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Marijuana and alcohol use among injured drivers evaluated at level I trauma centers in Arizona, 2008–2014

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ABSTRACT

Background: We examined marijuana and alcohol use trends among drivers aged ≥16 years evaluated at Level I trauma centers before and after Arizona legalized medical marijuana in April 2011.
Methods: We conducted interrupted time series (ITS) analysis of urine drug screens for marijuana metabolites and blood alcohol concentration (BAC) data from the 2008–2014 Arizona State Trauma Registry.
Results: Among 30,083 injured drivers, 14,710 had marijuana test results, and 2590 were positive for marijuana; of these, 1087 (42%) also tested positive for alcohol. Among 23,186 drivers with BAC results, 5266 exceeded the legal limit for their age. Compared with prelaw trends (models if law had not been enacted), postlaw models showed small but significant annual increases in the proportions of drivers testing positive for either substance. By the end of 2014, the proportion of drivers testing positive for marijuana was 9.6% versus a projected 5.6% if the law had not been enacted, and the proportion of drivers with illegal BACs was 15.7% versus a projected 8.2%. When ITS was restricted to only substance-tested drivers, no significant differences were detected.
Conclusions: Despite the small annual postlaw increases in the proportion of marijuana-positive drivers compared with the prelaw trend, alcohol-impaired driving remains a more prevalent threat to road safety in Arizona.

1. Introduction

As of March 2019, ten states and Washington DC had legalized marijuana for medical and recreational use and 22 states for only medical use. Arizona, the state of interest in this study, has legalized marijuana for medical use only (Insurance Institute for Highway Safety, 2019). On April 14, 2011, Arizona's Medical Marijuana Program began issuing Medical Marijuana Registry Identification cards (Arizona Department of Health Services, 2014). To qualify for the program, patients with a debilitating medical condition must submit required documentation from a physician, licensed in Arizona, and must renew their registration annually. The total number of qualifying patients in the program increased from 17,852 in 2011 to 61,272 in 2014 (Arizona Department of Health Services, 2014).

As more states have legalized marijuana use, there has also been an increase in public safety concerns related to impaired driving. Findings from the National Roadside Survey of Alcohol and Drug Use provide some justification for concerns. The proportion of weekend, nighttime drivers in the United States with any measurable amount of delta-9-tetrahydrocannabinol (THC), the psychoactive component of marijuana, or its active metabolite 11-OH-THC, measured in oral fluid, increased from 8.6% in 2007 to 12.6% during 2013–2014 (Berning et al., 2013).

Unlike alcohol, increasing THC concentrations in biologic fluids do not consistently equate with increased driving impairment (Sewell et al., 2009), and studies of crash risk among THC-positive drivers have reported inconsistent results (Asbridge et al., 2014; Compton and Berning, 2015; Li et al., 2013; Romano et al., 2014). However, authors of a recent metaregression analysis of this literature concluded that marijuana use was associated with a low-to-moderate increase in crash

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Table 1
Number of Injured Drivers Evaluated at Level I Trauma Centers, Number of Evaluated Drivers with Drug and Alcohol Test Results, and Number of Medical Marijuana Cardholders by Year — Arizona, 2008–2014.

	2008	2009	2010	2011[a]	2012	2013	2014	Total
No. of drivers evaluated at Level I trauma centers	4561	4185	4349	4560	4364	4195	3869	30 083
No. (%) of drivers with drug test results	2471 (54)	2033 (49)	1994 (46)	2133 (47)	2147 (49)	207 (50)	185 (48)	14 710 (49)
No. (%) of drivers with alcohol test results	3371 (74)	3072 (73)	3264 (75)	3504 (77)	3492 (80)	3454 (82)	3029 (78)	23 186 (77)
No. (%) of drivers with drug and alcohol test results	2338 (51)	1944 (46)	1922 (44)	2060 (45)	2077 (48)	2017 (48)	1781 (46)	14 139 (47)
No. of Arizona medical marijuana cardholders [b]	0	0	0	17 852	34 699	43 148	61 272	Not Applicable

[a] Medical marijuana legalization implemented in April 2011.
[b] Total number of active Arizona medical marijuana cardholders at the end of the calendar year.

risk (Rogeberg and Elvik, 2016). Also, studies examining driver error or crash risk among drivers who test positive for both marijuana and alcohol have consistently reported elevated risk compared with drivers testing positive for either substance alone (Downey et al., 2013; Dubois et al., 2015; Li et al., 2013; Sewell et al., 2009). Under Arizona law, drivers who test positive for THC at any concentration can be charged with driving under the influence of marijuana (Ariz. Rev. Stat., 2016).

Rates of alcohol and other drug testing of drivers involved in motor vehicle crashes are highest for crashes that involve a fatality (fatal crash), and testing rates vary substantially across states (National Highway Transportation Safety Administration, 2018). In 2014 in Arizona, 81% of the 417 fatally injured drivers and 30% of the 605 drivers who survived a fatal crash had alcohol test results recorded in the National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS) (National Highway Transportation Safety Administration, 2018). Testing rates for drugs other than alcohol (prescription or illicit; hereafter referred to as drugs) are lower. In 2014, approximately 78% of fatally injured drivers and only 8% of drivers who survived a fatal crash in Arizona had any drug test results recorded in FARS (National Highway Transportation Safety Administration, 2018). Even less is known about substance use among drivers involved in crashes in which no one is killed (nonfatal crashes). However, studies of persons injured in motor vehicle crashes have consistently reported alcohol and marijuana to be among the most commonly detected substances, and the two are often found in combination (Baldock and Lindsay, 2015; Brubacher et al., 2016; Walsh et al., 2005).

To more fully understand trends in marijuana and alcohol use among drivers injured in crashes before and after medical marijuana legalization, we examined Arizona State Trauma Registry (ASTR) data of drivers evaluated at any of the 10 Level I trauma centers in the state during 2008–2014. We described characteristics of drivers who tested positive for marijuana (THC), alcohol, and both marijuana and alcohol, and explored whether the proportion of drivers who tested positive for marijuana, alcohol, or the two substances combined changed post-legalization of medical marijuana.

2. Methods

ASTR receives data from trauma centers in Arizona, including all Level I trauma centers (L1TCs); eight of 10 L1TCs are located in the Phoenix Metropolitan Area, one in Tucson, and one in Flagstaff. ASTR contains data on patients triaged by emergency medical services (EMS) to trauma centers, patients with injuries transported from one hospital to another, or patients meeting other criteria, as defined in the ASTR inclusion criteria (Arizona Department of Health Services, 2016).

The decision to perform drug or alcohol testing at Arizona trauma centers is dependent on clinicians' judgment; if the clinician does not suspect substance use, testing is less likely to be performed. In this study, drug testing is defined as a qualitative urine drug screen (positive or negative) used to detect substances by enzyme immunoassay. ASTR separately records positive results for detectable levels of THC, methamphetamines, barbiturates, benzodiazepines, cocaine, opioids, and phencyclidine. All other drugs are categorized as other drugs. ASTR also records quantitative blood alcohol concentration (BAC) test results in grams per deciliter (g/dL).

For these analyses, we included drivers of cars, trucks of all sizes, or vans, aged ≥16 years, evaluated at a L1TC for injuries sustained in a motor vehicle crash during 2008–2014. We examined age, sex, race/ethnicity, whether drug or alcohol tests were performed, and test results.

The number of L1TCs in Arizona increased from eight during 2008–2013 to 10 in 2014; both L1TCs added in 2014 were in the Phoenix Metropolitan Area. The increase in L1TCs should not have substantially affected the number of injured drivers evaluated at L1TCs because EMS uses an established triage protocol based on injury severity when deciding whether to transport to a L1TC. For this study, we examined the proportion of drivers testing positive for marijuana, alcohol, or both marijuana and any detectable alcohol rather than total numbers. This approach helps account for the increase in L1TCs and unmeasured temporal trends that might have influenced crash risk (e.g., the economic recession and recovery or changes in travel patterns and traffic enforcement).

Because ATSR does not record whether an injured driver is an active patient in the Arizona Medical Marijuana Program, the annual number of Medical Marijuana Program qualifying patients for 2011–2014 was included in Table 1 to provide context to our analyses (Arizona Department of Health Services, 2014).

All statistical analyses were performed using SAS® version 9.3 (SAS Institute, Inc., Cary, North Carolina). We used interrupted time series analysis (Wagner et al., 2002) to assess whether significant changes occurred in the level and slope after the medical marijuana law was implemented in April 2011; we examined the monthly proportion of all drivers who had a positive urine drug screen for marijuana, BAC above the legal limit for their age (≥0.08 g/dL for drivers aged ≥21 years and any conclusive level (BAC > 0 g/dL) for drivers aged 16–20 years), and marijuana with any detectable alcohol. Any detectable alcohol, as opposed to BAC above the legal limit, was used in combination with marijuana because alcohol and marijuana have synergistic effects on driver impairment (Downey et al., 2013; Dubois et al., 2015; Li et al., 2013; Sewell et al., 2009). We defined April 2011 as the segmentation point for time series analysis, because it was the first month medical marijuana patient registry cards were issued. Models were corrected for up to 12th order autocorrelation using a back-step automatic selection procedure. We calculated the difference in proportion of drivers with a positive urine screen for marijuana use, estimated from the model, including terms associated with the implementation of the law (i.e., level and slope) and from the model, including terms associated only with baseline level and secular trends. This difference estimates the proportion of drivers who would not have tested positive had the law not been implemented and was considered statistically significant at $P < 0.05$. Confidence intervals for differences were calculated using the delta method reported previously (Zhang et al., 2009). The analysis was repeated for the outcomes of BAC above the legal limit and for marijuana with any detectable alcohol. We also repeated interrupted time series analyses, excluding untested drivers to observe whether trends in

Table 2
Characteristics of Injured Drivers Evaluated at Level I Trauma Centers by Drug and Alcohol Testing Results — Arizona, 2008–2014.[a].

Characteristics	Total		Tested for Drugs		Tested for Alcohol		Tested for Drugs and Alcohol		Positive for THC		Alcohol Above Legal Limit[b]		Positive for THC and Any Alcohol	
	No.	Col. %	No.	Row %	No.	Row %	No.	Row %	No.	Row %	No.	Row %	No.	Row %
Age (years)														
16–20	4151	14	2074	50	3134	75	1992	48	597	14	685	17	214	5
21–25	4707	16	2487	53	3757	80	2385	51	669	14	1239	26	325	7
26–34	5807	19	3107	54	4645	80	3004	52	642	11	1341	23	305	5
35–44	4514	15	2287	51	3528	78	2199	49	304	7	928	21	131	3
45–54	4080	14	1967	48	3121	76	1884	46	237	6	630	15	77	2
55–64	3183	11	1441	45	2340	74	1377	43	113	4	316	10	30	1
≥65	3641	12	1347	37	2661	73	1298	36	28	1	127	3	4	< 1
Sex														
Female	13 673	45	6330	46	10 027	73	6037	44	751	5	1440	11	241	2
Male	16 410	55	8380	51	13 159	80	8102	49	1839	11	3826	23	845	5
Race[c]														
White	21 530	72	9908	46	16 151	75	9511	44	1716	8	3238	15	646	3
Other	4533	15	2530	56	3780	83	2435	54	359	8	838	18	151	3
American Indian	1946	6	1201	62	1670	86	1172	60	277	14	920	47	215	11
Black	1479	5	819	55	1168	79	780	53	218	15	193	13	63	4
Asian	379	1	168	44	264	70	160	42	5	1	24	6	3	1
Pacific Islander	40	0	20	50	30	75	19	48	2	5	12	30	1	3
Hispanic[d]	7819	26	3962	51	6053	77	3811	49	643	8	1476	19	282	4
Total	30 083	100	14 710	49	23 186	77	14 139	47	2590	9	5266	18	1087	4

[a] Missing or unknown data are not displayed.
[b] Blood alcohol concentration limits are > 0 g per deciliter (g/dL) for drivers aged 16–20 years and ≥0.08 g/dL for drivers aged ≥21 years.
[c] A total of 176 persons (< 1%) of unknown race are not displayed; percentages do not add to 100%.
[d] Hispanic is not mutually exclusive of any race.

the proportion of drivers testing positive for drugs and alcohol were associated with trends in the proportion of drivers tested for drugs and alcohol.

This project was reviewed by the Centers for Disease Control and Prevention and determined to be exempt from human subjects regulations because we analyzed data without personal identifiers.

3. Results

During 2008–2014, 30,083 injured drivers aged ≥16 years involved in motor vehicle crashes who qualified for study inclusion were evaluated at Arizona L1TCs and reported in ASTR. Among injured drivers, 49% (n = 14,710) were tested for drugs, 77% (n = 23,186) were tested for alcohol, and 47% (n = 14,139) were tested for both drugs and alcohol (Table 1). Ninety-six percent of drivers tested for drugs were also tested for alcohol, and 61% of drivers tested for alcohol were also tested for drugs. The proportion of drivers tested for drugs varied by year, from 46% in 2010 to 54% in 2008 and 2013 (Table 1). The proportion of drivers tested for alcohol varied from 73% in 2009 to 82% in 2013.

Table 2 presents demographic characteristics of the total study population, number and proportion of injured drivers tested for drugs, alcohol, or both substances, and number and proportion of all drivers with positive test results. Certain differences in demographic characteristics were noted in the proportions of injured drivers who were tested. For example, for drugs, proportions tested varied by age from 54% among drivers aged 26–34 years to 37% among drivers aged ≥65 years, and by racial groups from 62% for American Indians to 44% for Asians. Proportions of drivers tested for alcohol showed similar patterns. For example, alcohol testing among racial groups varied from 86% for American Indians to 70% for Asians.

Overall, 9% of the 30,083 injured drivers tested positive for THC, 18% had BACs above the legal limit for their age, and 4% tested positive for both substances.

Among drivers with marijuana test results, age groups with the highest proportions testing positive were 16–20 years (29%, [597/2,074]) and 21–25 years (27%, [669/2,487]), declining to 2% among drivers aged ≥65 years (28/1,347). Racial groups with the highest proportions testing positive for marijuana among those tested were black (27%, [218/819]) and American Indian (23%, [277/1,201]). In addition, 18% (215/1,172) of American Indians who were tested for marijuana and alcohol had positive results for both substances, a proportion greater than twice that of other racial groups.

Of the 23,186 injured drivers tested for alcohol, 23% (n = 5266) had a BAC above the legal limit for their age; 80% (n = 4229) of these drivers had BACs ≥0.15 g/dL (data not shown). Although any detectable alcohol is illegal for drivers aged < 21 years, 82% (n = 564) of injured drivers aged 16–20 years with positive BACs had BACs ≥0.08 g/dL, levels which are illegal for drivers aged ≥21 years (data not shown). Among the 14,710 injured drivers with marijuana test results, 2590 (18%) were positive for THC; of these, 1087 (42%) also tested positive for any alcohol. Among the 1087 drivers who tested positive for both marijuana and alcohol, 72% (n = 781) had BACs ≥0.15 g/dL (data not shown).

3.1. Analysis of trends among injured drivers testing positive for marijuana or alcohol

The interrupted time series analysis estimated that during January 2008–April 2011, the proportion of injured drivers testing positive for marijuana decreased by 0.5%/year (95% CI: -1.0/year, 0.0/year). After medical marijuana legalization in April 2011, a significant increase in the slope of the trend line (i.e., measure of change in trend) occurred, which yielded a postlaw increasing slope of 0.6%/year (95% CI: 0.0/year, 0.8/year). The prelaw to postlaw abrupt level increase (i.e., measure of immediate change) of 0.6% (95% CI: -0.7, 1.9) was not significant (Fig. 1, Panel A). Based on the model, by December 2014 (study period end), the proportion of drivers that would test positive for marijuana was 9.6% versus a projected 5.6% if the law had not been enacted, a difference of 4.0 percentage points (95% CI: 1.2, 6.9).

During January 2008–April 2011, there was a 1.9%/year decrease in the proportion of injured drivers testing positive for alcohol above the legal limit for their age (95% CI: -2.6/year, -1.3/ year). After the law was implemented in April 2011, a significant increase in the slope of the trend line occurred, which yielded a postlaw slope of -0.5%/year

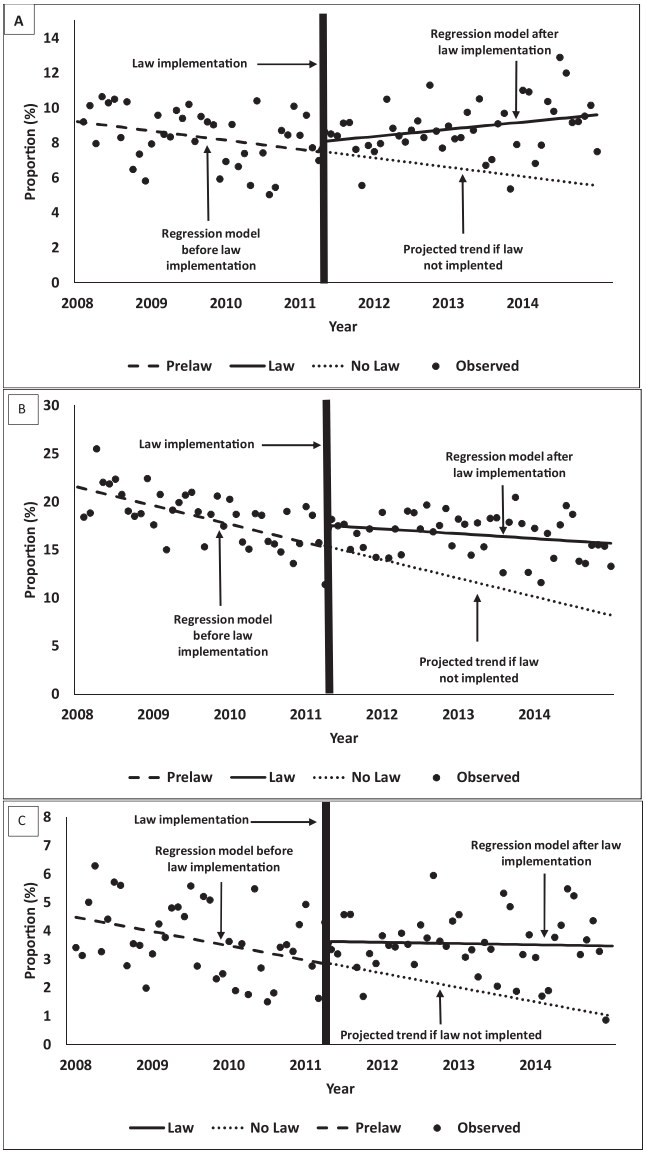

Fig. 1. A—Proportion of Injured Drivers Evaluated at Level I Trauma Centers Testing Positive for Marijuana — Arizona, 2008–2014 (N = 2590).
B—Proportion of Injured Drivers Evaluated at Level I Trauma Centers Testing Positive for Alcohol Above the Legal Limit for their Age[b] — Arizona, 2008–2014 (N = 5266).
C—Proportion of Injured Drivers Evaluated at Level I Trauma Centers Testing Positive for Marijuana plus Any Alcohol — Arizona, 2008–2014 (N = 1087).
[a]Blood alcohol concentration limits are > 0 grams per deciliter (g/dL) for drivers aged 16–20 years and ≥0.08 g/dL for drivers aged ≥21 years.

(95% CI: -1.0/year, 0.0/ year). The prelaw to postlaw abrupt level increase of 2.2 percentage points (95% CI: 0.5, 3.6) was also statistically significant. The difference in the proportion of drivers testing positive for alcohol above the legal limit at the end of 2014 was 7.5 percentage points (95% CI: 3.8, 11.1); 15.7% with the law versus a projected 8.2% if the law had not been enacted (Fig. 1, Panel B).

During January 2008–April 2011, there was a 0.5%/year decrease in the proportion of injured drivers testing positive for marijuana plus any alcohol (95% CI: -0.8/year, -0.2/year). After the law was implemented, a significant increase in the slope of the trend line occurred, yielding a postlaw slope of 0.0 percentage points per year (95% CI: -0.3/year, 0.2/year). The prelaw to postlaw abrupt level increase of 0.8 percentage points (95% CI: -0.1, 1.5) was also statistically significant. The difference in the proportion of injured drivers testing positive for marijuana plus any alcohol at the end of 2014 was 2.5 percentage points (95% CI: 0.9, 4.0); 3.5% with the law versus a projected 1.0% if the law had not been enacted) (Fig. 1, Panel C).

When restricting the time series analyses to only injured drivers who were tested for drugs or alcohol (i.e., excluding those who were not tested), no significant differences were observed between the prelaw and postlaw slopes for marijuana, alcohol, or the two substances combined.

4. Discussion

In a population of injured drivers evaluated at Arizona L1TCs during 2008–2014, we found that 9% of all drivers and 18% of drivers tested for drugs tested positive for marijuana. These proportions are similar in magnitude to those from other recent studies of marijuana use among crash-involved, injured drivers in the United States (Walsh et al., 2005), Australia (Baldock and Lindsay, 2015), Canada (Brubacher et al., 2016), and Europe (Cittadini et al., 2017). Likewise, we found that 18% of all drivers and 23% of drivers tested for alcohol had BACs above the legal limit for their age. Of note, among the drivers with BACs above the legal limit, 79% had BACs ≥0.15 g/dL, nearly twice the legal BAC limit for drivers aged ≥21 years. In addition, among drivers who tested positive for marijuana and any alcohol, 72% had BACs ≥0.15 g/dL. At BACs ≥0.15 g/dL, drivers aged 16–20 years are estimated to be approximately 500 times as likely to be involved in a fatal crash than their sober counterparts (i.e., BAC = 0 g/dL); for drivers aged ≥21 years, the risk for fatal crash involvement is approximately 100 times that of their sober counterparts (Voas et al., 2012). Any additional impairment from marijuana would likely increase their already excessive crash risk (Downey et al., 2013; Dubois et al., 2015; Li et al., 2013; Sewell et al., 2009).

Interrupted time series analysis revealed a small but statistically significant annual increase in the proportion of all injured drivers who tested positive for marijuana after medical marijuana was legalized in Arizona compared with what would have been expected without legalization based on existing trends. However, this association is not equal to causation and might reflect the overall trend of the general U.S. population consuming more marijuana during 2008–2014 (Center for Behavioral Health Statistics and Quality, 2014). This association might also be partially explained by changes in testing after legalization, because no significant increase was reported when excluding those who were not tested for drugs. Information was not available regarding whether or not any of 10 L1TCs altered their drug testing practices in response to the medical marijuana law, although changes were unlikely because there were far more recreational marijuana users than medical marijuana card holders (Hughes et al., 2016). Additionally, health care providers are more likely to test for drugs when they suspect a patient was driving under the influence. Because there is a direct correlation between suspecting a patient was driving under the influence and ordering drug testing, including all drivers and not restricting to only drivers tested for drugs likely provides a more accurate representation of trends.

We also report small but significant annual postlaw increases in proportions of injured drivers that tested positive for alcohol above the legal limit and positive for both marijuana and any alcohol. Whether any of these increases are directly associated with marijuana legalization is unclear. Arizona experienced a 28% decrease in police-reported drug-impaired or alcohol-impaired vehicle crashes resulting in serious injuries, from 888 in 2008 to 643 in 2014 (Arizona Governor's Office of Highway Safety, 2017). Additionally, impaired driving traffic enforcement increased markedly. Arrests for driving under the influence of drugs increased more than 500% from 694 in 2008 to 4190 in 2014, and arrests for driving under the influence of alcohol increased by 181% from 10,409 in 2008 to 29,250 in 2014 (Arizona Governor's Office of Highway Safety, 2015). Because we did not have access to impaired driver arrest records or crash incident reports for this study,

associations between enforcement activity and drug-related or alcohol-related crash occurrence could not be formally assessed. Surveillance systems that link information from multiple data sources, (including driving exposure and citation data, driver drug and alcohol test results, crash incident reports, and health care records) would aid in more fully understanding the role of substance use in crash occurrence and consequences including injury, disability, and medical costs; and better inform injury prevention strategies (Centers for Disease Control and Prevention (CDC), 2016).

Two recent evaluations of medical marijuana legalization reported postlaw reductions in overall fatal crash rates and attributed the reductions to declines in alcohol-impaired fatal crash rates (Anderson et al., 2013; Santaella-Tenorio et al., 2017). In interpreting the findings, the authors refer to the substitution hypothesis (Reiman et al., 2017) and suggest that declines in alcohol-impaired crash rates might be because some drivers were substituting marijuana use for alcohol, thus lowering their crash risk. Our finding of a slight but significant increase in the proportion of injured drivers evaluated at Arizona L1TCs who tested positive for both marijuana and alcohol after marijuana legalization does not add support for this theory. Furthermore, national surveys indicate that 66% of persons who use both marijuana and alcohol use the substances simultaneously (Subbaraman and Kerr, 2015). Simultaneous users report consuming both substances more often and driving under the influence of alcohol more often than their counterparts who use both substances but not simultaneously (Subbaraman and Kerr, 2015).

This study has additional limitations. Because drug or alcohol testing was largely dependent on the clinician's judgement, selection bias was present. The extent and effect of selection bias could not be fully examined with available data. As described above, clinicians' decisions to test for drugs might have been impacted by the law change. If a greater proportion of untested patients were THC positive in the prelaw period compared to the postlaw period, the postlaw trend of THC positivity could be biased upward. A positive THC urine screen does not necessarily indicate recent marijuana use; urine screens can remain positive without indicating impairment for multiple weeks, particularly among chronic users (Lapoint, 2015). Sensitivity and specificity of drug tests performed at the 10 L1TCs are unknown and can vary over time and location. The amount of time that elapsed between the motor vehicle crash and collection of each injured driver's BAC is unknown. Therefore, the BAC at the time of the crash could have been higher than the BAC recorded in the hospital record. In the trend analysis, we did not directly account for factors other than the medical marijuana law that might have influenced prevalence of substance-impaired driving and crash risk (e.g., the economic recession and recovery, changes in travel patterns, and traffic enforcement). In addition, the trend analysis did not incorporate a control condition (e.g., examining data from states that had not implemented medical marijuana legislation). Lastly, the study findings from Arizona L1TCs might not be generalizable to other hospital settings, states, or jurisdictions.

Our study found that overall, the proportion of drivers with BACs above the legal limit was twice the proportion of drivers who were marijuana-positive (but not necessarily marijuana-impaired), indicating that alcohol-impaired driving is a more prevalent threat to road safety in Arizona. Strategies exist that can help to identify individuals at risk. For example, screening, brief intervention, and referral to treatment (SBIRT) is a proven method to reduce morbidity, mortality, and healthcare costs associated with drug and alcohol abuse among adults (National Academies of Sciences, 2019). Injured drivers who test positive for drugs or alcohol at trauma centers are candidates for SBIRT, especially considering the prevalence of high BACs and polysubstance use in this population.

As more states consider legalizing marijuana, further research is needed to clarify the long-term effects of marijuana legalization (Governors Highway Safety Association, 2017), to develop accurate tests to evaluate whether drivers are impaired by marijuana (Governors Highway Safety Association, 2017), and to elucidate how marijuana affects the ability to drive when used with other substances (Li et al., 2013). Surveillance systems linking driver data from multiple other data sources could better inform prevention programs. Finally, broader implementation of proven strategies to prevent alcohol-impaired driving (National Academies of Sciences, 2019; Centers for Disease Control and Prevention, 2016) and reduce recidivism (Voas et al., 2016) could further reduce fatalities on U.S. roads.

Contributors

Jefferson M. Jones- Led planning of study, analysis, and writing of manuscript; Ruth A. Shults- Assisted in planning, analysis, and writing of manuscript; Byron Robinson- Statistician that conducted and reviewed analysis, assisted in writing of manuscript; Kenneth K. Komatsu-Generated idea of study, supervised analysis and reviewed manuscript; Erin K. Sauber-Schatz- Supervised analysis and manuscript

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Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Declaration of Competing Interest

All authors have no conflicts of interest.

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