Drug and Alcohol Dependence 150 (2015) 135–140

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

The impact of marijuana decriminalization on California drivers

Robin A. Pollini*, Eduardo Romano, Mark B. Johnson, John H. Lacey

Pacific Institute for Research and Evaluation, 11720 Beltsville Drive, Suite 900, Beltsville, MD 20705, United States

ARTICLE INFO

Article history:
Received 14 August 2014
Received in revised form 15 January 2015
Accepted 19 February 2015
Available online 1 March 2015

Keywords:
Marijuana
Cannabis
THC
Driving
California

ABSTRACT

Background: The liberalization of marijuana laws has led to concerns that such changes will increase "drugged driving" and crash-related mortality. California decriminalized marijuana effective January 1, 2011; we examine the impact of this change on marijuana-involved driving.
Methods: We used laboratory testing from roadside surveys and the Fatality Analysis Reporting System (FARS) to assess impacts on weekend nighttime drivers and fatally injured drivers, respectively. We calculated marijuana prevalence (measured by laboratory-confirmed delta-9-tetrahydrocannabinol [THC] in roadside surveys and cannabinoids in FARS) and compared corresponding 95% confidence intervals (CI) to identify statistically significant changes post-decriminalization. We also conducted multiple logistic regression analyses to determine whether the odds of marijuana-involved driving increased significantly after controlling for potential confounders.
Results: There was no statistically significant change in the prevalence of THC-positive driving among weekend nighttime drivers ($n = 894$) in 2012 (9.2%; 95% CI: 6.3, 12.2) compared to 2010 (11.3%; 95% CI: 8.5, 14.0) or in the adjusted odds of testing positive for THC (adjusted odds ratio [AOR] = 0.96; 95% CI: 0.57, 1.60). In contrast, we found a statistically significant increase in the prevalence of cannabinoids among fatally injured drivers in 2012 (17.8%; 95% CI: 14.6, 20.9) compared to the pre-decriminalization period 2008–2010 (11.8%; 95% CI: 10.3, 13.3). The adjusted odds of testing positive for cannabinoids were also significantly higher in 2012 (AOR = 1.67; 95% CI: 1.28, 2.18).
Conclusions: Our study generated discrepant findings regarding the impact of decriminalization on marijuana-involved driving in California. Factors that may have contributed to these findings, particularly methodological factors, are discussed.

1. Introduction

The United States is in the midst of an historic change related to the legal status of marijuana. By December, 2014, 23 states and the District of Columbia (DC) had legalized the use of marijuana for medicinal purposes (ProCon.org, 2014) and 17 states and DC had decriminalized marijuana, thereby reducing possession of small amounts for personal consumption from a criminal offense to a civil offense punishable by fine (NORML, 2014). In addition, in November 2012, voters passed ballot measures in both Colorado and Washington to legalize marijuana for recreational use, regulating it in a manner similar to alcohol that includes authorizing and taxing retail sales for customers ages 21 and older.

This liberalization of marijuana laws has been accompanied by concerns that such changes will lead to increases in "drugged driving" and crash-related fatalities. These concerns stem from experimental studies showing that marijuana can impair neurocognitive and psychomotor functions important for safe driving including reaction time, road tracking, and multiple task processing (Downey et al., 2013; Hartman and Huestis, 2013; Lenné et al., 2010; Ménétrey et al., 2005; Ramaekers et al., 2008, 2006a,b, 2000; Ronen et al., 2008). These concerns are also fueled by recent epidemiological studies suggesting increases in marijuana-involved driving and increased risk of fatal injury among marijuana-involved drivers (Li et al., 2013, 2012), although studies with similar methodologies have found no association between marijuana and fatal crashes (Romano et al., 2014).

Despite growing concerns regarding marijuana policy changes and their impacts on driving, few studies have directly examined whether laws that expand access to marijuana are directly associated with increases in its use among drivers and, subsequently, fatal crashes. A 2014 study found that cannabinoid prevalence among fatally injured drivers increased significantly in only three

* Corresponding author. Tel.: +1 301 755 2755; fax: +1 301 755 2799.
E-mail addresses: rpollini@pire.org (R.A. Pollini), romano@pire.org (E. Romano), mjohnson@pire.org (M.B. Johnson), lacey@pire.org (J.H. Lacey).

http://dx.doi.org/10.1016/j.drugalcdep.2015.02.024
0376-8716/

of 12 states that passed medical marijuana laws (Masten and Guenzburger, 2014). There have been no similar studies of the effects of marijuana decriminalization on drivers in the U.S.

In this paper we address the knowledge gap regarding marijuana decriminalization and driving using California as a case study. Marijuana possession was considered a misdemeanor criminal offense in California until January 1, 2011, when Senate Bill 1449 (SB1449) decriminalized the possession of up to 28.5 grams (≤1 ounce), making it an infraction punishable by maximum $100 fine with no criminal record (State of California, 2010). Did this change result in an increase in marijuana-related "drugged driving" and related fatalities in California? We examine pre- and post-decriminalization marijuana-positive driving among (a) weekend nighttime drivers, and (b) fatally injured drivers, to address this question.

2. Methods

We used drug testing data from roadside surveys and the National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS) to quantify the prevalence of marijuana-positive driving before and after marijuana decriminalization among weekend nighttime drivers and fatality injured drivers, respectively. Our goal was to identify any significant increases in marijuana-positive driving that could reasonably be attributed to decriminalization.

2.1. Roadside surveys

2.1.1. Site selection. The 2007 National Roadside Survey (NRS) used survey jurisdictions identified in the National Automotive Sampling System/General Estimates System (NASS/GES) to select a nationally representative sample of 60 survey sites (Lacey et al., 2009). The NASS/GES uses data from hundreds of thousands of vehicle crashes to identify survey locations representative of the continental U.S. as a whole. Five of the 2007 NRS sites were in California (Contra Costa County, Los Angeles County, Orange County, Ventura County, and the City of San Jose).

In 2010, the California Office of Traffic Safety (OTS) funded a replication of the California NRS data collection to generate state-level longitudinal data on alcohol and drug use among drivers (Johnson et al., 2012). Surveys were conducted in San Rafael (at the border with Contra Costa County), Torrance (Los Angeles County), Anaheim (Orange County) and Bakersfield (near Ventura County). We were unable to recruit cooperating police agencies within the City of San Jose, so Fresno was selected as a replacement. For geographic balance we also added the city of Eureka, located in Northern California (Humboldt County).

OTS funded roadside surveys again in 2012 to continue generating longitudinal data. Of the six sites surveyed in 2010, four were surveyed again in 2012: Anaheim, Eureka, Fresno, and San Rafael (we were unable to recruit police cooperation in Torrance and Bakersfield). These four sites constitute the roadside survey sample for our pre- and post-decriminalization analysis.

2.1.2. Data collection procedures. The procedures for the 2010 and 2012 surveys were similar to the 2007 NRS (Lacey et al., 2009) and were approved by the Pacific Institute for Research and Evaluation's Institutional Review Board. At each location, four specific 1-mile square areas were selected at random and a specific survey site was chosen in each area. The roadside surveys were stratified by day (Friday and Saturday) and time of night (10PM-midnight and 1–3AM), with each survey site assigned to one of the strata. Sites were located in lit parking areas alongside roadways with ample space for vehicles to enter and depart, and each was organized into three to four research bays. A police officer (or officers) was positioned on the roadway outside the interview area to manage traffic and vehicle recruitment and help ensure safety. Orange traffic signs that read "Voluntary Survey Ahead" were situated by the roadside several blocks upstream of the survey site and at the survey site entrance to alert drivers to the data collection activity.

For each survey, the police officer would attract the attention of a driver in an oncoming vehicle and wave that vehicle into the survey site. To minimize selection bias, the officer waved the third approaching vehicle into the site until all survey bays were filled. The next approaching vehicle was waved into survey bays as they became vacant. There were no consequences for drivers who ignored the police officer or failed to pull into the survey area as directed.

As a vehicle pulled into a research bay, the driver was immediately approached by a research assistant who said "you have done nothing wrong," and informed the driver that he or she was selected at random to take part in a survey. All potential participants were informed that the survey was voluntary and anonymous, and that they would earn $20 for participating.

2.1.3. Roadside survey interview. Data collection on consenting drivers involved five parts: (a) an interviewer-administered interview concerning general driving practices, demographics, drinking history (frequency and quantity); (b) breath test using a calibrated Intoxilyzer 400™ preliminary breath test (PBT); (c) a self-administered pencil-and-paper survey on drug use; (d) a pencil-and-paper survey on alcohol and drug problems based on the Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDASIS) (Grant et al., 1995); and (e) an anonymous oral fluid sample using the Quantisal™ data collection kit (Immunalysis Corporation, Pomona, CA).

2.1.4. Drug analysis and screening. Oral fluid samples were sent to Immunalysis Corporation for processing. All samples were initially screened using enzyme-linked immunosorbent assay (ELISA) microplate technology. For positive screening results, confirmation was performed using gas chromatography–mass spectrometry (GC/MS) or liquid chromatography–mass spectrometry (LC/MS/MS) technology. All the analytical procedures used for drug testing were fully validated according to established protocols. Negative, low-level, and high-level controls were run for each batch, along with calibration standards.

The drugs tested by bioassay included delta-9-tetrahydrocannabinol (THC; the active drug only and not metabolites) and a variety of other legal and illegal drugs (Lacey et al., 2011). The method for assaying oral fluid for THC has a limitation of quantification of 1 ng/mL, linearity of 0.5–32 ng/mL, intraday precision of 7.1% at 3 ng/mL and 2.9% at 12 ng/mL, and interday precision of 4.9% at 3 ng/mL and 1.6% at 12 ng/mL (6 replications over 5 days). The assay methods and limitations for THC did not differ for the 2010 and 2012 studies, nor did the proportion of recruited participants providing oral fluid samples at the four sites (78.4% in 2010 and 78.9% in 2012).

2.1.5. Key measures. The key dependent variable for this analysis was the presence or absence of THC. The key independent variable for the analysis was year (2012 vs. 2010).

2.1.6. Data analysis. We calculated THC prevalence and related 95% confidence intervals (95% CIs) for each of the four survey communities and compared site-specific confidence intervals by year to identify statistically significant changes in THC-positivity between 2010 and 2012. Then, using THC positivity as the dependent variable and year as the primary independent variable of interest, we aggregated data by site and calculated univariate odds ratios for all potential confounding variables; those that achieved significance at $p < 0.10$ were included in a multiple logistic regression model to determine whether there was a statistically significant increase in the odds of testing THC-positive in 2012 compared to 2010 after controlling for potential confounders.

2.2. Fatality Analysis Reporting System (FARS)

FARS is a census of all crashes on U.S. public roads that result in a death within 30 days. It contains an estimate of the blood alcohol content (BAC) of every driver involved in a fatal crash, consisting of either an actual BAC measurement or an imputed value based on other factors in the crash (Subramanian, 2002). Drug information is more limited but 20 states (including California) provide drug testing results for at least 80% of their fatally injured drivers, which minimizes the likelihood of selection bias that might arise from reporting only occasional, court-mandated analyses (Hingson et al., 2010).

2.2.1. Case selection. We used FARS data for 2008–2012. Because we did not have FARS data specific to the communities where we conducted roadside surveys (FARS data is only available by county, and would have provided only $N = 266$ cases for the four counties in the 2008–2012 study period) we used statewide data for this portion of the analysis. We limited our cases to drivers who were tested for drugs and had a known lab results for cannabinoids ($N = 6776$; see key measures below). To ensure proper identification of crash responsibility, we excluded drivers who: (i) presented a condition signaling them as mentally challenged; (ii) were involved in a police chase; (iii) were driving a bus, snowmobile, motorized wheelchair, construction or farm equipment; or (iv) were parked or in the process of parking a vehicle ($N = 781$). We also excluded multiple vehicle crashes ($N = 3135$) to limit our sample further to fatally injured drivers (surviving drivers are rarely tested for drugs) in single vehicle crashes (in which the driver was probably responsible for the crash), which is a selection strategy typical of many studies using driver fatality data (Haddon and Bradess, 1959; Romano et al., 2011; Romano and Pollini, 2013; Williams and Shabanova, 2003). This approach yielded a total study sample of $N = 2860$.

2.2.2. Key measures. FARS uses three variables to account for up to three drugs detected per case. Each variable is assigned a drug code: 000 (Not Tested for Drugs); 001 (No Drugs Reported/Negative); 100–295 (Narcotics); 300–395 (Depressants); 400–495 (Stimulants); 500–595 (Hallucinogens); 600–695 (Cannabinoids); 700–795 (Phencyclidine/PCP); 800–895 (Anabolic Steroids); 900–995 (Inhalants); 996 (Other Drugs); 997 (Tested for Drugs, Results Unknown); 998 (Tested for Drugs, Drugs Found, Type Unknown/Positive); and 999 (Unknown if Tested/Not Reported). The "Cannabinoids" category included test results for delta 9, hashish oil, hashish, marijuana, marinol, tetrahydrocannabinoid, THC, and "Cannabinoid, Type Unknown" (National Highway Traffic Safety Administration, 2011). For this study we considered drivers to be positive for cannabinoids if they tested positive for any substance in the cannabinoid category.