Crash Fatality Rates After Recreational Marijuana Legalization in Washington and Colorado

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Objectives. To evaluate motor vehicle crash fatality rates in the first 2 states with recreational marijuana legalization and compare them with motor vehicle crash fatality rates in similar states without recreational marijuana legalization.

Methods. We used the US Fatality Analysis Reporting System to determine the annual numbers of motor vehicle crash fatalities between 2009 and 2015 in Washington, Colorado, and 8 control states. We compared year-over-year changes in motor vehicle crash fatality rates (per billion vehicle miles traveled) before and after recreational marijuana legalization with a difference-in-differences approach that controlled for underlying time trends and state-specific population, economic, and traffic characteristics.

Results. Pre–recreational marijuana legalization annual changes in motor vehicle crash fatality rates for Washington and Colorado were similar to those for the control states. Post–recreational marijuana legalization changes in motor vehicle crash fatality rates for Washington and Colorado also did not significantly differ from those for the control states (adjusted difference-in-differences coefficient = +0.2 fatalities/billion vehicle miles traveled; 95% confidence interval = –0.4, +0.9).

Conclusions. Three years after recreational marijuana legalization, changes in motor vehicle crash fatality rates for Washington and Colorado were not statistically different from those in similar states without recreational marijuana legalization. Future studies over a longer time remain warranted. (*Am J Public Health*. Published online ahead of print June 22, 2017: e1–e3. doi:10.2105/AJPH.2017.303848)

A recent analysis found that medical marijuana legalization has been associated with overall reductions in motor vehicle crash fatalities, although the state-specific effects vary widely.[1] Other studies of marijuana-related motor vehicle crashes before and after medical marijuana legalization have produced conflicting results.[2–5] What remains unknown is whether recreational marijuana legalization affects motor vehicle crash fatality rates. The purpose of this study was to evaluate pre– and post–recreational marijuana legalization changes in motor vehicle crash fatality rates in the first 2 US states to pass recreational marijuana legalization—Washington (November 2012) and Colorado (December 2012)—and to compare them with motor vehicle crash fatality rates in 8 similar states without medical marijuana legalization or recreational marijuana legalization.

METHODS

We selected control states a priori based on their similarity to Washington or Colorado, primarily in terms of traffic and roadway characteristics but also in terms of population, drivers, vehicle ownership, and traffic laws (Appendix A, available as a supplement to the online version of this article at http://www.ajph.org). We then used the National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS) to determine the annual number of motor vehicle crash fatalities in Washington, Colorado, and each control state for 2009 through 2015. We obtained annual vehicle miles traveled data for each state from Federal Highway Administration reports and calculated annual motor vehicle crash fatalities per billion vehicle miles traveled.

We used a difference-in-differences approach[6] to compare year-over-year changes in motor vehicle crash fatality rates in Washington and Colorado following recreational marijuana legalization with the contemporaneous crash data for the control states. Common for analyzing policy-level interventions, this difference-in-differences approach allowed us to control for underlying time trends and state-specific population and traffic characteristics.[7] Our analysis included (for each state) year-specific population data; male-to-female population ratio; total annual Federal Highway Administration appropriations as a measure of road construction and maintenance activity; annual gross domestic product, per-capita real income, and unemployment rate as measures of economic conditions; per-capita alcohol consumption; and transportation system characteristics such as primary versus secondary seatbelt laws, road density, traffic density, and rurality.

We first used random-effects multivariate regression for panel data, incorporating the small-sample Swamy–Arora estimator individual-level variance component and clustered (by state) robust SEs, to confirm

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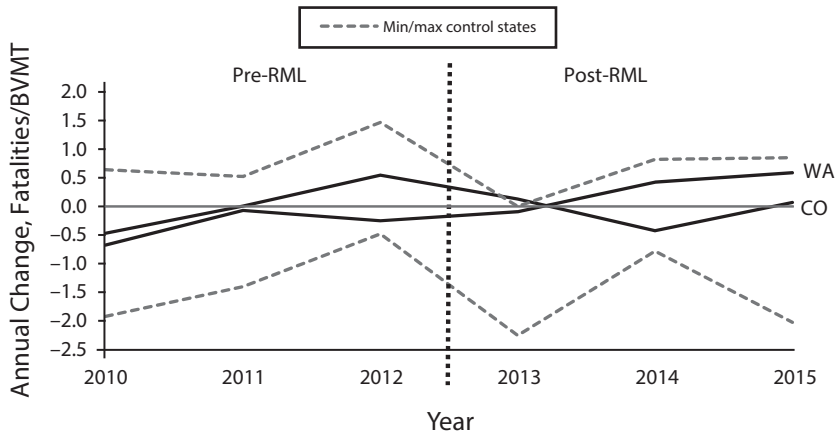
This article was accepted April 11, 2017.

doi: 10.2105/AJPH.2017.303848

parallel trends for the pre–recreational marijuana legalization (2009–2012) changes in motor vehicle crash fatality rates for Washington and Colorado and for the control states. We then modeled the interaction effect between recreational marijuana legalization (yes/no) and period (pre–/post–recreational marijuana legalization) on changes in motor vehicle crash fatality rates for the full study period (2009–2015), which produced the difference-in-differences coefficient. Positive difference-in-differences coefficients indicate higher motor vehicle crash fatality rates (smaller decreases or larger increases); negative coefficients indicate lower rates (larger decreases or smaller increases). We used the Hausman test to confirm appropriateness of the model specification. All tests were 2-sided with an α value of .05 used to establish statistical significance.



Note. min = minimum; max = maximum.

FIGURE 1—Annual Year-Over-Year Changes in Motor Vehicle Crash Fatality Rates per Billion Vehicle Miles Traveled (BVMT) Before and After Recreational Marijuana Legalization (RML): Washington (WA), Colorado (CO), and 8 Control States, 2010–2015

RESULTS

Alabama, Indiana, Kentucky, Missouri, South Carolina, Tennessee, Texas, and Wisconsin were the 8 states without either medical marijuana legalization or recreational marijuana legalization that most closely matched Washington and Colorado in terms of traffic, roadway, and population characteristics. Between 2009 and 2015, 60 737 motor vehicle crash fatalities occurred in Washington, Colorado, and the 8 control states. Overall, annual motor vehicle crash fatality rates decreased from 12.8 fatalities per billion vehicle miles traveled in 2009 to 11.4 fatalities per billion vehicle miles traveled in 2015.

Figure 1 shows the year-over-year changes in motor vehicle crash fatality rates for Washington and Colorado versus the control states in both the pre– and the post–recreational marijuana legalization periods. In the pre–recreational marijuana legalization period, the mean (±SD) year-over-year changes observed in Washington and Colorado did not differ from those observed in the control states (–0.2 [±0.4] vs –0.1 [±0.9] fatalities/billion vehicle miles traveled; $P = .38$). After legalization, motor vehicle crash fatality rates increased by a mean of +0.1 (±0.4) fatalities per billion vehicle miles traveled in Washington and Colorado and decreased by a mean of –0.5 (±0.9) fatalities per billion vehicle miles traveled in the control states each year. In the adjusted difference-in-differences analysis, however, the postlegalization changes in motor vehicle crash fatality rates observed in Washington and Colorado were not significantly different from those observed in the control states (difference-in-differences: +0.2; 95% confidence interval = –0.4, +0.9). (A summary of the results and the full regression model are shown in Appendix B, available as a supplement to the online version of this article at http://www.ajph.org.) Post hoc analyses that used nonclustered robust SEs, traditional random-effects regression, fixed-effects regression, or population rather than billion vehicle miles traveled as the denominator or that grouped Washington with its most similar control states and Colorado with its most similar control states all produced similar results (data not shown).

DISCUSSION

We found no significant association between recreational marijuana legalization in Washington and Colorado and subsequent changes in motor vehicle crash fatality rates in the first 3 years after recreational marijuana legalization. The difference-in-differences coefficient we observed, 0.2 fatalities per billion vehicle miles traveled, would equate to approximately 77 excess crash fatalities (of 2890 total) over nearly 38 million person-years of exposure in the 3 years since legalization. We do not view that as a clinically significant effect, but others might disagree. Although our findings seem at odds with the known effects of marijuana impairment[8,9] and with previous studies finding associations between motor vehicle crashes and marijuana use,[2–5] they are consistent with the most recent analysis of medical marijuana legalization and motor vehicle crash fatalities.[1]

This study was limited to the first few years after recreational marijuana legalization in only 2 states. Currently, however, Washington and Colorado are the only US states with multiyear postlegalization FARS data, and 2015 is the last year for which data are available. We used nonadjacent control states matched to Washington and Colorado based on traffic, roadway, and population characteristics, allowing a stronger analysis than if we had used adjacent, randomly selected, or a convenience sample of states as controls. All of the states had graduated drivers' licensing laws and used 0.08 grams per deciliter as their blood alcohol concentration threshold for impaired driving; all but 1 state (Tennessee) allowed administrative license revocation for impaired driving. Still, states are inherently unique and dynamic, and other unmeasured factors (e.g., enforcement activities; other laws and policy initiatives) could affect crash fatality rates. Selecting fewer control states could have provided for greater similarity

between Washington and Colorado and the control states but would have increased the risk of selection bias. We selected control states without medical marijuana legalization to provide the greatest opportunity to detect an effect of recreational marijuana legalization, presuming the difference between marijuana illegality and recreational marijuana legalization is likely greater than the difference between medical marijuana legalization and recreational marijuana legalization. We did not evaluate the effects of recreational marijuana legalization in Washington and Colorado separately, although their recreational marijuana legalization laws differ somewhat. Finally, we were unable to differentiate between the effects of recreational marijuana legalization (2012) and the effects of legalization of commercial marijuana sales (2014)—an issue deserving of future study.

Importantly, the absence of a statistically significant effect on motor vehicle crash fatality rates does not mean that recreational marijuana legalization is harmless. We did not assess other public health or policy implications of recreational marijuana legalization such as increased drug dependency, emergency department or rehabilitation center admission rates, suicides, or decreased economic productivity. A recent study reported increased marijuana-related emergency department visits among out-of-state visitors to Colorado following recreational marijuana legalization.[10]

This analysis was based on annual statewide motor vehicle crash fatality and billion vehicle miles traveled data; we were not able to evaluate possible differential effects in subpopulations such as younger versus older drivers or rural versus urban drivers. We studied total crashes rather than marijuana-impaired crashes because testing for marijuana use is not uniform in FARS-reported crashes, and the limitations of laboratory testing make studies of marijuana-impaired crashes difficult.[11] Also, FARS does not report nonfatal crashes, and no nationwide clearinghouse for nonfatal crash data is available. However, we also found no association between recreational marijuana legalization and total crash rates when analyzing available state-reported nonfatal crash statistics (Appenix C, available as a supplement to the online version of this article at http://www.ajph.org).

PUBLIC HEALTH IMPLICATIONS

We conclude that 3 years after recreational marijuana legalization in Washington and Colorado, the changes in motor vehicle crash fatality rates observed in those 2 states do not significantly differ from rate changes in similar states without recreational marijuana legalization. However, future studies over a longer time, including data from additional states with recent recreational marijuana legalization, remain warranted. AJPH

CONTRIBUTORS

J. D. Aydelotte and K. M. Luftman conceptualized the study. J. D. Aydelotte, L. H. Brown, K. M. Luftman, B. Coopwood, and C. V. R. Brown designed the study. L. H. Brown, K. M. Luftman, and A. L. Mardock acquired the data. J. D. Aydelotte, L. H. Brown, K. M. Luftman, P. G. R. Teixeira, and C. V. R. Brown analyzed and interpreted the data. J. D. Aydelotte, L. H. Brown, and K. M. Luftman drafted the article, and A. L. Mardock, P. G. R. Teixeira, B. Coopwood, and C. V. R. Brown provided additional critical revisions and intellectual content. All authors reviewed and approved the final version of the article.

HUMAN PARTICIPANT PROTECTION

The institutional review board affirmed that this study was not human participant research.

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