Published in final edited form as:
Drug Alcohol Depend. 2013 June 1; 130(0): 215–221. doi:10.1016/j.drugalcdep.2012.11.007.

Drinking Drivers and Drug Use on Weekend Nights in the United States*

Robert B. Voas[1], **John H. Lacey**[1], **Kristina Jones**[1], **Michael Scherer**[1], and **Richard Compton**[2]

[1]Impaired Driving Center, Pacific Institute for Research and Evaluation, 11720 Beltsville Drive, Suite 900, Calverton, MD 20705-3111

[2]National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE Washington, DC 20590

Abstract

BACKGROUND—Studies of drinking drivers in alcohol-related crashes have shown that high breath-alcohol concentrations (BrACs) are associated with illegal drug use. Until the 2007 National Roadside Survey (NRS), the prevalence of drugs among drinking drivers on U.S. roads was unknown. Using NRS data, we explore how many drivers with positive BrACs may also be using drugs and their significance to current drinking-driving enforcement procedures.

METHODS—Based on a stratified, random sample covering the 48 U.S. contiguous states, we conducted surveys on weekend nights from July-November 2007. Of the 8,384 eligible motorists contacted, 85.4% provided a breath sample; 70.0%, an oral fluid sample; and 39.1%, a blood sample. We conducted regression analyses on 5,912 participants with a breath test and an oral fluid or blood test. The dependent variables of interest were illegal drugs (cocaine, cannabinoids, street drugs, street amphetamines, and opiates) and medicinal drugs (prescription and over-the-counter).

RESULTS—10.5% of nondrinking drivers were using illegal drugs, and 26 to 33% of drivers with illegal BrACs (≥.08 g/dL) were using illegal drugs. Medicinal drug use was more common among nondrinking drivers (4.0%) than among drivers with illegal BrACs (2.4%).

CONCLUSIONS—The significant relationship between an illegal BrAC and the prevalence of an illegal drug suggests as many as 350,000 illegal drug-using drivers are arrested each year for DWI by U.S. alcohol-impaired driving enforcement. These drug-using drivers need to be identified and

*Supplementary material can be found by accessing the online version of this paper at http://dx.doi.org and by entering doi:…

CORRESPONDING AUTHOR: Robert B. Voas, Impaired Driving Center, Pacific Institute for Research and Evaluation, 11720 Beltsville Drive, Suite 900, Calverton, Maryland 20770, Telephone: 301-755-2720; Fax: 301-755-2799, voas@pire.org.

CONFLICT OF INTEREST
All authors declare that they have no conflicts of interest.

CONTRIBUTORS
All authors contributed to and have approved the final manuscript.

ETHICAL APPROVAL
The NRS survey was anonymous. Informed consent was obtained from all subjects. This study's methodologies were approved by the Pacific Institute for Research and Evaluation's Institutional Review Board.

appropriate sanctions/treatment programs implemented for them in efforts to extend per se laws to unapprehended drug users.

Keywords

DUI; DWI; drugged driving; drug prevalence; impaired driving; BrAC limit

1. INTRODUCTION

Worldwide attention to drugged driving has increased recently. European concern with drug-impaired driving led to the 2006 launch of an 18-nation research project on driving under the influence of drugs (DRUID), which is designed to support drugged-driving legislation in the European Union (Berghaus et al., 2010; Hels et al., 2011; Krismann et al., 2010; Schulze et al., 2011). In Australia, random roadside breath testing for alcohol has been extended to random testing for drugs via oral-fluid analysis (Boorman and Owens, 2010; Boorman and Swann, 2010). The U.S. Office of National Drug Control Policy (ONDCP, 2010) has issued a call for all states to enact per se drugged-driving laws aimed at reducing drugged-driving by 10% in 2015. This action reflected the increasing percentage of drug-positive fatally injured drivers in the United States (National Highway Traffic Safety Administration [NHTSA], 2010) and the increasing prevalence of drug-using drivers as evidenced in the U.S. 2007 National Roadside Survey (NRS; Lacey et al., 2009b). Currently, 17 states have enacted per se drugged-driving laws (Lacey et al., 2011; Walsh, 2009).

Enforcement of drugged-driving laws is restrained in the United States compared to Australia and some other industrialized countries where motorists can be stopped at random for a drug-screening test. In the United States, vehicles can only be stopped for cause, and a test can only be required if there is sufficient evidence of impaired driving to make an arrest. Thus, the current U.S. drugged-driving enforcement system functions primarily as an adjunct to the driving-while-intoxicated (DWI) by alcohol enforcement program, as most officers patrolling the highways are trained to detect drunk drivers, not drugged drivers. Drivers arrested in the field are transported to the police station for an alcohol test. Normally, if the driver's breath-alcohol concentration (BrAC) is ≥.08 g/dL (grams per deciliter), no further tests are conducted, as a conviction can be obtained based on the BrAC result. Typically, police only seek a drug test if the BrAC is <.08 g/dL. Even the testing of drivers with BrACs below.08 is limited because of the expense (Compton et al., 2009). Further, if a test is performed and the suspect is convicted of driving while impaired by a drug other than alcohol, the court record may be unclear because the offense is recorded as a "DWI," which does not distinguish between impairment by alcohol and impairment by other drugs. Consequently, the number of drivers currently being removed from the roadway for drug impairment is unknown (Compton et al., 2009).

This limitation in our knowledge is important to policy makers considering the ONDCP initiative. Evidence is strong that drug use by drivers is associated with alcohol consumption. For example, Ward and Dye (1999), in a summary of 20 epidemiological studies of drivers' cannabis use, found approximately 80% of marijuana users also used alcohol. Clearly, U.S. DWI alcohol enforcement programs are apprehending some drugged drivers (Maxwell et al., 2009; Smith et al., 2002), but the actual number is unknown. Moreover, it is possible that U.S. DWI enforcement identifies the drug users with the highest crash risk. The combination of drugs and alcohol appears to significantly increase the crash risk over alcohol alone (Drummer et al., 2004; Dussault et al., 2002; Gadegbeku & Amoros, 2010; Hels et al., 2011; Movig et al., 2004). In a summary of the relative risk of drugged drivers in the DRUID studies, Hels et al. (2011) reported that alcohol combined with other drugs typically fell into the "extremely high risk" category for crash involvement.

Presumably, in responding to the ONDCP initiative, U.S. policy makers will consider ways to increase the number of drugged drivers apprehended under current enforcement procedures; for example, by more testing of drivers with BrACs below .08. They will need to consider the tradeoff between devoting extra resources to the current enforcement system, thereby increasing both alcohol and related drug arrests, and using extra resources for additional officer training and drug screener devices to establish a special system for drug enforcement. Determining the extent to which the current U.S. DWI enforcement program that principally targets alcohol-impaired drivers results in the arrest of offenders who also use drugs will help inform such decisions.

Although the actual number of drug users currently arrested in the United States is obscured by the failure to test all arrestees, an opportunity to study the principal population from which those arrestees are drawn, nighttime weekend drivers, was provided by the 2007 National Roadside Survey (NRS; Lacey et al., 2011). That stratified random sample of weekend drivers on the roads of the 48 contiguous states collected breath samples to measure BrACs and oral-fluid samples to measure drug use. Though data were collected on Friday mornings and afternoons, we used only the nighttime data collected between 10 PM and 3 AM on Fridays and Saturdays because those are the primary times when DWI arrests occur. Alcohol-impaired driving can occur at any time; however, a century of experience has demonstrated that most drinking and driving occurs on weekend evenings. Consequently, those are the periods when police departments implement special alcohol enforcement patrols and sobriety checkpoints. We focused on weekend nights because the 2007 NRS data illustrated that 12.4% of the nighttime drivers had positive BrACs but only 1.1% of daytime drinkers had positive BrACs (Lacey et al., 2009a). Additionally, the occurrence of a crash during nighttime hours has long been used as a surrogate measure for alcohol involvement (Voas et al., 2009).

In this study, we focused on the principal target group of the U.S. impaired-driving enforcement program, weekend nighttime drivers, to estimate the number of drug users likely to be among the arrestees for DWI. Specifically, we investigated the four research questions: (a) What percentage of weekend nighttime drivers with illegal (≥.08) BrACs also were using drugs? These are the offenders typically convicted of an alcohol offense and not tested for drugs. (b) What percentage of weekend nighttime drivers with positive BrACs below the illegal limit (<.08) also were using drugs? These are the offenders who are usually but not always tested for drugs. (c) What are the major drugs of abuse used by weekend nighttime drivers with positive BrACs? These are the drug users likely to be affected by increasing current DWI enforcement efforts. (d) How many weekend nighttime drivers are using and possibly abusing prescription and over-the-counter drugs? This is significant because of the need to consider protections for prescription users in the enforcement of per se laws that make any measureable amount of a drug in a driver's system an offense (Voas et al., 2012).

2. METHODS

2.1 Survey Procedures

The 2007 NRS sampling plan and survey procedures (approved by the Pacific Institute for Research and Evaluation's Institutional Review Board) are fully described in Lacey et al., (2011) and in Supplementary Material[1]. The survey involved police stopping motorists at 300 locations nationwide and directing them into safe off-road locations for an interview by specially trained survey personnel. Potential participants were assured that they had done

[1]Supplementary material can be found by accessing the online version of this paper at http://dx.doi.org and by entering doi:…

nothing wrong and had been randomly selected for participation in an anonymous, voluntary national survey. Interviewers briefly described the purpose of the research and the participant's role in the survey, which was to answer a brief set of questions and take a breath test. They were informed that they could earn up to $65 for some additional portions of the survey.

The survey began with a set of 22 questions covering basic demographics, annual mileage, origin and destination of their current trip, drinking, and drinking and driving; a breath sample was then collected. After completing this initial segment of the survey, which took about 5 minutes, participants provided an oral-fluid sample by holding the collection device under their tongues for 3 to 5 minutes. While providing that sample, participants completed a questionnaire covering drug use, drug-use disorders, alcohol-use disorders, and other topics (Lacey et al., 2009b).

2.2 Response Rate

Of the 8,537 nighttime drivers entering the survey sites, 8,384 were eligible to participate, drivers aged 15 and younger and commercial drivers were ineligible. Of the eligible drivers, 6,920 (82.50%) were interviewed and 7,159 (85.45%) breath tested; some drivers agreed to the breath test but did not have time for an interview. In the second phase, we collected 5,869 (70.0%) oral-fluid samples and 3,276 blood tests from the 8,384 eligible drivers. A total of 5,908 drivers had a breath-test result and either an oral-fluid or blood-test analysis result, or both.

2.3 Measures

2.3.1 Driver's BrAC—The CMI, Inc., Intoxilyzer™ 400, which is on NHTSA's Conforming Products List for Evidential Breath-Test Devices (NHTSA, 1993), was used to collect evidentiary BrACs of participating drivers. In addition, a passive alcohol sensor (PAS Vr.™, Fredericksburg, Virginia), which detects and measures alcohol in the air in front of the driver's face, was used to alert the interviewer to a driver who might need assistance. A high reading resulted in the initiation of an impaired-driving protocol, designed to keep intoxicated drivers off the road (Lacey et al., 2011). That measure also provided a basis, along with gender and time of night, for imputing BrACs for participants for whom evidential BrACs were not available. Overall, we imputed 13% of the BrACs in this study (Lacey et al., 2009c).

2.3.2 Driver Drug Use—We collected approximately 1 ml of saliva from each participant using the Quantisal collection device (manufactured by Immunalysis Corporation, Pomona, California). The tubes containing saliva from each data-collection weekend were packaged and sent overnight to Immunalysis, Inc., where screening analyses using enzyme-linked immunosorbent assays (ELISA) were conducted. Positive specimens were then reanalyzed using a separate sample of the fluid, using gas chromatography-mass spectrometry (GC/MS) or liquid chromatography with tandem mass spectral detection (LC/MS/MS). These procedures are fully described in Lacey et al. (2009c).

Blood samples were drawn from participants in nearby phlebotomy van by a certified phlebotomist, who followed the Occupation Safety and Health Administration's (OSHA's) standards. Blood samples were analyzed using ELISA; positive specimens were confirmed using either GC/MS or LC/MS/MS (Lacey et al., 2009c).

The analysis of oral-fluid and blood samples for the 2007 NRS covered more than 50 substances, including illegal, prescription (Rx), and over-the-counter (OTC) drugs, which are listed in Supplementary Material[2]. The results from the oral-fluid and blood analyses

were combined to identify drug use for this study. We compared the drivers' B rACs in two drug categories drawn from that larger analysis: (a) illegal drugs, including cocaine, cannabinoids, street drugs (such as PCP), street amphetamines (such as MDMA), and opiates (such as heroin); and (b) medications, including Rx and OTC drugs. Of the 699 drivers who tested positive for an illegal drug, 78 (11%) were also positive for a medicinal drug and were retained in the illegal group and not counted in the medicinal group to create mutually exclusive categories. In addition, we separately analyzed marijuana and cocaine, the only two drugs with enough cases for analysis.

2.3.3 Other Driver Variables—The survey included demographic questions covering age, ethnicity, education, and employment status; self-reported percentage of usual nighttime driving; and trip origin (bar, restaurant, friend's home, their home, and other). The time of the interview (early: 10 PM to midnight; late: 1 to 3 AM) was also included in the analysis. Participants also were asked (a) if they had been a driver in a nighttime crash, and (b) if they had been arrested for a DWI.

2.4 Data Analysis

We undertook the analyses in two steps. First, we conducted a multinomial logistic regression for each of the two classes and two individual drugs predicting the five BrAC categories: .00, >.00<.05, ≥.05<.08, ≥.08<.12, and ≥.12. These analyses did not include covariates. Next, to determine the robustness of the results of the first analysis, we explored the significance of nine factors that might influence the strength of the relationship between BrAC and drug use in drivers. We explored BrACs and nine other variables related to each of the four dependent drug categories entered in the analysis as binary quantities by using four logistic regressions. The control variables, driver demographics, driving history, and trip characteristics, were entered simultaneously. We analyzed the data using SAS statistical software (version 9.1; SAS Institute, Cary, North Carolina) and STATA 11 statistical software (StataCorp LP, College Station, Texas). Finally, we used the STATA procedure "svy" to accommodate the NRS sampling design and provide population estimates. Prevalence percentages throughout this paper and the two tables are based on weighted estimates, and *Ns* are actual counts of participants.

3. RESULTS

Table 1 shows the results of the multinomial logistic regression relating drug use to BrACs. Also shown are the percentages of all drivers in each row, column, or cell. The percentages are weighted to reflect national estimates using the system developed for the 2007 National Roadside Survey (Lacey et al., 2009a). The overall prevalence of illegal drug use was 3 times greater than medication (Rx/OTC) use, 12.4% compared to 3.9%. The percentage of all drivers with BrACs ≥.08 (columns 4 and 5 in Table 1) using an illegal drug was 29.4, approximately 3 times greater (OR3.53, CI 2.27–5.40) than for drivers with zero BrACs. The percentage of drug users rises with the BAC, suggesting that there is a significant correlation between the two indicators. This is misleading, however, because of the large number of zero cases. If only drivers with positive BACs are considered, the correlation between BAC and reported illegal drug use is $r = 0.043$, $p = .548$. Similarly, combining the two high BrAC levels, the percentage of drivers with illegal BrACs positive for marijuana (15.3%) or cocaine (9.8%) was also greater by a factor of 3 and 4.5, respectively, than for zero BrAC drivers. Similar differences were found for drivers with positive BrACs below the illegal .08 level. In contrast, there were no significant differences between zero and

[2]Supplementary material can be found by accessing the online version of this paper at http://dx.doi.org and by entering doi:…

positive BrAC drivers in the use of Rx or OTC drugs. Drivers not using drugs were about 60% less likely to have positive BrACs than drivers using drugs.

Table 2 provides the results of the four logistic regression analyses relating driver characteristics and BrACs to the four dependent drug measures. Ns and percentages in Table 2 are lower than in Table 1 due to missing data, resulting in the inclusion of additional variables. Adjusted ORs and 95% confidence intervals (CIs) are provided for each covariate. Based on the *Ns* in the table header, 86% of the respondents in the illegal drug category was accounted for by marijuana (54%) and cocaine (32%). Thus, the relationship of users of the two individual drugs (particularly marijuana) to those in the illegal category is high. After adjusting for covariates, the relationships between alcohol use and drug use (top line, Table 2) are slightly higher than in Table 1. Women were about half as likely as men to use illegal drugs. The overall illegal drug use by underage drivers, though not significantly less than young adults aged 21 to 34 (OR 0.83, CI 0.60–1.116) was more than double that of drivers aged 35 and older (OR 0.34, CI 0.22–0.53). Their use of cocaine, however, was lower than that of young adults. African Americans were more likely and Hispanics and all other ethnic groups less likely than White drivers to be using marijuana, but there were no significant ethnic differences in cocaine use. Drivers with graduate school training were less likely to be illegal drug users. Illegal drug users reported driving more at night, but drivers interviewed late at night were not more likely to be using illegal drugs.

Illegal drug users were less likely to be coming from a bar or restaurant but more likely to report a previous DWI arrest.

Drivers aged 35+ used medications (Rx/OTC) more often than underage drivers. Hispanic and All Other ethnic group drivers were less likely to use medications than were White drivers. Medication users were more likely to report a previous nighttime crash (OR=2.03, CI 123-3.35). We could not determine from our data whether involvement in a crash led to the use of a medication or whether medication use played a role in the crash. A positive BrAC at the roadside was not significantly associated with medication use, supporting the finding from Table 1 that medications do not account for the relationship of an illegal BrAC to illegal drug use.

4. DISCUSSION

4.1 Drivers with Illegal BrACs

Our first research aim was to determine the percentage of weekend nighttime drivers with illegal (≥.08) BrACs who were also using drugs. That number is approximately 25 to 30% (see Table 1). Most DWI enforcement occurs on weekend nights, suggesting those nights would provide a reasonable basis for estimating the current level of drug users among the 1.4 million arrested drivers reported to the FBI each year (Federal Bureau of Investigation, 2010). This suggestion is strengthened by a separate analysis we conducted of the 226 NRS drivers who reported a prior alcohol- or drug-related arrest in the 2007 NRS. Of those drivers, 24.7% was found to be using drugs. If current U.S. DWI arrest rates are proportional to the 2007 NRS figure of 25 to 30% of illegal drivers using drugs, then the number of drug users arrested each year could be in the range of 350,000 to 400,000. That figure reflects the 10 PM to 3 AM period. The proportion of DWI arrestees who are using drugs may be lower at other times. For example, only 11% of daytime compared to 14% of nighttime drivers in the 2007 NRS were using drugs (Lacey et al., 2009b). Conversely, because officers base their arrests on driver performance and because the combination of alcohol with another substance increases impairment, the number of drug-using drinking drivers apprehended by the police may be greater than the nighttime number in the 2007 survey. As noted, the actual figure is unknown (Compton et al., 2009); however, these figures suggest that between

300,000 and 400,000 drug users are currently being removed from the road by the U.S. impaired-driving enforcement system. Most of these probably receive at least a short license suspension for either refusing a chemical test or for having a BrAC ≥ .08.

4.2 Drivers with BrACs Lower than the Illegal Limit

Surprisingly, the answer to our second aim, the percentage of drug use by drivers with positive BrACs below the illegal level (combining columns 2 and 3 in Table 1), was 26%, not significantly lower than the percentage for drivers with illegal BrACs. This suggests that increasing the currently limited testing rate for drivers with BrACs below the legal limit could increase drug-driving convictions.

Our third objective was to determine the major drugs of abuse used by alcohol-impaired drivers. Our data clearly show that marijuana and cocaine make up 80% of the illegal drugs used by drinking drivers.

4.3 Major Drugs of Abuse Used by Drinking Drivers

The predominant illegal drug used by drivers in the 2007 NRS was cannabis, which supports the research indicating that marijuana is more prevalent in North America than in Europe (Jones et al., 2003). Our result is consistent with that of Beirness and Beasley (2010) who also found cannabis and cocaine to be the two most often-used drugs in the province of British Columbia, Canada. These results indicate that up to 30% of the U.S. drivers with illegal BrACs ≥.08 are drug positive, which would place them in the “extremely high-risk” category as defined in the DRUID program (Hels et al., 2011). How much the combined use of an illegal drug and alcohol increases crash risk varies substantially with the type of substance, the legal (country) environment, and the type of research conducted (Shinar, 2007). An example provided in the DRUID report (Hels et al., 2011) shows six adjusted ORs for being seriously injured in a crash in six countries. The OR estimates for the drug-alcohol combination varied from 7.20 in Italy to 148.7 in Finland. All of the ORs were substantially higher than for cannabis or cocaine alone. The possible synergic effect of the alcohol-drug combination was also noted in 4 of the 10 studies included in the meta-analysis of the crash risk associated with cannabis use by Asbridge et al. (2012). Other studies, however, have failed to find a potentiating effect. Penning et al. (2010) in their meta-analysis found that the significant relationship between cannabis and crash involvement disappeared when corrected for the presence of a positive BrAC. Romano and Voas (2011) in a recent study of drugs in drivers fatally injured in single-vehicle crashes obtained a similar result. The Walsh et al. (2005) study of crash-injured drivers admitted to an emergency room of a Maryland hospital found little difference in the percentage of drinking versus nondrinking drivers who were using drugs. Ramaekers et al. (2004) in their review of cannabis crash culpability studies found that the cannabis-alcohol combination did not produce substantially higher ORs than alcohol alone. Thus, though there is some controversy regarding the significance of the alcohol-marijuana combination, the alcohol-impaired drivers apprehended in the United States may include some of the highest-risk drug users because of this combined use.

4.4 Driver Use of Medications

Though impossible to determine how many medicated drivers had been using the substances legally, the data suggest that the association between a positive BrAC and drug use among drivers is not the abuse of medications, but the consumption of illegal substances. In the 2007 NRS, a higher percentage of zero BAC drivers was found to be using medications than drivers with positive BrACs. With an aging population, more Rx-using drivers would be expected in the future. This will complicate any zero per se drugged-driving laws that expose prescription holders to a charge of DWI (Voas et al., 2012).

4.5 Characteristics of Drinking Drivers Who Use Drugs

We conducted the regression analysis (Table 2) of the two individual drugs and the two categories of drugs primarily to demonstrate that the BrAC/illegal drug-use relationship is robust, but it also identified several items of interest concerning drug use by drivers. As cannabis and cocaine accounted for more than 80% of the illegal drugs detected in the participating drivers, the ORs for those substances provided the primary findings of interest. In keeping with their prevalence among drinking drivers, female ORs for marijuana were only half those of males. More interesting though is the relationship of age to drug use. Drivers aged 20 and younger were far more likely to use marijuana than adults were. They were nearly twice as likely to be cannabis positive than adults aged 21 to 34, which NHTSA has identified as the age group for involvement in fatal crashes, and eight times more likely than adults aged 45 and older to be marijuana-positive. This is consistent with the 1996 Household Survey of Drug Abuse (SAMHSA, 1998), which found that 13% of the respondents aged 20 and younger compared to 5% of those aged 21 and older reported driving after drug use. This appears to reflect the increasing use of cannabis by teenagers and college students. The picture is quite different for cocaine use, which was primarily found in the high-risk driver group aged 21 to 34. This apparent association of type of drug use by age warrants additional study. African-American drivers in the 2007 survey were twice as likely to use cannabis as White drivers were, and Hispanic drivers where half as likely to use marijuana. The reasons for these cultural differences are complex and beyond adequate analysis here. Overall, among demographic factors, age and gender appear to be the most important moderators of drugged driving.

4.6 Limitations of this Study

The limitations of the 2007 NRS study—the first in which both alcohol and drugs were tested—should be kept in mind when interpreting the results. Although the 2007 NRS was a stratified random sample of the 48 U.S. contiguous states, the sampling period for this study was limited to Friday and Saturday nights when alcohol-impaired drivers are most prevalent. Drug use by high-BAC drivers at other times may vary from those reported here. Further, 29% of the eligible drivers did not participate in all elements of the data collection. However, the high rate of participation in the breath test and the willingness of respondents to report prior DWI arrests suggest that most participants were reasonably comfortable with the survey. About a third of the refusers appear to have been concerned with the oral-fluid or blood test.

4.7 Probable Effect Per Se Laws

The probable effect of the adoption by all states of drugged-driving per se laws as recommended by the ONDCP is uncertain. Presumably, per se laws would provide for drug testing of all drivers currently being arrested for DWI. However, the expense involved in the laboratory analytic procedures for drugs will likely continue to discourage drug testing. To achieve a higher drugged-driving testing rate, it may be necessary to enhance the existing sanctions for the DWI offense if both alcohol and another drug are used. One procedure for which there is precedent is to make the use of drugs an aggravating factor in the DWI offense. Currently, many states provide for enhanced sanctions for DWI offenders with very high (.15) BrACs (McCartt and Northrup, 2004). Florida, among other states, provides for enhanced DWI penalties for child endangerment. Because treating and monitoring comorbid offenders with both alcohol and drug problems involves more time and expense, enhanced penalties for such offenders may be appropriate and can help justify the increased cost of drug testing. If drugged-driving per se laws ensured drug testing of all individuals arrested for DWI, it might have a general deterrent effect on combining drinking with drug use. The relationship between a high BrAC and drug use also suggests that programs or laws that increase the arrests of drinking drivers, such as conducting sobriety checkpoints or lowering

the BAC limit from .08 to .05, will increase the apprehension of drugged drivers. In sum, it appears that under the current alcohol-oriented DWI enforcement system, a substantial number of drug-using drivers is arrested. This offers opportunities for increasing the apprehension of drug-using drivers by strengthening alcohol enforcement.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

ROLE OF FUNDING SOURCE

The 2007 National Roadside Survey from which the data for this study were used was funded by the National Highway Traffic Safety Administration under contract number DTNH22-6-C-00040 and by the National Institute on Alcohol Abuse and Alcoholism under grant R01 AA0016407. The analysis and reporting of the data were supported by the National Institute on Alcohol Abuse and Alcoholism under grants R01 AA0016407, R01 AA018352, and P20 AA017831.

References

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. Retrieved from http://www.bmj.com/content/344/bmj.e536. [PubMed: 22323502]

Beirness DJ, Beasley EE. A roadside survey of alcohol and drug use among drivers in British Columbia. Traffic Inj Prev. 2010; 11:215–221. [PubMed: 20544564]

Berghaus, G.; Sticht, G.; Greliner, W.; Lenz, D.; Naumann, T.; Wiesenműller, S. DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) Deliverable 112b. Federal Highway Research Institute; Bergisch-Gladbach, Germany: 2010. Meta-analysis of empirical studies concerning the effects of medicines and illegal drugs including pharmacokinetics on safe driving. Available from http://www.druid-project.eu/cln_031/nn_107548/Druid/EN/deliverales-list/downloads/Deliverable__1__1__2__B,templateId=raw,property=publicationFile.pdf/Deliverable_1_1_2_B.pdf Accessed

Boorman, M.; Owens, K. An Evaluation of the Deterrent Value of Random Breath Testing (RBT) and Random Drug Testing (RDT) across Australia (abstract). T2010 Conference; 22–26 August 2010; International Conference on Alcohol, Drugs and Traffic Safety (ICADTS); Oslo, Norway. 2010. p. 36

Boorman, M.; Swann, P. Victorian Impaired Driving Legislation (2000) and Random Roadside Oral Fluid Legislation (2004): Theory and Results of 2 Different Enforcement Strategies (abstract). T2010 Conference; 22–26 August 2010; International Conference on Alcohol, Drugs and Traffic Safety (ICADTS); Oslo, Norway. 2010. p. 35

Compton, R.; Vegega, M.; Smither, D. Report No DOT HS 811 268. U.S Department of Transportation, National Highway Traffic Safety Administration; Washington, DC: 2009. Drug-Impaired Driving: Understanding the Problem and Ways to Reduce It (A Report to Congress). Available from http://www.nhtsa.gov/staticfiles/nti/pdf/811268.pdf

Drummer OH, Gerostamoulos J, Batziris H, Chu M, Caplehorn J, Robertson MD, Swann P. The involvement of drugs in drivers of motor vehicles killed in Australian road traffic crashes. Accid Anal Prev. 2004; 36:239–248. [PubMed: 14642878]

Dussault, C.; Brault, M.; Bouchard, J.; Lemire, AM. The Contribution of Alcohol and Other Drugs Among Fatally Injured Drivers in Quebec: Some Preliminary Results. In: Mayhew, DR.; Dussault, C., editors. International Council on Alcohol, Drugs and Traffic Safety; Proceedings of Alcohol, Drugs and Traffic Safety - T 2002: 16th International Conference on Alcohol, Drugs and Traffic Safety; August 4–9, 2002; Montreal, Canada. 2002. p. 423-430.

Federal Bureau of Investigation. Crime in the United States, 2009. U.S Department of Justice, Federal Bureau of Investigation; Washington, DC: 2010. Available from http://www2.fbi.gov/ucr/cius2009/index.html

Gadegbeku, B.; Amoros, E. the SAM Group. DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) Deliverable. Federal Highway Research Institute; Bergisch-Gladbach, Germany: 2010. Responsibility Study: Main Illicit Psychoactive Substances Among Car Drivers Involved in Fatal Road Crashes in France; p. 232Available from http://www.druid-project.eu/cln_031/nn_107548/Druid/EN/deliverales-list/downloads/Deliverable__2__3__2,templateId=raw,property=publicationFile.pdf/Deliverable_2_3_2.pdf

Hels, T.; Bernhoft, IM.; Lyckegaard, A.; Houwing, S.; Hagenzieker, M.; Legrand, S.; Isalberti, C.; Van der Linden, T.; Verstraete, A. DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) Deliverable D235. Federal Highway Research Institute; Bergisch-Gladbach, Germany: 2011. Risk of Injury by Driving with Alcohol and Other Drugs. Available from http://www.druid-project.eu/cln_031/nn_107548/Druid/EN/deliverales-list/downloads/Deliverable__2__3__5,templateId=raw,property=publicationFile.pdf/Deliverable_2_3_5.pdf

Jones, RK.; Shinar, D.; Walsh, JM. DOT HS 809 642. National Highway Traffic Safety Administration; Washington, DC: 2003. State of Knowledge of Drug-Impaired Driving.

Krismann, M.; Schőch, H.; Knoche, A.; Hargutt, V.; Klipp, S. DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) Deliverable. Federal Highway Research Institute; Bergisch-Gladbach, Germany: 2010. Evaluation of Legal Measures to Combat DUI/DUID; p. 141Available from http://www.druid-project.eu/cln_031/nn_107548/Druid/EN/deliverales-list/downloads/Deliverable__1__4__1,templateId=raw,property=publicationFile.pdf/Deliverable_1_4_1.pdf

Lacey, J.; Kelley-Baker, T.; Furr-Holden, CDM.; Voas, R.; Romano, E.; Torres, P.; Tippetts, AS.; Ramirez, A.; Brainard, K.; Berning, A. DOT HS 811 248. U.S. Department of Transportation, National Highway Traffic Safety Administration; Washington, DC: 2009a. 2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Alcohol Results. Available from http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/2007+National+Roadside+Survey+of+Alcohol+and+Drug+Use+by+Drivers

Lacey, JH.; Kelley-Baker, T.; Furr-Holden, CDM.; Voas, R.; Romano, E.; Ramirez, A.; Brainard, K.; Moore, C.; Torres, P.; Berning, A. DOT HS 811 249. U.S. Department of Transportation, National Highway Traffic Safety Administration; Washington, DC: 2009b. 2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Drug Results. Available from http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/2007+National+Roadside+Survey+of+Alcohol+and+Drug+Use+by+Drivers

Lacey, JH.; Kelley-Baker, T.; Furr-Holden, D.; Voas, RB.; Moore, C.; Brainard, K.; Tippetts, AS.; Romano, E.; Torres, P.; Berning, A. Report No DOT HS 811 237. U.S. Department of Transportation, National Highway Traffic Safety Administration; Washington, DC: 2009c. 2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Methodology. Available from http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/2007+National+Roadside+Survey+of+Alcohol+and+Drug+Use+by+Drivers

Lacey JH, Kelley-Baker T, Voas RB, Romano E, Furr-Holden CD, Torres P, Berning A. Alcohol- and drug-involved driving in the United States: methodology for the 2007 National Roadside Survey. Eval Rev. 2011; 35:319–353. [PubMed: 21997324]

Maxwell JC, Freeman J, Davey J. Too young to drink but old enough to drive under the influence: a study of underage offenders as seen in substance abuse treatment in Texas. Drug Alcohol Depend. 2009; 104:107–112. [PubMed: 19473785]

McCartt AT, Northrup VS. Effects of enhanced sanctions for high-BAC DWI offenders on case dispositions and rates of recidivism. Traffic Inj Prev. 2004; 5:270–277. [PubMed: 15276928]

Movig KL, Mathijssen MP, Nagel PH, van Egmond T, de Gier JJ, Leufkens HG, Egberts AC. Psychoactive substance and the risk of motor vehicle accidents. Accid Anal Prev. 2004; 36:631–636. [PubMed: 15094417]

National Highway Traffic Safety Administration. Highway Safety Programs; Model Specifications for Devices to Measure Breath Alcohol (17 September Notices). Federal Register. 1993; 58:48705.

National Highway Traffic Safety Administration. Report No DOT HS 811 415. NHTSA's National Center for Statistics and Analysis; Washington, DC: 2010. Traffic Safety Facts: Crash Stats - Drug Involvement of Fatally Injured Drivers. Available from http://www-nrd.nhtsa.dot.gov/Pubs/811415.pdf

Office of National Drug Control Policy. National Drug Control Strategy, 2010. Office of National Drug Control Policy; Washington, DC: 2010. Available from http://www.whitehousedrugpolicy.gov/publications/policy/ndcs10/ndcs2010.pdf

Penning R, Veldstra JL, Daamen AP, Olivier B, Verster JC. Drugs of abuse, driving and traffic safety. Curr Drug Abuse Rev. 2010; 3:23–32. [PubMed: 20088818]

Ramaekers JG, Berghous G, van Laar M, Drummer OH. Dose related risk of motor vehicle crashes after cannabis use. Drug Alcohol Depend. 2004; 73:109–119. [PubMed: 14725950]

Romano E, Voas RB. Drug and alcohol involvement in four types of fatal crashes. J Stud Alcohol Drugs. 2011; 72:567–576. [PubMed: 21683038]

Schulze, H.; Schumacher, M.; Urmeew, R.; Auerbach, K. DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) Deliverable 018. Federal Highway Research Institute; Bergisch-Gladbach, Germany: 2011. Work Performed, Main Results and Recommendations. Available from http://www.druid-project.eu/cln_031/nn_1109608/Druid/EN/deliverales-list/deliverables-list-node.html?__nnn=true

Shinar, D. Traffic Safety and Human Behavior. Elsevier; Kidlington, Oxford: 2007.

Smith JA, Hayes CE, Yolton RL, Rutledge DA, Citek K. Drug recognition expert evaluations made using limited data. Forensic Sci Int. 2002; 130:167–173. [PubMed: 12477639]

Substance Abuse and Mental Health Services Administration. 1998 National Household Survey on Drug Abuse. Department of Health and Human Services; Rockville, MD: 1998.

Voas RB, DuPont RL, Shea CL, Talpins SK. Prescription drugs, drugged driving and per se laws. Inj Prev. 2012 epub ahead of print.

Voas RB, Romano E, Peck R. Validity of surrogate measures of alcohol involvement when applied to nonfatal crashes. Accid Anal Prev. 2009; 41:522–530. [PubMed: 19393802]

Walsh, JM. DOT HS 811 236. National Highway Traffic Safety Administration; Washington, DC: 2009. A State-by-State Analysis of Laws Dealing with Driving Under the Influence of Drugs. Available from http://druggeddriving.org/pdfs/WalshStatebyStateDrugLawsAnalysis811236.pdf

Walsh JM, Flegel R, Atkins R, Cangianelli LA, Cooper C, Welsh C, Kerns TJ. Drug and alcohol use among drivers admitted to a Level-1 trauma center. Accid Anal Prev. 2005; 37:894–901. [PubMed: 15927139]

Ward, NJ.; Dye, L. Cannabis and Driving: A Review of the Literature and Commentary (ISSN 1468–9138). Department of the Environment, Transport and the Regions; London, UK: 1999.

Table 1

Multinomial logistic regressions models examining the relationship between drug use and BAC by 5,908 weekend nighttime (10 PM to 3 AM) drivers in the 2007 National Roadside Survey

	Substance *(total n=5908, 100% of total)*									
	Any illegal drug N=699; 12.4%		**Marijuana N=379; 6.8%**		**Cocaine N=225; 2.7%**		**Rx/OTC N=277; 3.9%**		**No Substance N=4935, 83.7%**	
BAC g/dL level *(total n=5908, 100 % of total)*	**OR, lower CI-upper CI**	**%**	**OR, lower CI-upper CI**	**%**	**OR, lower CI-upper CI**	**%**	**OR, lower CI-upper CI**	**%**	**OR, lower CI-upper CI**	**%**
BAC ≤ 0.12 g/dL	4.05*		2.02		8.43*		0.69		0.32*	
(*n*=43, 0.7%)	2.11–7.78	33.3	0.77–5.30	11.9	3.95–18.0	21.4	0.11–4.33	2.4	0.17–0.69	64.3
BAC ≥ 0.08 < 0.12 g/dL	3.29*		3.35*		3.68*		0.53		0.40*	
(*n*=88, 1.5%)	2.03–5.34	27.4	1.88–5.90	17.9	1.80–7.53	10.7	0.12–2.30	2.4	0.25–0.64	70.2
BAC ≥ 0.05 < 0.08 g/dL	3.27*		2.75*		3.85*		0.87		0.37*	
(*n*=112, 1.2%)	2.07–5.16	28.1	1.54–4.90	14.7	1.98–7.48	10.5	0.29–2.61	3.1	0.24–0.58	68.8
BAC > 0.00 to < 0.05 g/dL	2.96*		2.55*		3.36*		0.75		0.42*	
(*n*=424, 71.7%)	2.35–3.72	25.8	1.90–3.41	13.7	2.36–4.78	9.6	0.43–1.31	3.1	0.34–0.52	71.1
BAC=0.00 g/dL										
(*n*=5241, 88.7%)	*reference*	10.5	*reference*	5.9	*reference*	2.3	*reference*	4.0	*reference*	*85.4*

Odds ratios (OR) and 95% confidence intervals (CI) for presence of substance listed above. *Ns* are observed values, prevalence data (percentages) are weighted to represent the national level using NRS procedure described in Lacey et al., 2009a. Marijuana (379) and cocaine (225) included in the 699 illegal drug category. Overlapping cases: illegal category includes 78 Rx/OTC cases and cocaine includes 33 Rx/OTC cases that were excluded from the Rx/OTC category. Marijuana had no overlapping cases.

* $p<.01$

Table 2

Logistic regression models examining blood alcohol concentration (BAC g/dL) and selected characteristics as predictors for driver's use of illegal subtances or Rx/OTC (prescription and over-the-counter medications) as determined by oral fluid or blood sample, 2007 NRS, n=4,286.

Characteristics	Any illegal drug N=699; 11.3%	Marijuana N=379; 6.8%	Cocaine N=225; 2.7%	Rx/OTC N=277; 3.9%
	OR, lower CI-upper CI	OR, lower CI-upper CI	OR, lower CI-upper CI	OR, lower CI-upper CI
BAC g/dL level:				
BAC ≥0.08 g/dL	4.08, 2.53–6.59[1]	4.21, 1.54–11.50[1]	4.18, 2.67–6.56[1]	0.73, 0.30–1.74
BAC > 0.00 to < 0.08g/dL	3.96, 2.38–6.57[1]	3.35, 1.69–6.64[1]	3.51, 2.61–4.72[1]	0.93, 0.48–1.77
BAC=0.00 g/dL	*reference*	*reference*	*reference*	*reference*
Gender:				
Women	0.55, 0.43–0.70[1]	0.51, 0.42–0.62[1]	0.62, 0.35–1.08	1.32, 0.94–1.84
Men	*reference*	*reference*	*reference*	*reference*
Age:				
21–34	0.83, 0.60–1.16	0.42, 0.31–0.58[2]	2.27, 1.21–4.27[2]	0.91, 0.47–1.77
35–44	0.34, 0.22–0.53[1]	0.14, 0.08–0.24[1]	1.48, 0.67–3.21	3.32, 1.71–6.49[1]
45+	0.24, 0.12–0.47[1]	0.03, 0.01–0.07[1]	1.67, 0.55–5.06	1.80, 1.20–2.69[1]
< 21	*reference*	*reference*	*reference*	*reference*
Ethnicity:				
African American	1.90, 1.45–2.42[1]	2.46, 1.66–3.63[1]	1.37, 0.88–2.12	0.88, 0.44–1.74
Hispanic	0.59, 0.46–0.77[1]	0.48, 0.33–0.72[1]	0.90, 0.62–1.29	0.68, 0.52–0.88[1]
Other	4.78, 0.56–1.09	1.12, 0.75–1.65	0.53, 0.25–1.11	0.20, 0.07–0.55[1]
White	*reference*	*reference*	*reference*	*reference*
Education:				
Did not graduate high school	1.07, 0.79–1.44	0.84, 0.47–1.50	1.52, 0.96–2.42	1.35, 0.71–2.56
Some college to graduate school	0.45, 0.37–0.54[1]	0.74, 0.55–1.02	0.29, 0.21–0.39[2]	1.02, 0.65–1.62
High school graduate	*reference*	*reference*	*reference*	*reference*
Employment:				
Student	1.05, 0.08–1.38	0.80, 0.50–1.28	1.39, 0.56–3.49	0.65, 0.26–1.66
Other	0.76, 0.47–1.23	0.76, 0.39–1.45	0.58, 0.27–1.25	1.05, 0.55–2.01
Employed/self-employed	*reference*	*reference*	*reference*	*reference*
Normal daytime/nighttime driving pattern:				
Percentage of nighttime driving >40%	1.51, 1.08–2.12	1.36, 0.95–1.95	1.54, 0.97–2.43	1.20, 0.83–1.74
0-40%	*reference*	*reference*	*reference*	*reference*
Surveyed late at night:				
1 to 3 AM	0.92, 0.74–1.16	0.69, 0.52–0.93[2]	1.12, 0.77–1.62	1.03, 0.54–1.96
10 PM to midnight	*reference*	*reference*	*reference*	*reference*
Trip origin:				

Characteristics	Any illegal drug N=699; 11.3%	Marijuana N=379; 6.8%	Cocaine N=225; 2.7%	Rx/OTC N=277; 3.9%
	OR, lower CI-upper CI	OR, lower CI-upper CI	OR, lower CI-upper CI	OR, lower CI-upper CI
bar, tavern, restaurant	0.73, 0.55–0.97[2]	0.79, 0.43–1.44	0.91, 0.54–1.55	0.82, 0.54–1.25
All other origination places	*reference*	*reference*	*reference*	*reference*
Previous nighttime crash	1.19, 0.85–1.67	1.44, 0.85–2.43	0.56, 0.32–0.99[2]	2.03, 1.23–3.35[1]
No prior nighttime crash	*reference*	*reference*	*reference*	*reference*
Prior arrest for alcohol/drug use	1.73, 1.36–2.20[1]	0.91, 0.48–1.73	2.74, 1.22–6.14	0.58, 0.23–1.51
No prior arrest for alcohol/drug	*reference*	*reference*	*reference*	*reference*

Data are from the 2007 National Roadside Survey (Lacey, et.al. 2009). *Ns* are observed values, prevalence data (percentages) are weighted to represent the national level using NRS procedure described in Lacey et al., 2009a Marijuana (379) and Cocaine (225) included in the 699 illegal drug category. Overlapping cases: illegal category includes 78 Rx/OTC cases and cocaine includes 33 Rx/OTC cases that were excluded from the Rx/OTC category. Marijuana had no overlapping cases.

[1] $p<.01$,

[2] $p<.05$