Published in final edited form as:
J Psychoactive Drugs. 2013 ; 45(3): 211–217. doi:10.1080/02791072.2013.804230.

Marijuana as a Predictor of Concurrent Substance Use Among Motor Vehicle Operators

Michael Scherer, Ph.D.[a], **Robert B. Voas, Ph.D.**[b], and **Debra Furr-Holden, Ph.D.**[c]

[a]Post-Doctoral Fellow, Department of Mental Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

[b]Pacific Institute for Research and Evaluation, Calverton, MD

[c]John Hopkins University, Baltimore, MD

Abstract

Despite the adverse effects associated with marijuana abuse and dependence, marijuana is becoming more common-place in activities such as driving. Previous literature has discussed the high rates of cocaine, opioid and benzodiazepine use among users of marijuana, but no research has addressed the rates of concurrent use among drivers meeting Abuse or Dependence criteria. Each of these substances may produce effects detrimental to driving safety which may be compounded by concurrent substance use. This research examines rates of marijuana use, abuse and dependence among an active sample of drivers (N = 7,734) in the 2007 National Roadside Survey. Mean age of participants was 36.89 years, and the majority was male (60.1%) and identified as White (59.2%). Participants who used marijuana but did not meet diagnostic criteria for Abuse (n = 165) or Dependence (n = 112) were significantly more likely to test positive for all substances than were those who did not use marijuana. Further, those that met criteria for Marijuana Abuse or Dependence were more likely than those who did not meet criteria to test positive for THC, cocaine and benzodiazepines and THC, cocaine, and opioids respectively. The current research has implications for policy development and drugged driving interventions.

Keywords

Marijuana; Cocaine; Opioids; Benzodiazepines; Driving

Despite adverse effects of non-medicinal marijuana use (Hall & Degenhardt, 2009) its recreational use has steadily increased (Bostwick, 2012) to the point where marijuana is now the single most used illicit substance (United Nations Office on Drugs and Crime, 2011). Furthermore, the legalization of marijuana has seen continuous momentum (Mendes, 2010) likely resulting from increased social acceptance of the substance and its use. Increased social acceptance of a substance likely results in an increase in its use in common-place activities such as driving. This is of concern as marijuana use impedes response times (Hart

Please address correspondence to Michael Scherer, Ph.D., Johns Hopkins University, Bloomberg School of Public Health, Department of Mental Health, 624 N. Broadway, 8th floor, 895, Baltimore, MD 21205; phone: 443-287-8271; fax: 410-955-0237; mscherer@jhsph.edu.

et al., 2010), coordination and motor functioning (Lane et al., 2004) all of which are important behaviors associated with safe driving. Marijuana is the most prevalent drug in U.S. roadside surveys where it has been detected in 7% of weekend drivers (Lacey et al. 2009b), and the most prevalent drug detected in fatally injured drivers (25% of those tested for drugs; Office of National Drug Control Policy, 2011).

Two recent studies have found a modest but significant relationship between marijuana and crash involvement. Li et al. (2011) conducted a meta-analysis of the last 20 years and found 9 studies which addressed marijuana use and crash involvement and reported a pooled odds ratio of 2.66 (95% CI: 2.07–3.41) with the relationship to crash involvement rising in a dose response relationship. Laumon et al. (2005) compared 6,766 culpable crash-involved drivers with 3,006 non-culpable drivers and found that the crash responsible drivers were 2.4 times more likely to use marijuana and also found support for a dose response relationship. The 2011 report by Hels et al. on 9 European countries called the Driving Under the Influence of Drugs, Alcohol and Medications (DRUID) program found the risk of driving with marijuana use was similar to the risk of driving with low alcohol concentration. While a large number of studies of crash involved drivers have reported a positive relationship between presence of marijuana and crash involvement, establishing a firm relationship has been difficult because of the variability between studies (see Ward & Dye, 1999; Moskowitz, 2006; Shinar, 2007).

Much of the extant literature has focused on alcohol as the chief contributor to driving under the influence (DUI) when, in fact, drivers between the ages of 21–25 are 2.5 times more likely to use marijuana and other drugs and drive rather than to drink alcohol and drive (Fergusson et al., 2008). In the United States, one in six teenagers have driven under the influence of marijuana (Anderson et al., 2010) and approximately half of those who use marijuana are under the influence while operating motor vehicles (Johnson & White, 1989). Those that use marijuana and drive are at considerable risk of crash involvement, similar to those who consumed only alcohol (Anderson et al., 2010; Fergusson et al., 2008). In a case control study of 1,105 automobile accidents in which at least one vehicle occupant was taken to the hospital, Blows et al. (2005) asked drivers to self-report marijuana use in the three hours prior to the crash in the twelve months prior to the crash. They found a that habitual marijuana users were over nine times more likely than non-users to be involved in car crashes with injuries (OR = 9.5, 95% CI = 2.8–32.3).

An extensive body of research has discussed the propensity of those using marijuana to use other substances as well (Bonn-Miller & Zvolensky, 2009; Olthuis, Darredeau, & Barrett, 2012; Nakawaki & Crano, 2012). This has been studied in terms of marijuana use and the concurrent use of alcohol (Blows et al., 2005), cocaine (Higgins et al., 2007; Lindsay et al., 2009), opioids (Subramaniam et al., 2010) and/or benzodiazepines (Yacoubian, 2003). The concurrent use of these substances with marijuana may compound risks associated with driving under the influence as each may further impair drivers. In a study of stimulant users, Mann et al. (1993) found that those using cocaine were 2–3 times more likely to be involved in automobile accidents than the general public. Similar research has found that use of benzodiazepines results in slowed reaction time and increases in tracking errors, while the use of opioids results in impaired concentration, reduced information processing times, ability to track objects, and poorer visual acuity (Leung, 2011). Obviously, such consequences of use could have serious impacts on driving and may be compounded when used in conjunction with marijuana. Despite these concerns, however, the knowledge of the actual rates of marijuana use and concurrent use of other substances among drivers not involved in hospitalizations or crashes is limited.

Concerns of having an active polysubstance user driving a vehicle under the influence are palpable. Hels, et al. (2011) report on the 9-nation DRUID study placed "multiple drug combinations" in their highest crash risk category. However, until recently data on the rates motor vehicle operators use marijuana and other drugs have been derived from crash sites, hospital visitations or arrests in which the operator is suspected of being under the influence of a substance. Though these situations provide convenient opportunities to estimate substance use among drivers, they do not provide an adequate picture of the rates of substance use by the general driving population. This is because drivers who use substances are often not involved in accidents, hospitalizations or arrests. Recently, roadside surveys in which oral fluid has been collected to provide a basis for measuring drug prevalence have been conducted under the DRUID program in Europe (Hels, et al., 2011) and by Lacey, et al. (2009a) in the United States. The current study makes use of the Lacey et al. data to examine the prevalence of substance use, abuse and dependence in a random sample of drivers at risk for substance use but not involved in arrests or injured in crashes. Specifically, we examine the rates of marijuana use, abuse and dependence among drivers and compare the three levels of marijuana users to non-users on rates of cocaine, opioid and benzodiazepine use. Given the literature on this topic, we would expect to see significant increases in the use of cocaine, opioids and benzodiazepines among marijuana users when compared to non-users. Similarly, as alcohol is the second most used substance while driving, we would expect to see elevated blood alcohol content levels among marijuana users when compared to non-users. Finally, we differentiate the three conditions of marijuana use based on clinical abuse and dependence criteria to determine if increased marijuana use predicts polysubstance use.

Method

Sample

The current study is a secondary analysis of data from the 2007 U.S. National Roadside Survey (NRS) which was designed to estimate the prevalence of substance use and misuse among a random sample of day and nighttime weekend drivers in the 48 contiguous states. Participants completed self-report measures and biological measures including breath tests, oral fluid samples and blood samples. The data gathered in this study represent the first U.S. national prevalence estimate of substance use among active motor vehicle operators. For the current study we used a subset (N = 7,734) of the total sample who provided demographic and substance use data. Because the 2007 NRS is described elsewhere (Lacey et al., 2009b; Lacey et al. 2011) it is outlined below only as it is relevant to the current study.

Participants of the 2007 NRS were randomly selected weekend nighttime drivers at designated roadside locations across the contiguous United States (See Lacey et al., 2009b; 2011). Drivers were flagged down by police officers whom directed them to off road study personnel between 10 pm and 3 am on Friday and Saturday nights. Participants were informed that they had done nothing wrong but been selected at random to participate in a national survey and that they would remain anonymous. Recruiting and survey procedures were approved by the Pacific Institute's Institutional Review Board. Drivers who provided informed consent were breath tested and participated in a brief, 22 question interview covering demographics, driving and alcohol use. Participants were then offered the opportunity to earn $5 for completing an alcohol use survey (not reported herein), and an additional $10 to provide oral fluid samples and complete a drug use survey. Finally they were offered an additional $50 to provide a blood sample. Oral fluid and blood samples were used to screen for a variety of substances including -but not limited to - marijuana, cocaine, opioids, and benzodiazepines. Of the 10,909 eligible drivers (commercial drivers and drivers under 16 were not interviewed) who entered the site, 9,094 agreed to participate in the basic interview, 7,719 provided an oral fluid sample, 3,276 provided blood samples and 7,882 responded to the drug questionnaire (Lacey 2009b). This study was based on 7,734. Participants were between the ages of 16 and 93 (M_{age} = 36.89, *sd* = 15.16) and the majority of the sample was male (60.1%) and identified as White (59.2%). Twenty-five percent of the sample reported having used marijuana at some point in their lives (See Table 1).

Measures

General Demographics—Participant self-reported demographic information including age, sex, race, distance from home and highest education level attained. Study personnel recorded the time of day in which data was gathered.

Substance Use Information—Participants BAC was measured using hand held breath test device, the CMI Inc. Intoxilyser 400™. Participants also provided oral fluid and blood samples which were forwarded to the Immunalysis Corp. in Pomona California for screening using enzyme linked immunoabsorbent assays followed by verification of positive samples with mass spectral detection using liquid chromatography-mass spectrometry. Approximately 50 substances were covered by this analysis (See Lacey, 2009b, p. 35 for detailed list), but only marijuana, cocaine, opioids, and benzodiazepines were examined in the current study as these were the most frequently found substances in the sample. Participants also self-reported use of marijuana, cocaine, opioids, and benzodiazepines in which they reported whether they had used the substances in the *past 24 hours, past two days, past month, past year, over a year ago*, or *never*.

Drug Use Disorder (DUD) Questionnaire (Scherer et al., 2013)—Only participants who reported using marijuana completed the DUD. The DUD was based on the Alcohol Use Disorder questionnaire and Associated Disabilities Diagnostic Interview Schedule (AUDADIS; Cottler et al., 1997; Grant & Dawson, 1997). The DUD has a single item per symptom for Substance Abuse and Substance Dependence as listed in the Diagnostic and Statistical Manual of Mental Disorders, fourth edition, text revision (DSM-IV-TR; American Psychiatric Association, 1994). Participants who reported marijuana use were then placed into one of three categories based on their responses to DUD items – "Marijuana Use" encompassed those who had used marijuana but did not meet criteria for either diagnosis. “Marijuana Abuse” and “Marijuana Dependence” were reserved for those who met the diagnostic criteria for either. As is the case in the DSM-IV-TR, participants could not be placed into both Abuse and Dependence categories. Rather, if requirements for both were met, participants were categorized as Marijuana Dependent.

Statistical Analyses

Chi-square statistics were conducted to determine significant differences in substance-related factors among conditions of marijuana use categories. A series of logistic regression analyses were conducted to determine differences between marijuana use categories, positive indicators of blood or oral fluid for tetrahydrocannabinol (THC – the principal psychoactive constituent found in marijuana), cocaine, opioids, benzodiazepines, and BAC levels. Age, sex and race were controlled in all logistic regressions. All statistical analyses used SPSS v. 18.0 (SPSS Inc., Chicago, IL).

Results

Chi-square analyses were used to identify differences between groups for each of the substance-related variables. A significant difference was found between categories of marijuana use on levels of measured BAC as well as other substance use (See Table 2).

A series of logistic regression analyses were performed to assess the ability of marijuana use categories to predict positive indicators of THC, cocaine, opioids, and benzodiazepines in oral fluid and/or blood samples. Table 3 displays the associations between marijuana use categories and each of these substances. The overall model predicting marijuana use was significant ($p < .001$) indicating the model was able to distinguish between those who used marijuana and those who did not. After controlling for the effects of age, sex and race, marijuana use categories were significant predictors of positive substance indicators – primarily when comparing the Non-use marijuana condition to all other conditions. Specifically, non-users were about ten (AOR= 10.04; 95% CI: 7.98–12.63), nine (AOR= 8.92; 95% CI: 5.94–13.38), and twelve (AOR= 12.03; 95% CI: 7.81–18.52) times less likely than marijuana users, abusers and dependents respectively to have positive oral fluid and/or blood indicators for THC; and almost three (AOR= 2.94; 95% CI: 2.02–4.29), four (AOR= 3.51; 95% CI: 1.86–6.61) and seven (AOR= 6.63; 95% CI: 3.69–11.89) times less likely than marijuana users, abusers, and dependents respectively to have positive oral fluid and/or blood indicators for cocaine.

Those who used marijuana but did not meet diagnostic criteria for abuse or dependence were almost twice as likely as non-users to have positive oral fluid or blood screens for opioids (AOR= 1.84; 95% CI: 1.21–2.80) and over twice as likely to test positive for benzodiazepines (AOR= 2.36; 95% CI: 1.29–4.32). Those in the marijuana abuse category were approximately four times more likely than non-users to test positive for benzodiazepines (AOR= 4.04; 95% CI: 1.68–9.72) while those in the marijuana dependent category were over twice as likely as the non-use group to test positive for opioids (AOR= 2.64; 95% CI: 1.19–5.85).

Finally, those who fell into the marijuana dependent category were over twice as likely (AOR= 2.65; 95% CI: 1.38–5.05) as the marijuana users to have positive screens for cocaine in their oral fluid and/or blood. No other significant differences were noted among those that used marijuana to some extent.

Among participants submitting valid breath tests, BAC was found to be significant at all levels (0, between 0 and .08, and above .08) between marijuana non-users and marijuana users, with users being about twice as likely to have a BAC below illegal levels without being at zero (AOR= 1.78; 95% CI: 1.34–2.36) and above the 0.08 illegal level (AOR= 2.13; 95% CI: 1.30–3.48). Similarly, those in the marijuana use category were about half as likely as non-users to have no BAC whatsoever (AOR= 0.52; 95% CI: 0.41–0.67). No significant differences were noted in any other comparisons (See Table 4).

Discussion

Marijuana use can result in reduced response times (Hart et al., 2010), motor coordination and functioning (Lane et al., 2004). Additionally, the use of alcohol, cocaine, opioids or benzodiazepines may have varied effects including impaired reaction time, coordination, information processing time, concentration, visual acuity or increases in tracking errors (Leung, 2011). Each of these substances has been shown to have an adverse effect on the skills necessary for driving and to have been associated with crash involvement in some studies. Therefore, combining their use is likely to compound their adverse effects. Despite this concern, the current study is one of the first endeavors to examine concurrent substance use among an active sample of U.S. drivers who have not been involved in accidents, hospitalizations or arrests.

Consistent with our hypotheses, participants who met criteria for marijuana use, abuse and dependence were respectively three, three and a half, and six and a half times more likely than non-users to test positive for cocaine in blood and/or oral fluid samples. Those in the marijuana dependence condition were over two and a half times more likely than those in the marijuana use condition to test positive for cocaine. This is consistent with previous research conducted by the Substance Abuse and Mental Health Services Administration (SAMHSA; 1995) indicating high rates of comorbid marijuana and cocaine use. Curiously, a significant relationship was found between marijuana users and marijuana dependents, but not between users and abusers. This is likely the result of the relatively minor differences between those who casually use marijuana and those that meet diagnostic criteria for abuse.

Those in the marijuana use condition were about twice as likely as those in the non-use condition to test positive for either opioids or benzodiazepines. This provides further support of the elevated rates of concurrent substance use among drivers who also use marijuana. This relationship, however, was not significant between non-users and abusers testing positive for opioids, and between non-users and dependents testing positive for benzodiazepines. These results may be due to the relatively low number of respondents meeting the criteria for marijuana abuse and dependence while simultaneously using these substances (See Table 2). That is, with a larger sample size, these relationships may also be significant. However they are consistent with the finding in the analysis of this sample by

Furr-Holden, et al. (2011) which found that drivers who met criteria for alcohol dependence and abuse were not overrepresented among high BAC drivers.

Consistent with the Furr-Holden results, the only significant differences found on BAC among marijuana use conditions were found between non-users and users of marijuana, while no significant difference was noted between non-users and marijuana abusers or dependents. This may be indicative a having a drug of choice. That is, those that meet diagnostic criteria for marijuana abuse or dependence may devote large amounts of time to its exclusive use and acquisition that it leaves little time or interest for alcohol use. Those that do not meet the abuse and dependence criteria, however, are likely to be much more casual users of marijuana and, as such, are less likely to devote great amounts of time to its use or acquisition allowing time for alcohol use. If we consider the findings in this light, the results indicate that casual users of marijuana (i.e., those in the marijuana use condition) are about 1.5 times and twice as likely as non-users to have a BAC below or above 0.08 respectively.

The current study also supports findings by Fergusson et al. (2008) who suggested marijuana use among drivers exceeds the rate of alcohol use among drivers. In the current study, 661 nighttime drivers tested positive for alcohol use, while 784 tested positive for marijuana use by means of blood or oral fluid tests. Together, these two findings lend support to the idea that DUI interventions should be retooled and adapted to the change in modern patterns of substance use. That is, where DUI interventions have typically focused on alcohol use education, the current study suggests that it may be necessary to adapt or expand these interventions to include marijuana use.

The current study has several limitations. First, although cross-sectional designs are appropriate to the research questions posited herein, they cannot be used for making causal inferences. They may be useful, however, to stimulate further scientific understanding as was the goal in this research. Further, the current research bases much of its discussion on contributors to motor vehicle accidents (i.e., reduced motor coordination, reduced reaction times, etc.), but does not collect any data on this specific topic. Indeed, the discussion of how use and concurrent use of these substances may contribute to motor vehicle accidents may have been strengthened by analysis of such data. Finally, the current study examines specifically marijuana and concurrent substance use, and the applicability and generalizability of these findings to populations beyond those used in this study are limited.

Despite these limitations, however, the current study has several strengths. First, much of the previous research on this topic has been conducted by means of self-report. The current study is notably strengthened by the use of biological measures including blood and oral fluid samples as well as breathalyzer recordings of BAC. Furthermore, traditional research in the area of substance use among drivers was gathered from accidents, hospitalizations and arrests which do not address actual rates of substance use among drivers, as those drivers who use substances but are not involved in any of these scenarios would not be measured. The current research provides valuable information to fill this gap in knowledge.

As the popularity of marijuana increases among the general population, and as the legalization of marijuana appears increasingly possible, the need to understand the role of this substance in everyday life becomes an imperative. The findings from the current study underscore the need to update and adapt current interventions geared toward DUI offenders. The current study also begins to illustrate the concerns associated with marijuana use among drivers. Specifically, that marijuana is the most used substance among drivers, and that its use predicts the concurrent use of other substances which may impede driving to some extent. In an attempt to address concerns associated with marijuana use and driving, it may be necessary to further develop educational components discussing the use of substances other than alcohol in basic driver's education classes. Enhancing protocols to tailor DUI interventions and driver's education classes to include marijuana use may be valuable in addressing these concerns.

References

American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 4. Washington DC: American Psychiatric Association; 1994.

Anderson BM, Rizzo M, Block RI, Pearlson GD, O'Leary DS. Sex differences in the effects of marijuana on simulated driving performance. Journal of Psychoactive Drugs. 2010; 42:19–30. [PubMed: 20464803]

Blows S, Ivers RQ, Connor J, Ameratunga S, Woodward M, Norton R. Marijuana use and car crash injury. Addiction. 2005; 100:605–611. [PubMed: 15847617]

Bonn-Miller MO, Zvolensky MJ. An evaluation of the nature of marijuana use and its motives among young adult active users. The American Journal on Addictions. 2009; 18:409–416. [PubMed: 19874161]

Bostwick JM. Blurred boundaries: The therapeutics and politics of medicinal marijuana. Mayo Clinic Proceedings. 2012; 87:172–186. [PubMed: 22305029]

Cottler LB, Grant BF, Blaine J, Mavreas V, Pull C, Hassin D, Compton WM, Rubio-Stipec M, Mager D. Concordance of the DSM-IV alcohol and drug use disorder criteria and diagnoses as measured by AUDADIS-ADR, CIDI and SCAN. Drug and Alcohol Dependence. 1997; 47:195–205. [PubMed: 9306045]

Fergusson D, Horwood J, Boden J. Is driving under the influence of cannabis becoming a greater risk to river safety than drink driving? Findings from a longitudinal study. Accident Analysis and Prevention. 2008; 40:1345–1350. [PubMed: 18606265]

Furr-Holden CD, Voas RB, Lacey J, Romano E, Jones K. The prevalence of alcohol use disorders among night-time weekend drivers. Addiction. 2011; 106:1251–1260.10.1111/j. 1360-0443.2011.03408.x [PubMed: 21342301]

Grant BF, Dawson DA. Prevalence and correlates of alcohol use and DSM-IV alcohol dependence in the United States: Results of the National Longitudinal Alcohol Epidemiologic Survey. Journal of Studies on Alcohol. 1997; 58:464–473. [PubMed: 9273910]

Hall W, Degenhardt L. The adverse health effects of nonmedical cannabis use. Lancet. 2009; 374:1383–91. [PubMed: 19837255]

Hart CL, Ilan AB, Gevans A, Gunderson EW, Role K, Colley J, Foltin RW. Neurophysiological and cognitive effects of smoked marijuana in frequent users. Pharmacology, Biochemistry and Behavior. 2010; 96:333–341.

Hels, T.; Bernhoft, IM.; Lyckegaard, A.; Houwing, S.; Hagenzieker, M.; Legrand, S.; Isalberti, C.; Van der Linden, T.; Verstraete, A. 6th Framework Programme, Deliverable D2.3.5. 2011. Risk of injury by driving with alcohol and other drugs. DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines).

Higgins ST, Heil SH, Dantona R, Donham R, Matthews M, Badger GJ. Effects of varying the monetary value of voucher-based incentives on abstinence achieved during and following treatment among cocaine-dependent outpatients. Addiction. 2007; 102:271–281. [PubMed: 17222282]

Johnson V, White HR. An investigation of factors related to intoxicated driving behaviors among youth. Journal of Studies on Alcohol. 1989; 50:320–330. [PubMed: 2787875]

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. National Highway Traffic Safety Administration, U.S. Department of Transportation; Washington, DC: 2009a. 2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Methodology. Retrieved from http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811237.pdf

Lacey, JH.; Kelley-Baker, T.; Furr-Holden, CD.; Voas, R.; Romano, E.; Ramirez, A.; Brainard, K.; Moore, C.; Torres, P.; Berning, A. DOT HS 811 249. Washington, DC: National Highway Traffic Safety Administration; 2009b. 2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Drug Results. Retrieved from http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811249.pdf

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. Evaluation Review. 2011; 35:319–353. [PubMed: 21997324]

Laumon B, Gadegbeku B, Martin JL, Biecheler AB. SAM Group. Cannabis intoxication and fatal road crashes in France population based case-control study. British Medical Journal. 2005; 331:1371–1376. [PubMed: 16321993]

Lane SD, Cherek DR, Pietras CJ, Tcheremissine OV. Acute marijuana effects on response-reinforcer relations under multiple variable-interval schedules. Behavioural Pharmacology. 2004; 15:305–309. [PubMed: 15252282]

Leung SY. Benzodiazepines, opioids and driving: An overview of the experimental research. Drug and Alcohol Review. 2011; 30:281–286. [PubMed: 21545558]

Li MC, Brady JE, DiMaggio CJ, Lusardi AR, Tzong KY, Li G. Marijuana use and motor vehicle crashes. Epidemiologic Reviews. 2011; 34:65–72. [PubMed: 21976636]

Lindsay JA, Stotts AL, Green CE, Herin DV, Schmitz JM. Cocaine dependence and concurrent marijuana use: A comparison of clinical characteristics. American Journal of Drug and Alcohol Abuse. 2009; 35:193–198. [PubMed: 19462304]

Mann, RE.; Anglin, L.; Vingilis, ER.; Larkin, E. Self-reported driving risks in a clinical sample of substance users. In: Utzelmann; Berghous; Kroj, editors. Alcohol, Drugs and Traffic Safety. Cologne, Germany: TUV Rheinland; 1993. p. 860-865.

Mendes, E. [accessed July 13 2012] New high of 46% of Americans support legalizing marijuana. 2010. Available at: http://www.gallup.com/poll/144086/New-High-Americans-Support-Legalizing-Marijuana.aspx

Moskowitz, H. Commentary on Variability Among Epidemiological Studies of Drugs and Driving. Transportation Research Circular No. E-C096: Drugs and Traffic: A Symposium; June 20–21, 2005; Woods Hole, MA: Transportation Research Board of the National Academies; 2006. p. 36-40.

Nakawaki B, Crano WD. Predicting adolescents' persistence, non-persistence, and recent onset of nonmedical use of opioids and stimulants. Addictive Behavior. 2012; 37:716–721.

Office of National Drug Control Policy.. Drug testing and Drug involved Driving of Fatally injured Drivers in the United States: 2005–2009. Office of National Drug Control Policy, Executive Office of the President; Washington D.C: 2011 Oct. p. 26p

Olthuis JV, Darredeau C, Barrett SP. Substance use initiation: The role of simultaneous polysubstance use. Drug and Alcohol Review. 2012; 31:1–5. [PubMed: 22212069]

Scherer M, Furr-Holden D, Voas RB. Drug Use Disorder (DUD) Questionnaire: Scale development and validation. Evaluation Review. 2013 in press.

Shinar, D. Traffic Safety and Human Behavior. 1. Kidlington, Oxford: Elsevier; 2007.

Substance Abuse and Mental Health Services Administration. Advance Report No. 10. Washington, DC: U.S. Department of Health and Human Services; 1995. Preliminary estimates from 1994 National Household Survey on Drug Abuse.

Subramaniam GA, Ives ML, Stitzer ML, Dennis ML. The added risk of opioid problem use among treatment-seeking youth with marijuana and/or alcohol problem use. Addiction. 2010; 105:686–698. [PubMed: 20403020]

United Nations Office on Drugs and Crime. World Drugs Report. New York: United Nations; 2011.

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

Yacoubian GS. Correlates of benzodiazepine use among a sample of arrestees surveyed through the Arrestee Drug Abuse Monitoring (ADAM) Program. Substance Use and Misuse. 2003; 38:127–139. [PubMed: 12602810]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 1

Descriptive Statistics for Study Sample Population

	Total Sample (*N* = 7734)	
	n	***%***
Sex		
Male	4645	60.1
Female	3070	39.7
Race		
White	4576	59.2
Black	1241	16.0
Asian	232	3.0
Other	334	4.3
Education Level		
Did not complete HS	731	9.5
High School Degree	1936	25.0
Some College	2823	36.5
College Degree and Beyond	2151	27.8
Time of Day		
Daytime	1860	24.0
Nighttime	5874	76.0
Miles from Home		
0–5 miles	3795	49.1
6–10 miles	1072	13.9
11–20 miles	1502	19.4
Over 20 miles	1272	16.4
Blood Alcohol Content (BAC)		
BAC = 0.0	6851	88.6
0.0 < BAC < 0.08	548	7.1
BAC > 0.08	136	1.8
Marijuana Use		
Use	672	8.7
Abuse	165	2.1
Dependence	112	1.4
Other Substance Use		
Cocaine	251	3.2
Opioids	260	3.4
Benzodiazepines	107	1.4

Table 2

Multivariate Analyses of Diagnostic Criteria of Marijuana Use and Other Substance Use

	Marijuana Non-Use (n = 6785)		**Marijuana Use (n = 672)**		**Marijuana Abuse (n = 165)**		**Marijuana Dependence (n = 112)**		
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**	χ^2
Alcohol Use									
BAC = 0.0	6063	89.4	549	81.7	144	87.3	95	84.8	52.49^{***}
0.0 < BAC < 0.08	439	6.5	82	12.2	14	8.5	13	11.6	
BAC > 0.08	106	1.6	25	3.7	3	1.8	2	1.8	
Cocaine Use	170	2.5	48	7.1	14	8.4	19	17.0	124.70^{***}
Opioid Use	212	3.1	32	4.8	9	5.5	7	6.3	10.11^{*}
Benzodiazepine Use	84	1.2	14	2.1	6	3.6	3	2.6	10.84^{*}

* = p<.05,

** = p<.01,

*** = p<.001

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 3

Summary of Logistic Regression Odds Ratios with Marijuana Use Diagnostic Criteria as a Predictor of Other Substance Use

	Blood/Oral Fluid Positive for THC		Blood/Oral fluid Positive for Cocaine		Blood/Oral Fluid Positive for Opioids		Blood/Oral Fluid Positive for Benzodiazepines	
	AOR	(95% CI)	AOR	(95% CI)	AOR	(95% CI)	AOR	(95% CI)
Predictors								
MJ Non-use v. MJ Use	10.04***	7.98–12.63	2.94***	2.02–4.29	1.84**	1.21–2.80	2.36**	1.29–4.32
MJ Non-use v. MJ Abuse	8.92***	5.94–13.38	3.51***	1.86–6.61	1.86	0.85–4.07	4.04**	1.68–9.72
MJ Non-use v. MJ Dependence	12.03***	7.81–18.52	6.63***	3.69–11.89	2.64*	1.19–5.85	3.02	0.91–10.02
MJ Use v. MJ Abuse	0.85	0.56–1.29	1.22	0.62–2.42	0.96	0.40–2.28	1.32	0.45–3.88
MJ Use v. MJ Dependence	1.33	0.85–2.08	2.65**	1.38–5.05	1.74	0.72–4.23	1.16	0.30–4.42
MJ Abuse v. MJ Dependence	1.38	0.77–2.45	1.73	0.75–3.98	1.66	0.51–5.41	1.82	0.33–9.99

* = p<.05,

** = p<.01,

*** = p<.001

[1] Controlling for age, sex and race

Table 4

Summary of Logistic Regression Odds Ratios with Marijuana Use Diagnostic Criteria as a Predictor of Blood Alcohol Content

	BAC = 0.0		0.0 < BAC < 0.08		BAC > 0.08	
	AOR	**(95% CI)**	**AOR**	**(95% CI)**	**AOR**	**(95% CI)**
Predictors						
MJ Non-use v. MJ Use	0.52***	0.41–0.67	1.78***	1.34–2.36	2.13**	1.30–3.48
MJ Non-use v. MJ Abuse	0.79	0.45–1.38	1.26	0.68–2.33	1.24	0.38–4.01
MJ Non-use v. MJ Dependence	0.67	0.38–1.19	1.60	0.86–2.98	1.02	0.24–4.23
MJ Use v. MJ Abuse	1.46	0.81–2.63	0.73	0.38–1.39	0.62	0.18–2.12
MJ Use v. MJ Dependence	1.29	0.70–2.39	0.89	0.46–1.73	0.48	0.11–2.12
MJ Abuse v. MJ Dependence	1.04	0.45–2.38	0.97	0.92–1.02	0.97	0.14–6.85

* = p<.05,

** = p<.01,

*** = p<.001

[1] Controlling for age, sex and race