



Changes in driver cannabinoid prevalence in 12 U.S. states after implementing medical marijuana laws

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ABSTRACT

Objective: To determine if cannabinoid prevalence increased among fatal-crash-involved drivers in 12 U.S. states after implementing medical marijuana laws. **Methods:** Time series analyses of 1992 to 2009 driver cannabinoid prevalence from the Fatality Analysis Reporting System. **Results:** Increased driver cannabinoid prevalence associated with implementing medical marijuana laws was detected in only three states: California, with a 2.1 percentage-point increase in the percentage of all fatal-crash-involved drivers who tested positive for cannabinoids (1.1% pre vs. 3.2% post) and a 5.7 percentage-point increase (1.8% vs. 7.5%) among fatally-injured drivers; Hawaii, with a 6.0 percentage-point increase (2.5 vs. 8.5) for all drivers and a 9.6 percentage-point increase (4.9% vs. 14.4%) among fatally-injured drivers; and Washington, with a 3.4 percentage-point increase (0.7% vs. 4.1%) for all drivers and a 4.6 percentage-point increase (1.1% vs. 5.7%) among fatally-injured drivers. Changes in prevalence were not associated with the ease of marijuana access afforded by the laws. **Discussion:** Increased prevalence of cannabinoids among drivers involved in fatal crashes was only detected in a minority of the states that implemented medical marijuana laws. The observed increases were one-time changes in the prevalence levels, rather than upward trends, suggesting that these laws may indeed provide marijuana access to a stable population of patients as intended, without increasing the numbers of new users over time. Although this study provides some insight into the potential impact of these laws on public safety, differences between states in drug testing practices and regularity, along with the fairly recent implementation of most medical marijuana laws, suggest that the long-term impact of these laws may not yet be known. **Practical applications:** It is recommended that nationwide standardization of drug testing procedures and criteria be considered to improve the consistency of testing both between and within jurisdictions.

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1. Introduction

The first medical marijuana law in the United States was passed in 1996, allowing California physicians under state law to recommend the use of marijuana for symptom relief for patients with specified medical conditions. Eighteen other United States jurisdictions have subsequently passed medical marijuana laws (Table 1), which vary in degree of regulation, qualifying medical conditions, provisions for patient access to marijuana, and protections from legal or civil penalties (NORML, 2012; ProCon.org, 2012; The Marijuana Policy Project, 2011). Most laws provide both legal protections and means to legally access marijuana, but some, like Maryland's, provide some protection from criminal prosecution, but no routes to legally access marijuana.

Recent use of marijuana is associated with 2 to 6 times higher risk of crashing while driving a motor vehicle—depending on the dose—compared to driving unimpaired (Asbridge, Hayden, & Cartwright, 2012; Baldock, 2008; Bates & Blakely, 1999; Beirness, Simpson, & Williams,

2006; Li et al., 2012; Ramaekers, Berghaus, van Laar, & Drummer, 2004). From 1992 to 2009, about 20,000 drivers nationwide involved in fatal crashes tested positive for cannabinoids (National Highway Traffic Safety Administration [NHTSA], 2012). In some states, self-reported marijuana use among young adults was higher after implementation of medical marijuana laws (Anderson & Rees, 2011; U. S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Office of Applied Studies [DHHS], 2010), but whether cannabinoid use increased among motor vehicle drivers in medical marijuana states—a potential concern for traffic safety—is less clear (Crancer & Crancer, 2010; Johnson, Kelley-Baker, Voas, & Lacey, 2012; Lacey, Kelley-Baker, Romano, Brainard, & Ramirez, 2012; Lacey et al., 2009).

To address this question, we looked at changes in cannabinoid prevalence among drivers involved in fatal crashes from 1992 to 2009 in 12 states that passed medical marijuana laws, adjusting for changes in drug testing rates and national trend towards higher driver cannabinoid prevalence (NHTSA, 2010, 2012). A potential dose–response relationship was also explored between changes in cannabinoid prevalence in these states and ease of patient access to marijuana afforded by the laws.

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Table 1
19 U.S. jurisdictions with medical marijuana laws as of December 2012, dates of initial enactment or significant modification, and effective dates.

Jurisdiction	Initial enactment and significant modifications	Effective date
1. Alaska	Ballot Measure 8 (Nov 3, 1998) Senate Bill 94 (Jun 1, 1999)	Mar 4, 1999 Jun 2, 1999
2. Arizona	Ballot Proposition 203 (Nov 2, 2010)	Apr 14, 2011
3. California	Proposition 215 (Nov 5, 1996) Senate Bill 420 (Oct 12, 2003)	Nov 6, 1996 Jan 1, 2004
4. Colorado	Ballot Amendment 20 (Nov 7, 2000) House Bill 1284 & Senate Bill 109 (Jun 7, 2010)	Jun 1, 2001 Jul 1, 2010
5. Connecticut	House Bill 5389 (May 31, 2012)	Oct 1, 2012
6. Delaware	Senate Bill 17 (May 13, 2011)	Jul 1, 2011
7. District of Columbia	Amendment Act B18-622 (May 21, 2010) Emergency Amendment to Title 22 (Apr 14, 2011)	Jul 27, 2010 Apr 14, 2011
8. Hawaii	Senate Bill 862 (Jun 14, 2000)	Dec 28, 2000
9. Maine	Ballot Question 2 (Nov 2, 1999) Senate Bill 611 (Apr 2, 2002) Question 5/Legislative Document 1811 (Nov 3, 2009/Apr 9, 2010) Legislative Document 1296 (Jun 24, 2011)	Dec 22, 1999 Jul 25, 2002 Dec 23, 2009 Sep 22, 2011
10. Maryland	Senate Bill 502 (May 22, 2003) Senate Bill 308 (May 10, 2011) Proposal 1 (Nov 4, 2008)	Oct 1, 2003 Jun 1, 2011 Dec 4, 2008
11. Michigan	Administrative Regulations (Apr 4, 2009)	Apr 6, 2009
12. Montana	Initiative 148 (Nov 2, 2004) Senate Bill 423 (May 14, 2011)	Nov 2, 2004 Jul 1, 2011
13. Nevada	Ballot Question 9 (Nov 7, 2000) Assembly Bill 453/Assembly Bill 519 (Jun 15, 2001)	Oct 1, 2001 Oct 1, 2001
14. New Jersey	Senate Bill 119 (Jan 18, 2010) Administrative Regulations (Nov 23, 2011)	Oct 1, 2010 Dec 19, 2011
15. New Mexico	Senate Bill 523 (Apr 2, 2007) Administrative Regulations (Dec 1, 2008) Revised Administrative Regulations (Dec 15, 2010)	Jul 1, 2007 Dec 15, 2008 Dec 30, 2010
16. Oregon	Senate Bill 240 (Mar 5, 2012) Ballot Measure 67 (Nov 3, 1998) House Bill 3052 (Jul 21, 1999) Senate Bill 1085 (Sep 8, 2005)	Jul 1, 2012 Dec 3, 1998 Jul 21, 1999 Jan 1, 2006
17. Rhode Island	Senate Bill 0710 (Jan 3, 2006) Senate Bill 0791 (Jun 21, 2007) House Bill 5359 (Jun 16, 2009) House Bill 8172 (Jun 22, 2010) Senate Bill 2555/House Bill 7888 (May 22, 2012)	Jan 3, 2006 Jun 21, 2007 Jun 16, 2009 Jun 22, 2010 May 22, 2012
18. Vermont	Senate Bill 76/House Bill 645 (May 26, 2004) Senate Bill 00007 (May 30, 2007) Senate Bill 17 (Jun 2, 2011)	Jul 1, 2004 Jul 1, 2007 Jun 2, 2011
19. Washington	Initiative 692 (Nov 3, 1998) Senate Bill 6032/Administrative Regulations (May 8, 2007) Senate Bill 5798 (Apr 1, 2010)	Nov 3, 1998 Jul 22, 2007/Nov 2, 2008 Jun 10, 2010

Note. This information was compiled from [ProCon.org \(2012\)](#), [NORML \(2012\)](#), state legislative web sites, and correspondence with state personnel.

2. Methods

2.1. Data source and coding

We examined records of all drivers from the Fatality Analysis Reporting System for the period 1992 to 2009 ([NHTSA, 2012](#)). This database contains information on drivers, vehicles, and environmental conditions for all motor vehicle crashes in the United States that involve a death within 30 days of the incident. Drivers involved in fatal crashes were examined because this database contains detailed drug test results for drivers and no such database for nonfatal crashes exists in the United States. Drivers were classified as having been tested for drugs if one or more of the available drug result fields on their record indicated that they had tested either positive or negative for any drug besides alcohol (codes 1–10 and 98 for 1992; codes 100–996, 998 for 1993–2009), and positive for cannabinoids if at least one of the available drug result fields indicated that a cannabinoid or related metabolite was detected in their urine or blood (code 6 for 1992; codes 600–695 for 1993–2009), regardless of whether alcohol or other drugs were also detected. Drivers were also classified as to whether or not they were killed in the crashes. The percentages of drivers tested for drugs and the percentages who tested positive for cannabinoids were aggregated by state and calendar year. To allow for follow-up time, only the 14 states that enacted a medical marijuana law before 2010 (AK, CA, CO, HI, MD, ME, MI,

MT, NM, NV, OR, RI, VT, and WA) were considered for potential inclusion as medical marijuana states. Changes in driver cannabinoid prevalence across time in the other 37 jurisdictions were used as a proxy for nationwide trends in driver cannabinoid use in the absence of medical marijuana laws. Because most medical marijuana states require proof of residency in order to qualify for their programs ([NORML, 2012](#); [ProCon.org, 2012](#)), the control prevalence would be minimally biased due to patients who cross state borders to obtain medical marijuana.

2.2. Data analysis

The method used for determining whether there was a reliable change in driver cannabinoid prevalence after the enactment of medical marijuana laws in each state was Auto-Regressive Integrated Moving Average (ARIMA) interrupted time series analysis ([Box & Jenkins, 1970](#); [Box & Tiao, 1975](#)). ARIMA analysis was used because it provides the most flexibility and power for modeling time series, allows for multiple and time-varying intervention points, and results in state-specific estimates of changes in driver cannabinoid prevalence associated with implementing the laws along with each subsequent modification of the laws ([Yaffee & McGee, 2000](#)). Through this method, the annual percentages of fatal-crash-involved drivers (both those who were killed and those who survived) who tested positive for cannabinoids in each

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