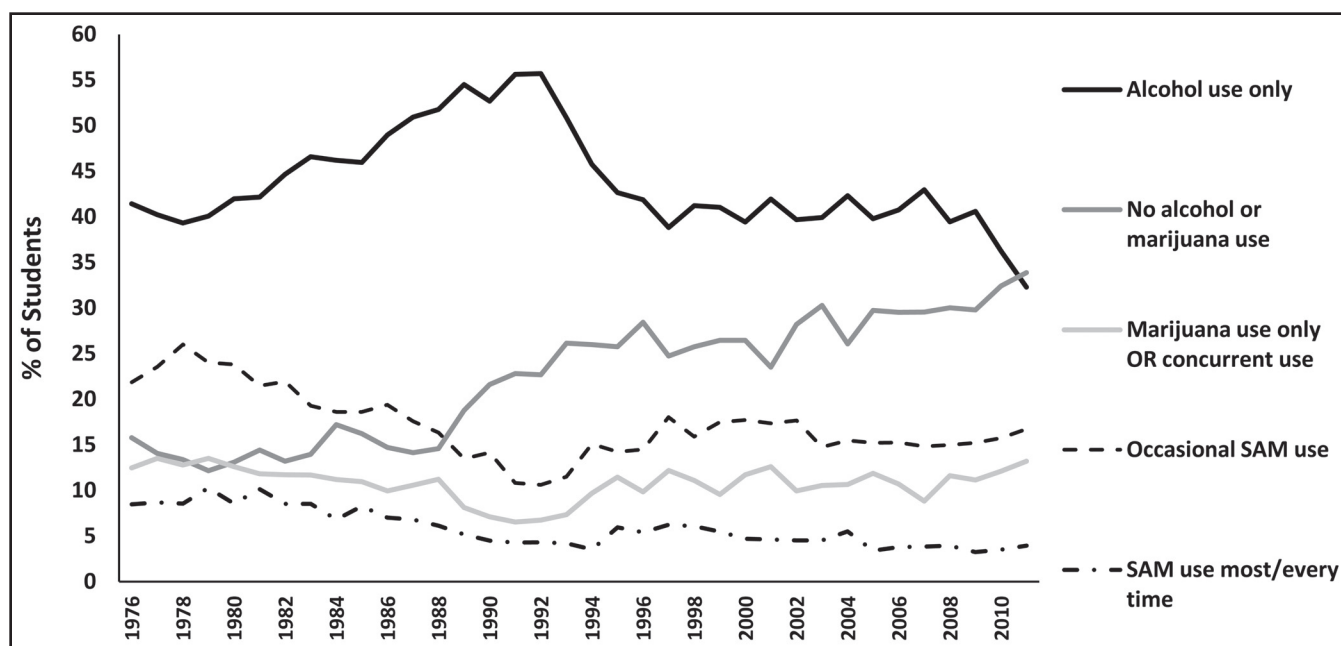


FIGURE 2. Trends in past-12-month simultaneous alcohol and marijuana (SAM) use status among U.S. high school seniors, 1976–2011. *Notes:* Simultaneous use indicates use of marijuana along with alcohol so that the effects overlapped. Occasional SAM use indicates simultaneous use a few or some of the times the respondent used marijuana. SAM use most/every time indicates simultaneous use most of the time/every time the respondent used marijuana. Standard error ranges (across years): for no alcohol or marijuana use, 0.91–2.04; for alcohol use only, 1.21–2.04; for marijuana use only or concurrent use, 0.58–1.10; for occasional SAM use, 0.84–1.41; for frequent SAM use, 0.43–0.87.

marijuana. As Figure 1 shows, mean alcohol use frequency peaked in 1979 (16.5 occasions), with an overall decrease to 7.5 occasions in 2011. Mean marijuana use frequency also peaked in 1979 (9.7 occasions) and decreased through 1992 to 2.3 occasions. Mean marijuana use frequency then increased to 5.8 occasions by 1997 and then slightly decreased through 2009 to 4.4 occasions. Data for 2010 and 2011 indicated increasing marijuana use frequency.

An average of 22% of students reported neither alcohol nor marijuana use in the past 12 months, 44% reported alcohol use only, less than 1% reported marijuana use only, 10% reported concurrent use, 18% reported SAM use a few or some of the times they used marijuana in the past 12 months, and 6% reported SAM use most/every time. Cases reporting marijuana use only were combined with those reporting concurrent use, resulting in a five-level SAM use status measure: no alcohol or marijuana use, alcohol only, marijuana only/concurrent use, occasional SAM use, SAM use most/every time. Figure 2 indicates that the percentage of high school seniors reporting neither alcohol nor marijuana use has been generally increasing since the mid-1980s, reaching 34% in 2011, compared with a low of 12% in 1979. The percentage of seniors reporting only alcohol use rose from 1978 through the early 1990s and then experienced a sharp decline through 1997 (reporting marijuana only/concurrent use or any degree of SAM use declined during the rise in alcohol use only and then increased during the decrease in alcohol

use only). Trends for all SAM use status categories other than no alcohol/marijuana use showed relative stability from the late 1990s through 2007, when a sharp decrease began in the percentage of students reporting alcohol use only, with some level of corresponding increase for marijuana only/concurrent use and both SAM use categories. In 2011, 32% of seniors reported alcohol use only, 17% occasional SAM use, 13% marijuana use only/concurrent use, and 4% SAM use most/every time.

Bivariate associations between SAM use status, miles driven in an average week, and substance use frequency were examined. Results (Figure 3) indicate that as individuals moved up in the SAM use status categories, they also increased the average miles driven and use frequency of alcohol and marijuana.

#### *Unsafe driving prevalence and trends*

In 2011, 20% of high school seniors reported receiving a moving violation ticket or warning in the past 12 months; 14% reported an accident involving property damage or personal injury. Among students reporting any tickets/warnings, 3% reported doing so after drinking alcohol and 4% following marijuana use. Among students reporting any accidents, 3% reported doing so after drinking alcohol and 1% following marijuana use. Figures 4 and 5 indicate (a) decreases over time in overall tickets/warnings and accidents



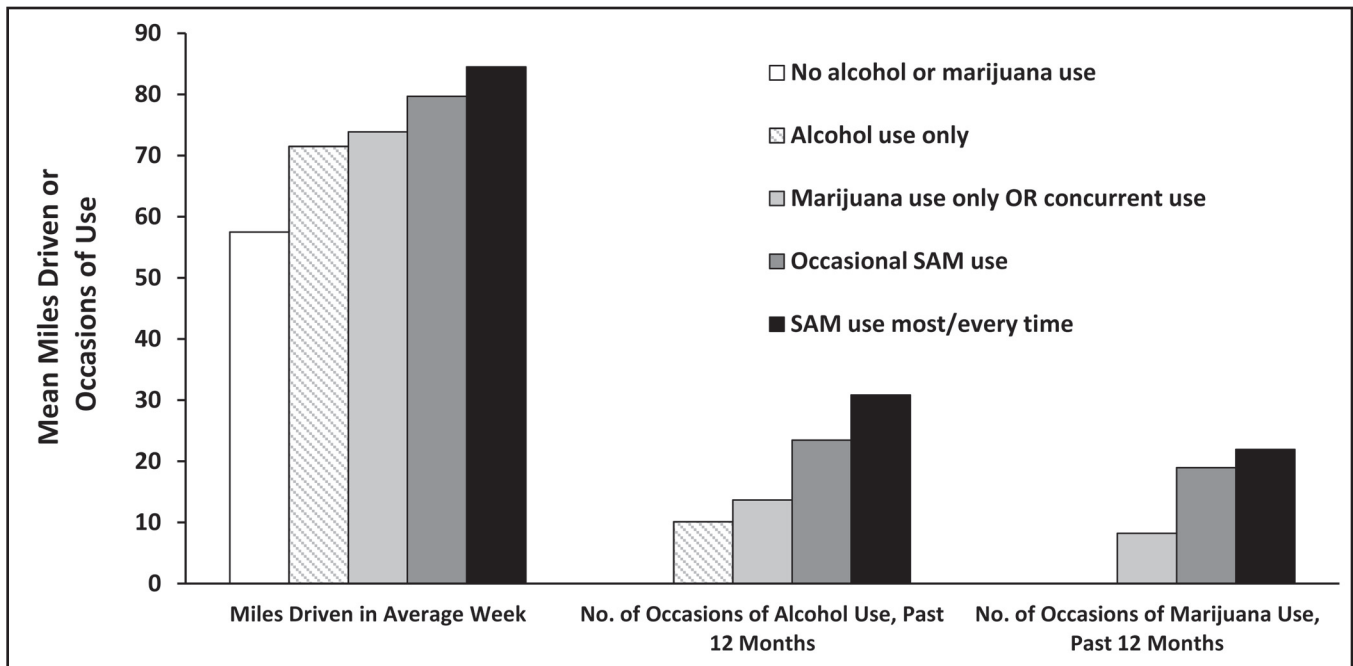


FIGURE 3. Associations between past-12-month simultaneous alcohol and marijuana (SAM) use status, substance use frequency, and average miles driven among U.S. high school seniors, 1976–2011. *Notes:* Simultaneous use indicates use of marijuana along with alcohol so that the effects overlapped. Occasional SAM use indicates simultaneous use a few or some of the times the respondent used marijuana. SAM use most/every time indicates simultaneous use most of the time/every time the respondent used marijuana. Bivariate associations between each category of SAM use status and listed outcomes were significant at  $p < .0001$  for number of occasions of both alcohol and marijuana use in the past 12 months. Bivariate associations with miles driven in an average week were significant at  $p < .0001$  for all comparisons other than alcohol use only versus marijuana use only/concurrent use, which was significant at  $p < .05$ . Standard error ranges: for miles driven in an average week, 0.64–1.26; for alcohol use frequency, 0.10–0.23; for marijuana use frequency, 0.15–0.30.

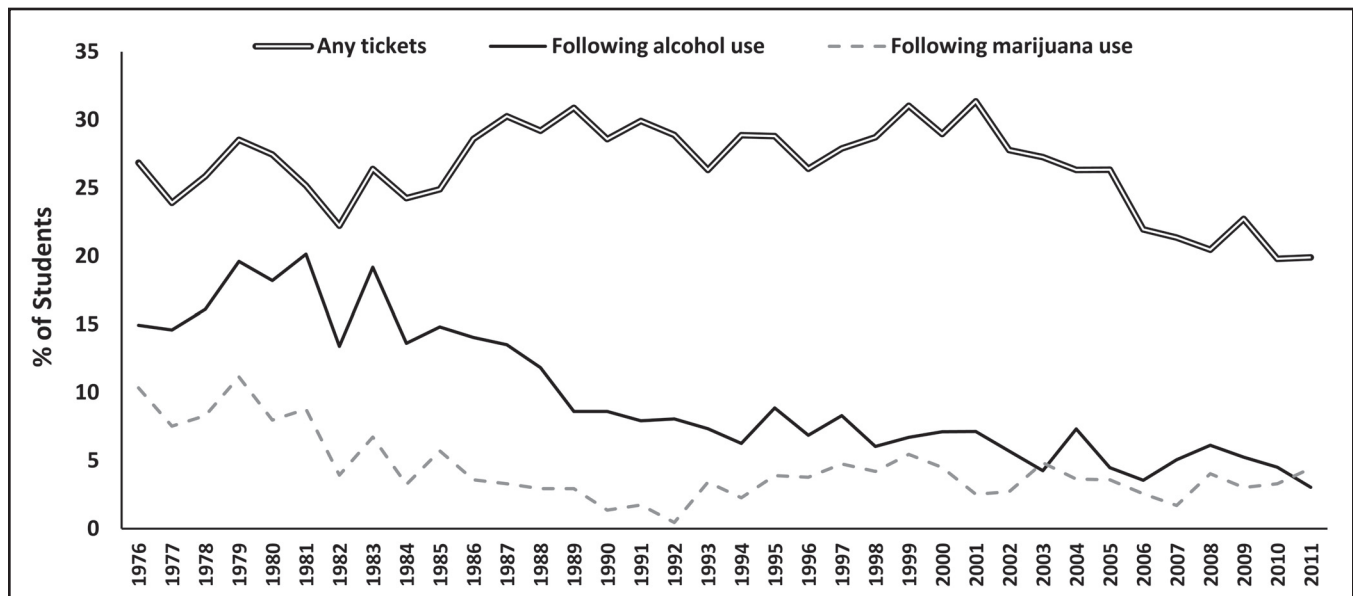


FIGURE 4. Trends in past-12-month tickets/warnings among U.S. high school seniors, 1976–2011. *Notes:* Tickets/warnings where the respondent was driving for moving violations such as speeding, running a stop light, or improper passing. Any tickets/warnings reported for all high school students. Tickets/warnings following alcohol or marijuana use reported only for those students reporting any overall tickets/warnings. Standard error ranges (across years): for any tickets/warnings, 1.15–1.78; for tickets/warnings following alcohol use, 0.88–2.38; for tickets/warnings following marijuana use, 0.26–1.83.

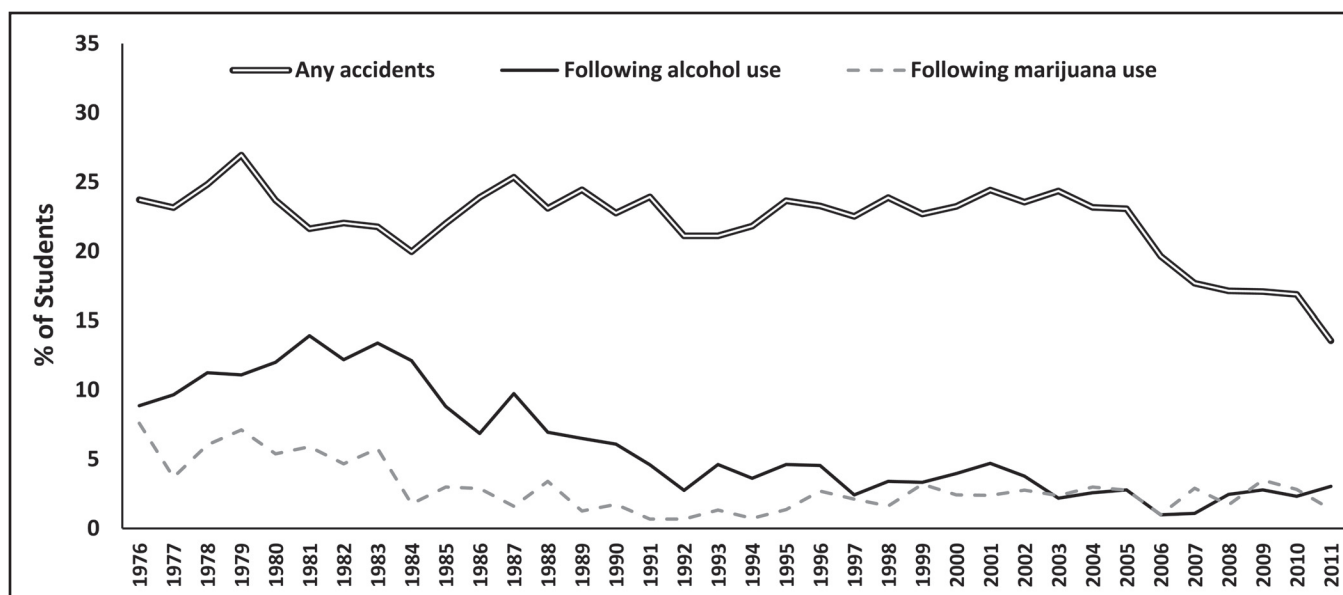


FIGURE 5. Trends in past-12-month accidents among U.S. high school seniors, 1976–2011. Notes: Accidents in which the respondent was driving for collisions involving property damage or personal injury—not bumps or scratches in parking lots. Any accidents reported for all high school students. Accidents following alcohol or marijuana use reported only for those students reporting any overall accidents. Standard error ranges (across years): for any accidents, 0.92–1.51; for accidents following alcohol use, 0.57–1.74; for accidents following marijuana use, 0.31–1.90.

(especially for tickets/warnings and accidents following substance use) and (b) strong similarities in the rates of tickets/warnings and accidents following alcohol and marijuana use since the early 2000s.

#### *Substance use frequency, simultaneous alcohol and marijuana use status, and unsafe driving*

Associations between substance use frequency and unsafe driving during the past 12 months are presented in Table 2. Bivariate models included only one substance use frequency measure (alcohol or marijuana). Before other factors were controlled for, students with higher alcohol or marijuana substance use frequency were more likely than those with low use frequency to report all forms of unsafe driving examined. For example, when used as the sole predictor of any tickets/warnings (see Table 2, “Bivariate results”), alcohol use frequency had a statistically significant odds ratio (OR) of 1.030 and marijuana use frequency had a statistically significant OR of 1.023. When all covariates—including SAM use status—were added to the models (see Table 2, “Multivariate results”), some differences were observed. Higher alcohol use frequency continued to be associated with a higher likelihood of any tickets/warnings and accidents, as well as tickets/warnings and accidents following alcohol use. However, the adjusted ORs for alcohol use frequency and the odds of tickets/warnings or accidents following marijuana use (0.996 and 0.998, respectively) were not statistically significant. This indicates that alcohol use frequency was not uniquely associated with these particular unsafe driving

measures after covariates were controlled for. The multivariate results in Table 2 also show that marijuana use frequency was not uniquely associated with any tickets/warnings, any accidents, or tickets/warnings following alcohol use after covariates were controlled for. Marijuana use frequency continued to show significant and positive associations in multivariate models with the likelihood of reported tickets/warnings following marijuana use and accidents following either alcohol or marijuana use.

The strength of the association between alcohol use frequency and each unsafe driving measure was compared with the corresponding association between marijuana use frequency and each unsafe driving measure in multivariate models (test significance reported in the last column in Table 2). Results show that for any tickets/warnings and accidents, as well as tickets/warnings and accidents following alcohol use, associations between substance use frequency and the unsafe driving measure were statistically stronger for alcohol than for marijuana. However, the associations between marijuana use frequency and tickets/warnings or accidents following marijuana use were statistically stronger for marijuana use frequency than for alcohol use frequency.

Associations between an individual’s past-12-month SAM use status and unsafe driving during the same period are presented in Table 3. The table includes four  $p$  value columns for both bivariate and multivariate results:  $p^b$  is the significance of no use versus all other SAM use status categories;  $p^c$  is the significance of alcohol only versus marijuana only/concurrent use, occasional SAM use, and SAM use most/every time;  $p^d$  is the significance of marijuana only/concur-

Variable	Bivariate results			Multivariate results			
	OR	[95% CI]	<i>p</i> <sup>a</sup>	AOR	[95% CI]	<i>p</i> <sup>a</sup>	<i>p</i> <sup>b</sup>
Tickets/warnings <sup>c</sup>							
Any tickets							
Alcohol use frequency <sup>d</sup>	1.030	[1.029, 1.032]	***	1.010	[1.008, 1.012]	***	†
Marijuana use frequency <sup>d</sup>	1.023	[1.021, 1.024]	***	1.000	[0.997, 1.002]		
Any tickets occurring after alcohol use <sup>e</sup>							
Alcohol use frequency	1.078	[1.074, 1.082]	***	1.057	[1.052, 1.063]	***	†
Marijuana use frequency	1.042	[1.039, 1.046]	***	1.002	[0.997, 1.007]		
Any tickets occurring after marijuana use <sup>e</sup>							
Alcohol use frequency	1.065	[1.059, 1.071]	***	0.996	[0.988, 1.004]		
Marijuana use frequency	1.113	[1.106, 1.120]	***	1.084	[1.074, 1.094]	***	‡
Accidents <sup>f</sup>							
Any accidents							
Alcohol use frequency	1.023	[1.021, 1.024]	***	1.007	[1.005, 1.008]	***	†
Marijuana use frequency	1.018	[1.016, 1.019]	***	1.001	[0.999, 1.003]		
Any accidents occurring after alcohol use <sup>g</sup>							
Alcohol use frequency	1.085	[1.079, 1.092]	***	1.063	[1.055, 1.070]	***	†
Marijuana use frequency	1.048	[1.044, 1.052]	***	1.008	[1.001, 1.014]	*	
Any accidents occurring after marijuana use <sup>g</sup>							
Alcohol use frequency	1.071	[1.063, 1.079]	***	0.998	[0.988, 1.008]		
Marijuana use frequency	1.114	[1.105, 1.122]	***	1.082	[1.070, 1.095]	***	‡

rent use versus both SAM use status categories; and  $p^e$  is the significance of occasional SAM use versus SAM use most/every time. Bivariate models showed that, before other factors were controlled for, an individual's SAM use status was significantly associated with that individual's likelihood of reporting unsafe driving (both in general and following substance use), and the likelihood of unsafe driving increased with each relevant category of SAM use status. For example, compared with students reporting neither alcohol nor marijuana use in the past 12 months, the bivariate OR for any tickets/warnings was 1.79 for students reporting alcohol use, 2.22 for marijuana only/concurrent use, 3.16 for occasional SAM use, and 3.67 for students reporting SAM use most/every time. In Table 3, column  $p^b$  under "Bivariate results" indicates that all of the observed ORs were significantly higher than for students reporting no use ( $p < .001$ ); column  $p^c$  that the odds of any tickets/warnings for students reporting marijuana only/concurrent use and both SAM use status categories were significantly higher than for alcohol use alone ( $p < .001$ ); column  $p^d$  that the odds of any tickets/warnings for students reporting both SAM use categories were significantly higher than for marijuana only/concurrent use ( $p < .001$ ); and column  $p^e$  that the odds of any tickets/warnings for students reporting SAM use most/every time

In multivariate models, an individual's likelihood of reporting any tickets/warnings increased between those with a status of no alcohol or marijuana use to alcohol use only, to marijuana only/concurrent use, and to any SAM use. No significant differences in the likelihood of any tickets/warnings were observed between individuals reporting occasional SAM use versus those reporting SAM use most/every time (see "Multivariate results" column  $p^e$ ). The likelihood of any accidents increased between no alcohol or marijuana use to alcohol use only, to marijuana only/concurrent use or any SAM use (no significant differences in the likelihood of any accidents were observed between individuals reporting marijuana only/concurrent use, occasional SAM use, or SAM use most/every time; see Columns  $p^d$  and  $p^e$ ). The likelihood that an individual reported either tickets/warnings



TABLE 3. Associations between past-12-month simultaneous alcohol and marijuana (SAM) use status and unsafe driving among U.S. high school seniors, 1976–2011

Variable	Bivariate results							Multivariate results					
	% <sup>a</sup>	OR	[95% CI]	<i>p</i> <sup>b</sup>	<i>p</i> <sup>c</sup>	<i>p</i> <sup>d</sup>	<i>p</i> <sup>e</sup>	AOR	[95% CI]	<i>p</i> <sup>b</sup>	<i>p</i> <sup>c</sup>	<i>p</i> <sup>d</sup>	<i>p</i> <sup>e</sup>
<b>Tickets/warnings<sup>f</sup></b>													
Any tickets/warnings													
No use	15.7	(ref.)		(ref.)				(ref.)		(ref.)			
Alcohol only	25.0	1.79	[1.68, 1.91]	***	(ref.)			1.40	[1.30, 1.49]	***	(ref.)		
Marijuana only/concurrent use	29.2	2.22	[2.05, 2.40]	***	***	(ref.)		1.63	[1.50, 1.78]	***	***	(ref.)	
Occasional SAM use <sup>g</sup>	37.1	3.16	[2.94, 3.40]	***	***	***	(ref.)	1.90	[1.73, 2.09]	***	***	***	(ref.)
SAM use most/every time <sup>h</sup>	40.7	3.67	[3.35, 4.03]	***	***	***	***	1.89	[1.68, 2.13]	***	***	**	
Any tickets/warnings occurring after alcohol use <sup>i</sup>													
Alcohol only	6.2	(ref.)		(ref.)				(ref.)		(ref.)			
Marijuana only/concurrent use	7.4	1.62	[1.32, 1.99]	***	(ref.)			1.01	[0.81, 1.27]			(ref.)	
Occasional SAM use	17.4	4.26	[3.69, 4.91]	***	***	(ref.)		1.63	[1.35, 1.97]	***	***	(ref.)	
SAM use most/every time	29.5	8.44	[7.18, 9.92]	***	***	***		2.19	[1.76, 2.71]	***	***	***	
Any tickets/warnings occurring after marijuana use <sup>j</sup>													
Marijuana only/concurrent use	2.9	(ref.)		(ref.)				(ref.)				(ref.)	
Occasional SAM use	10.5	22.58	[16.71, 30.53]	***	***	(ref.)		3.17	[2.16, 4.65]	***	***	(ref.)	
SAM use most/every time	17.7	41.61	[30.36, 57.02]	***	***	***		4.81	[3.22, 7.17]	***	***	***	
<b>Accidents<sup>j</sup></b>													
Any accidents													
No use	14.6	(ref.)		(ref.)				(ref.)		(ref.)			
Alcohol only	21.2	1.57	[1.48, 1.67]	***	(ref.)			1.24	[1.16, 1.32]	***	(ref.)		
Marijuana only/concurrent use	25.7	2.03	[1.88, 2.20]	***	***	(ref.)		1.52	[1.40, 1.65]	***	***	(ref.)	
Occasional SAM use	29.4	2.45	[2.29, 2.62]	***	***	***	(ref.)	1.52	[1.39, 1.66]	***	***		(ref.)
SAM use most/every time	31.3	2.68	[2.44, 2.93]	***	***	***	*	1.49	[1.32, 1.68]	***	***		
Any accidents occurring after alcohol use <sup>k</sup>													
Alcohol only	3.7	(ref.)		(ref.)				(ref.)		(ref.)			
Marijuana only/concurrent use	4.2	1.54	[1.16, 2.05]	**	(ref.)			0.83	[0.60, 1.13]			(ref.)	
Occasional SAM use	11.6	4.62	[3.82, 5.59]	***	***	(ref.)		1.38	[1.07, 1.78]	*	***	(ref.)	
SAM use most/every time	22.5	10.17	[8.25, 12.54]	***	***	***		1.90	[1.42, 2.53]	***	***	***	
Any accidents occurring after marijuana use <sup>k</sup>													
Marijuana only/concurrent use	1.7	(ref.)		(ref.)				(ref.)				(ref.)	
Occasional SAM use	7.8	27.39	[18.41, 40.77]	***	***	(ref.)		3.57	[2.14, 5.94]	***	***	(ref.)	
SAM use most/every time	13.0	48.13	[31.70, 73.07]	***	***	***		4.89	[2.88, 8.28]	***	***	*	

Notes: Multivariate models controlled for the following: substance use frequency, average miles driven per week, gender, race/ethnicity, number of parents in the home, average parental education, college plans, grade point average, nights out during the week for recreation, truancy, population density, region, and year. OR = unadjusted odds ratio; AOR = adjusted OR; CI = 95% confidence interval; ref. = reference. <sup>a</sup>Percentage of each listed category of SAM use status with specified unsafe driving measure; <sup>b</sup>significance level of the OR for the specified unsafe driving measure where the referent category was “no use”; <sup>c</sup>significance level of the OR for the specified unsafe driving measure where the referent category was “alcohol only”; <sup>d</sup>significance level of the OR for the specified unsafe driving measure where the referent category was “marijuana only/concurrent use”; <sup>e</sup>significance level of the OR for the specified unsafe driving measure where the referent category was “occasional SAM use”; <sup>f</sup>tickets/warnings where the respondent was driving for moving violations such as speeding, running a stop light, or improper passing; <sup>g</sup>occasional SAM use defined as SAM use a few or some of the times the respondent used marijuana; <sup>h</sup>SAM use most/every time defined as SAM use most of the time or every time the respondent used marijuana; <sup>i</sup>only among students reporting any overall tickets/warnings. Models for tickets/warnings following alcohol use do not include individuals who reported no alcohol use; models for tickets/warnings following marijuana use do not include individuals who reported no marijuana use; <sup>j</sup>accidents in which the respondent was driving for collisions involving property damage or personal injury—not bumps or scratches in parking lots; <sup>k</sup>only among students reporting any overall accidents. Models for accidents following alcohol use do not include individuals who reported no alcohol use; models for accidents following marijuana use do not include individuals who reported no marijuana use. \**p* < .05; \*\**p* < .01; \*\*\**p* < .001.

or accidents following alcohol use did not differ significantly between those reporting alcohol use only and those reporting marijuana only/concurrent use (see Column *p*<sup>c</sup>). However, the likelihood of unsafe driving following alcohol use was significantly higher for those reporting occasional SAM use and significantly increased again for those reporting SAM use most/every time (see Columns *p*<sup>d</sup> and *p*<sup>e</sup>). Finally, the likelihood of either tickets/warnings or accidents following marijuana use increased significantly based on each relevant SAM use status category: Those reporting marijuana use

only/concurrent use had the lowest likelihood, with significant increases for occasional SAM use and then also for SAM use most/every time (see Columns *p*<sup>d</sup> and *p*<sup>e</sup>).

Thus, after miles driven and all other covariates were controlled for, the number of indicators of unsafe driving—both unsafe driving in general as well as unsafe driving after drug use—were clearly lowest for high school seniors reporting no alcohol or marijuana use. Individuals using marijuana only or using alcohol and marijuana concurrently (but not simultaneously) were more likely to report unsafe driving than

students using alcohol only for unsafe driving in general but not for unsafe driving following alcohol use. Individuals reporting any level of SAM use were more likely to report (a) any form of unsafe driving than were students who reported alcohol use only and (b) any form of unsafe driving other than any accidents than students who reported marijuana only/concurrent use. In comparisons of the likelihood of unsafe driving between individuals reporting occasional SAM use versus SAM use most/every time, significant differences were observed only for unsafe driving following substance use (where significantly higher odds of unsafe driving were associated with SAM use most/every time).

To illustrate the differences in the likelihood of any unsafe driving associated with SAM use status categories, predicted probabilities were estimated for any tickets/warnings and accidents using results from multivariate models. The predicted probabilities of any tickets/accidents based on SAM use status were .13 (no alcohol or marijuana use), .18 (alcohol use only), .20 (marijuana use only/concurrent use), and .22 (for both levels of SAM use). The predicted probabilities of any accidents based on SAM use status were .12 (no alcohol or marijuana use), .14 (alcohol use only), and .17 (for marijuana use only/concurrent use as well as both levels of SAM use).

#### *Stability of associations over time*

The prior models were run including 36 years of data. To explore whether the observed associations held constant over time, multivariate models for any overall tickets/warnings and accidents were repeated for each of the following year groupings: 1976–1985, 1986–1995, 1996–2005, and 2006–2011. The observed pattern of findings was generally stable across periods. Thus, although rates of use frequency and SAM use status changed over time, the associations between these risk factors and the risk factor of unsafe driving did not.

### **Discussion**

This study used a nationally representative cross-sectional sample of high school seniors to investigate associations between an individual's self-reported past-year history of substance use frequency and SAM use status and indicators of unsafe driving during the same period. Results indicated that higher substance use frequency (especially alcohol use frequency) was significantly and positively associated with unsafe driving. However, having engaged in any unsafe driving was also significantly and positively associated with SAM use status, with the highest likelihood associated with SAM use for most unsafe driving measures, followed by concurrent use and then use of alcohol alone. Individuals who reported SAM use most or every time had a higher likelihood than those who reported occasional SAM use of reporting unsafe driving following either alcohol or marijuana

use. These associations were generally stable over time and held after miles driven and other factors known to associate with both risky driving and substance use were controlled for.

The above findings further develop Dunlop and Romer's (2010) work, which indicated the need to consider (a) that multiple substances may be a better indicator of crash risk than specific drug use and (b) that alcohol use frequency may be an especially strong independent risk factor linked with the likelihood of unsafe driving among teens. The current results indicate that understanding adolescent unsafe driving may be enhanced by separating out the risks associated with multiple substance users who do not engage in simultaneous use (i.e., concurrent users) from those who report varying degrees of simultaneous use.

These findings should be considered within their limitations. The analyses used self-report data for all measures. Confirmation of substance use, the number of unsafe driving events, or whether unsafe driving events occurred following any type of substance use was not possible. Students who engaged in the dangerous behavior of unsafe driving may be less likely to report such behavior as well as substance use; to the extent this may have occurred, the observed associations between drug use status and unsafe driving risk may be underestimated (for an in-depth discussion of the validity of the study's self-report data, please see Bachman et al., 2011). Further, the data are cross-sectional and thus cannot be used to draw causal conclusions. However, the current study's use of a representative national sample and consistent measures over time contribute significantly to the field's understanding of associations between an adolescent's drug-using status and his or her risk of unsafe driving.

This study found that a significant number of high school seniors reported using alcohol within the past 12 months but not using marijuana, whereas almost none (0.53%) reported using marijuana within the same period and not using alcohol. In the United States, high school seniors do not appear to usually use marijuana exclusively. Some seniors did report using both substances but not engaging in SAM use, allowing models to examine possible differences in the likelihood of unsafe driving between individuals who report engaging in SAM use specifically versus those who report concurrent use of both substances.

Individuals who reported SAM use were a high-risk group for possibly engaging in unsafe driving: They simultaneously reported higher mean miles driven per week and higher substance use frequency, and previous research with these data has shown that students who engage in any SAM use are more likely to report going out in the evenings for fun/recreation and to be truant (Terry-McElrath et al., 2013). The associations in the current analyses between SAM use and any tickets/warnings and accidents indicate that this group is indeed prone to unsafe driving in general. However, results showing that SAM use most/every time was associ-

ated with increased rates of tickets/warnings and accidents following the use of alcohol or marijuana (when compared with occasional SAM use) may indicate a unique association with unsafe driving above and beyond (a) tendencies toward dangerous driving and (b) individual substance effects.

Results from a separate national sample of U.S. high school students indicate that youth themselves rank driving after drinking alcohol as the greatest hazard to driving safety, followed by use of an electronic device/racing other cars (both items ranked second), followed by driving under the influence of marijuana/road rage (both items ranked third) (Ginsburg et al., 2008). Heavy drinkers in the study reported significantly lower perceived risk of driving after both alcohol and marijuana use. Heavy drinkers also perceived less risk for road rage and greater exposure to situations where teen drivers were drinking alcohol or smoking marijuana (Ginsburg et al., 2008). Reviews of studies examining drug use and driving have repeatedly found that individuals who engage in driving after substance use have significantly fewer concerns about the degree of impairment resulting from substance use than those who do not drive after use (Kelly et al., 2004). Some epidemiological studies have indicated that marijuana users may be able to compensate for driving impairment by using behavioral strategies such as decreased speed and increased following distance (Sewell et al., 2009). The combination of marijuana with alcohol “eliminates the ability to use such strategies effectively, however, and results in impairment even at doses which would be insignificant were they of either drug alone” (Sewell et al., 2009, p. 185). Clearly, youth who are involved with substance use downplay the increased risks associated with driving under the influence of alcohol. It is likely that these youth would also be likely to discount the increased risks of unsafe driving due to SAM use, as well as the possible increased risk of unsafe driving in general. Yet, such information—conveyed effectively—may help to lower the significant costs associated with unsafe driving among youth.

The current study indicates that not only heavy substance users, but also those who participate in concurrent or simultaneous use, have increased rates of unsafe driving in general, as well as driving after substance use. These findings have several implications for comprehensive prevention and intervention efforts involving young drivers, peers, parents/guardians, schools, and the general public (Komro and Toomey, 2002; Runyan and Yonas, 2008). Driver’s education should instruct young drivers on the increased risk of impairment resulting from combined alcohol and marijuana use in ways that are believable and effective (Sewell et al., 2009), as well as heighten awareness of the observed associations between general risk-taking tendencies and unsafe driving. Driver’s education programs also should target peer influence by aiming to increase the likelihood that peers will be alert for the increased risk of unsafe driving based on a friend’s

SAM use status and be willing to engage in designated driver practices.

As noted by Williams and Mayhew (2008), parents play a primary role in issues affecting young drivers, including providing consent to obtain a learner’s permit, enforcing existing legal policies, and setting family-specific driving rules. Programs to improve teen driving safety via increasing and improving parental involvement that are either under development or have been implemented should strive to educate parents on (a) the risks associated with risk-taking in general when considering if their teen is ready to drive and (b) risks and increased impairment associated with combined alcohol and marijuana use. For example, neither “Parents are the Key” nor “Drive it HOME” currently alert parents to the increased impairment resulting from combining substances or encourage parents to discuss such increased risks with their children (CDC, 2012a; Drive it HOME, 2013).

School-based substance use prevention curricula should aim to provide age-appropriate, accurate, and effective information on the increased risk of impairment resulting from combined alcohol and marijuana use. Larger scale prevention efforts should include mass communication campaigns designed to increase the general awareness of the risks of combined substance use. Increased prevention and intervention efforts may be especially needed given recent state policy movements toward legalization of adult recreational marijuana use. As noted by Bramness (2012), marijuana use (and in this case, concurrent and especially SAM use) may have consequences that reach far beyond the individual user.

## References

- Asbridge, M., Hayden, J. A., & Cartwright, J. L. (2012). Acute cannabis consumption and motor vehicle collision risk: Systematic review of observational studies and meta-analysis. *BMJ*, *344*, e536.
- Bachman, J. G., Johnston, L. D., O’Malley, P. M., & Schulenberg, J. E. (2011). *The Monitoring the Future Project after thirty-seven years: Design and procedures (Monitoring the Future Occasional Paper No. 76)*. Ann Arbor, MI: Institute for Social Research, The University of Michigan; 2011.
- Bingham, C. R., & Shope, J. T. (2004). Adolescent developmental antecedents of risky driving among young adults. *Journal of Studies on Alcohol*, *65*, 84–94.
- Bingham, C. R., & Shope, J. T. (2005). Adolescent predictors of traffic crash patterns from licensure into early young adulthood. In Association for the Advancement of Automotive Medicine (Eds.), *Association for the Advancement of Automotive Medicine 49th annual proceedings*, Boston, Massachusetts, September 12–14, 2005 (pp. 245–259). Barrington, IL: Association for the Advancement of Automotive Medicine.
- Bramness, J. G. (2012). Commentary on Bosker et al. (2012): Driving under the influence of cannabinoids. *Addiction*, *107*, 1845–1846.
- Calabria, B., Degenhardt, L., Hall, W., & Lynskey, M. (2010). Does cannabis use increase the risk of death? Systematic review of epidemiological evidence on adverse effects of cannabis use. *Drug and Alcohol Review*, *29*, 318–330.

- Centers for Disease Control and Prevention. (2012a). *Eight danger zones*. Atlanta, GA: Author. Retrieved from <http://www.cdc.gov/ParentsAreTheKey/danger/index.html>.
- Centers for Disease Control and Prevention. (2012b). *Teen drivers: Fact sheet*. Atlanta, GA: Author. Retrieved from [http://www.cdc.gov/MotorVehicleSafety/Teen\\_Drivers/teendrivers\\_factsheet.html](http://www.cdc.gov/MotorVehicleSafety/Teen_Drivers/teendrivers_factsheet.html).
- Collins, R. L., Ellickson, P. L., & Bell, R. M. (1998). Simultaneous polydrug use among teens: Prevalence and predictors. *Journal of Substance Abuse, 10*, 233–253.
- Drive it Home (2013). *Drinking, drugs and drowsiness*. Itasca, IL: National Safety Council. Retrieved from <http://www.driveithome.org/NewDriverRisks/Pages/ImpairedDriving.aspx>.
- Dunlop, S. M., & Romer, D. (2010). Adolescent and young adult crash risk: Sensation seeking, substance use propensity and substance use behaviors. *Journal of Adolescent Health, 46*, 90–92.
- Earleywine, M., & Newcomb, M. D. (1997). Concurrent versus simultaneous polydrug use: Prevalence, correlates, discriminant validity, and prospective effects on health outcomes. *Experimental and Clinical Psychopharmacology, 5*, 353–364.
- Federal Highway Administration. (2011). *Our nation's highways 2011*. Washington, DC: Author. Retrieved from <http://www.fhwa.dot.gov/policyinformation/pubs/hf/pl11028/onh2011.pdf>.
- Ginsburg, K. R., Winston, F. K., Senserrick, T. M., Garcia-España, F., Kinsman, S., Quistberg, D. A., . . . Elliott, M. R. (2008). National young-driver survey: Teen perspective and experience with factors that affect driving safety. *Pediatrics, 121*, e1391–e1403.
- Hall, W., & Degenhardt, L. (2009). Adverse health effects of non-medical cannabis use. *The Lancet, 374*, 1383–1391.
- Insurance Institute for Highway Safety. (2012). *Fatality facts 2008: Teenagers*. Arlington, VA: Author. Retrieved from <http://www.iihs.org/iihs/topics/t/teenagers/fatalityfacts/teenagers/2008>
- Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2012). *Monitoring the Future National survey results on drug use, 1975–2011: Volume I, Secondary school students*. Ann Arbor, MI: Institute for Social Research, The University of Michigan. Retrieved from [http://monitoringthefuture.org/pubs/monographs/mtf-vol1\\_2011.pdf](http://monitoringthefuture.org/pubs/monographs/mtf-vol1_2011.pdf)
- Kelly, E., Darke, S., & Ross, J. (2004). A review of drug use and driving: Epidemiology, impairment, risk factors and risk perceptions. *Drug and Alcohol Review, 23*, 319–344.
- Komro, K. A., & Toomey, T. L. (2002). *Strategies to prevent underage drinking*. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism. Retrieved from <http://pubs.niaaa.nih.gov/publications/arh26-1/5-14.htm>
- Li, M.-C., Brady, J. E., DiMaggio, C. J., Lusardi, A. R., Tzong, K. Y., & Li, G. (2012). Marijuana use and motor vehicle crashes. *Epidemiologic Reviews, 34*, 65–72.
- Martin, C. S., Clifford, P. R., & Clapper, R. L. (1992). Patterns and predictors of simultaneous and concurrent use of alcohol, tobacco, marijuana, and hallucinogens in first-year college students. *Journal of Substance Abuse, 4*, 319–326.
- Office of National Drug Control Policy. (2012). *Drugged driving*. Washington, DC: Author. Retrieved from <http://www.whitehouse.gov/ondcp/drugged-driving>.
- O'Malley, P. M., & Johnston, L. D. (2007). Drugs and driving by American high school seniors, 2001–2006. *Journal of Studies on Alcohol and Drugs, 68*, 834–842.
- Pakula, B., Macdonald, S., & Stockwell, T. (2009). Settings and functions related to simultaneous use of alcohol with marijuana or cocaine among clients in treatment for substance abuse. *Substance Use & Misuse, 44*, 212–226.
- Ramaekers, J. G., Berghaus, G., van Laar, M., & Drummer, O. H. (2004). Dose related risk of motor vehicle crashes after cannabis use. *Drug and Alcohol Dependence, 73*, 109–119.
- Runyan, C. W., & Yonas, M. (2008). Conceptual frameworks for developing and comparing approaches to improve adolescent motor-vehicle safety. *American Journal of Preventive Medicine, 35*, Supplement 3, S336–S342.
- Sewell, R. A., Poling, J., & Sofuoglu, M. (2009). The effect of cannabis compared with alcohol on driving. *The American Journal on Addictions, 18*, 185–193.
- Shope, J. T., Waller, P. F., Raghunathan, T. E., & Patil, S. M. (2001). Adolescent antecedents of high-risk driving behavior into young adulthood: Substance use and parental influences. *Accident Analysis and Prevention, 33*, 649–658.
- Terry-McElrath, Y. M., O'Malley, P. M., & Johnston, L. D. (2013). Simultaneous alcohol and marijuana use among US high school seniors from 1976 to 2011: Trends, reasons, and situations. *Drug and Alcohol Dependence, 133*, 71–79.
- U.S. Department of Transportation. (2010). *Distracted driving 2009. Traffic safety facts, research note* (DOT HS 811 379). Washington, DC: Author.
- U.S. Department of Transportation. (2012a). *Alcohol-impaired driving. Traffic safety facts, 2010 data* (DOT HS 811 606). Washington, DC: Author.
- U.S. Department of Transportation. (2012b). *Overview. Traffic safety facts, 2010 data* (DOT HS 811 630). Washington, DC: Author.
- Williams, A. F., & Mayhew, D. R. (2008). Graduated licensing and beyond. *American Journal of Preventive Medicine, 35*, Supplement 3, S324–S333.