Medical marijuana laws (MMLs) and dispensary provisions not associated with higher odds of adolescent marijuana or heavy marijuana use: A 46 State Analysis, 1991–2015

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Abstract

Background: States are rapidly moving to reverse marijuana prohibition, most frequently through legalization of medical marijuana laws (MMLs), and there is concern that marijuana legalization may affect adolescent marijuana use.

Methods: This natural-experimental study used state Youth Risk Behavior Survey (YRBS) data collected from participants in grades 9–12 from 1991 to 2015 in 46 states ($N = 1,091,723$). Taking advantage of heterogeneity across states in MML status and MML dispensary design, difference-in-difference estimates compared states with enacted MMLs/dispensaries to non-MML/dispensaries states. Multivariable logistic regression modeling was used to adjust for state and year effects, and student demographics. The main outcome assessed was past 30-day adolescent marijuana use ["any" and "heavy" (20)].

Results: In the overall sample, the adjusted odds of adolescents reporting any past 30-day marijuana use was lower in states that enacted MMLs at any time during the study period (OR

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0.94, 95% CI 0.89 to 0.99; $p < .05$), and in states with operational dispensaries in 2015 (OR 0.93, 95% CI 0.88 to 0.99; $p < .05$). Among grade cohorts, only 9th graders showed a significant effect, with lower odds of use with MML enactment. We found no effects on heavy marijuana use.

Conclusions: This study found no evidence between 1991 and 2015 of increases in adolescents reporting past 30-day marijuana use or heavy marijuana use associated with state MML enactment or operational MML dispensaries. In a constantly evolving marijuana policy landscape, continued monitoring of adolescent marijuana use is important for assessing policy effects.

Keywords

Marijuana; medical marijuana; marijuana laws; adolescents; substance use; heavy marijuana use

Introduction

California was the first state to pass a comprehensive medical marijuana law (MML) in 1996, and now more than two-thirds of the United States (U.S.) population lives in a state with an MML, the most liberal category of marijuana laws prior to 2012, when adult-use was first enacted. Although there was concern that the loosening of restrictions on marijuana would lead to increases in use among adolescents, the prevalence of use has remained remarkably stable, and natural-experimental ("quasi-experimental") studies with nonrandom groups have not indicated post-MML increases in marijuana use among adolescents[1–17]. In fact, there have been *declines* in marijuana use among U.S. high school students; data from CDC's National Youth Risk Behavior Surveillance System indicate that lifetime and past 30-day use decreased from 1999 to 2017 (47%–36% and 27%–20%)[18].

Although the lack of an increase in adolescent use is positive news, continued monitoring is critical because policy impacts lag; MMLs may take several years to cause changes in youth marijuana use[19]. Most literature to date has focused more broadly assessing "any cannabis use" patterns, which may mask potentially more serious adverse effects, such as problematic use or cannabis use disorders. Additional analyses are merited to further assess whether the quantity and/or frequency of cannabis use patterns have changed, such as "heavy marijuana use."

Additionally, current studies evaluating MMLs have not accounted for differences in policy provisions across states. There is substantial heterogeneity across state MMLs with respect to provisions, variations within provisions, and the fidelity of implementation and enforcement of provisions (Choo et al., 2014). Heterogeneity may affect changes in frequency of use through its impact on cost, access, potency, and overall quantity of marijuana within a state. Medical marijuana is supplied through dispensary systems; locations where patients or consumers can access various cannabis products in a safe and legal manner[20].

Marijuana remains a Schedule I drug federally under §801 of the Controlled Substance Act. However, in October 2009, the acting Deputy Attorney General announced formal guidelines for federal prosecutors in states that have enacted MMLs, which became known as the "Ogden Memo." This memo clarified that the federal government would not intervene

in legally operating state MML activities, and may have consequently contributed to the growth of state marijuana commercialization, markets and market saturation, including dispensaries, which may be particularly relevant for youth because their presence could lead to increases in exposure through both retail outlet saturation and cheaper illicit market products.

The purpose of this study is to evaluate the associations between enactment and implementation of state MMLs and MML dispensary systems on adolescent marijuana use using cross-sectional grade cohorts, pre-enactment of adult-use ("recreational") laws, which may have differential effects. We used National YRBS data from 46 states (1991–2015) to compare prevalence of use before versus after MML passage, summarizing differences in states with versus without MMLs.

Methods

Data sources

We used state-level YRBS data from 1991 to 2015 to examine associations between MMLs and adolescent marijuana use. YRBS is a cross-sectional, school-based survey collected by the CDC biennially since 1991 with the goal of monitoring priority health risk behaviors among youth at the national, state, and local levels. YRBS data are based on self-administered questionnaires completed by high school students in grades 9–12. Procedures for obtaining parental permission included either active permission (i.e., parents must send a signed form permitting student participation) or passive permission (parents only send back signed form if student not permitted to participate)[21]. The study was determined to be exempt by the IRB at Johns Hopkins Bloomberg School of Public Health.

Study sample

States use a two-stage cluster sample design to obtain a representative sample. Our analytic sample consists of 12 pseudo-panel cohorts, each representing the year when cohort respondents were surveyed as high school students. We use all available weighted YRBS data from 46 states ($N = 1,091,723$), nineteen of which had state-level MML(s) in at least some years [356 state/year combinations]. Nineteen states in the dataset enacted MMLs during the study period (1991–2015). Table 1 shows the MML states and available years of data pre-and-post MML enactment. Stata 15 MP was used to merge state-level MML data with individual-level YRBS data, and for all analyses.

Measures

Dependent variables included two dichotomous variables at the individual-level: past 30-day marijuana use, coded 'yes' if an adolescent reported any marijuana use in the past 30-days, and past 30-day frequent marijuana use, coded 'yes' if the adolescent reported using marijuana 20 times in the past 30-days (i.e., daily or near daily)[22].

MML predictor variables included three dichotomous variables, one indicating whether the state had enacted a MML in the state-year data were collected (yes/no), and two dispensary-specific variables, including: whether a state permits any dispensaries (yes/no),

and whether any dispensaries were operational in the current year being examined (yes/no) (i.e., implemented by 2015). The main predictor variables were presence of an MML and provisions for dispensaries. State-level data on MMLs were collected and cross-checked using information from marijuana reform proponent websites, various state government websites, the National Conference of State Legislatures, and the Office of National Drug Control Policy. Table 2 shows the MML dispensary provisions assessed and status by MML state.

Covariates included: survey year (13 dichotomous variables to indicate each biennial year of data collection, 1991–2015), state (46 dichotomous variables to indicate each state in dataset), sex, grade level, and race/ethnicity (i.e., White, Black, Hispanic, and other race).

Methods

Difference-in-difference analyses were conducted using logistic regression procedures to examine the associations between MML predictor variables and past 30-day adolescent marijuana use dependent variables. A separate fixed effects multiple logistic regression model yielding odds ratios (OR) and 95% confidence intervals (CI) was estimated for each dependent variable with each of the MML predictor variables, while retaining the same set of adjustment variables across all models. In all models assessing the general MML variable, the control group included all states without MMLs, some of which subsequently enacted an MML after 2015 but had not yet done so during the study period. In all models assessing MML dispensary variables, the control group additionally included states with MMLs that did not have the dispensary-specific provision assessed in the specific model. Because states that adopted MMLs may have differed systematically from those that did not, "state" was an important adjustment variable in these analyses; we controlled for clustering by state. Grade-stratified models were also conducted.

Results

This study found no evidence between 1991 and 2015 of increases in adolescents reporting past 30-day marijuana use or heavy marijuana use associated with state MML enactment or operational MML dispensaries. Table 3 presents the adjusted odds ratios and 95% confidence intervals for any past 30-day marijuana use and for frequent marijuana use in the past 30 days in association with presence of an MML and the three dispensary provisions. Estimates represent the average difference in marijuana use (i.e., over all time points) before versus after policy change, across states (comparing states with versus without the policy). The prevalence of any past 30-day marijuana use was 6% lower for all adolescents (aOR: 0.94, 95% CI: 0.89–0.99) and 9% lower for 9th graders (aOR: 0.91, 95% CI: 0.83–0.99) in MML vs. non-MML states. The differences did not hold for frequent marijuana use. Dispensary provisions were not associated with marijuana use, with one exception. Past 30-day marijuana use was 7% lower for all adolescents living in MML states with dispensaries in 2015, compared to adolescents in states without MMLs or with MMLs but no dispensaries.

Discussion

Using more than 20 years of repeated cross-sectional YRBS data from 46 states, we evaluated the association between MMLs and specific MMLs provisions with marijuana use among 9th–12th graders. Our main finding was that adolescents residing in states with MMLs had significantly lower odds of past 30-day ("current") marijuana use compared to adolescents residing in non-MML states (6%). In grade stratified analyses, the 9th graders had 9% lower odds, whereas there were no differences for other grade levels. This finding is counterintuitive and may be an artifact of the trend toward declining levels of substance use.[23] States that passed MMLs have higher levels of use and may therefore have larger declines. There were no differences in daily/near daily use for the full sample or for grade-stratified analyses.

We looked at dispensaries, which is innovative given that most studies treat MMLs as a dichotomous homogenous variable, without addressing heterogeneity across states[7,8,24,25] Although we did not observe increases based on dispensaries, it is well established that there is a time lag between the passing of new policies and their full implementation and impact. Thus, these results may not be representative of states with fully matured medicinal markets. Future studies should look at additional years of data collection using different datasets, as well as including additional lagged policy variables, to determine effects. With additional years, analyses will have power to determine effects for additional margins of use (e.g., frequent use), and using longitudinal datasets will permit assessment of causality vs. association.

Results may not be generalizable to adolescents not attending public schools, absent, or who have dropped out of school.[26] Although findings likely are an underestimate of the association between MMLs and marijuana use for the general population of adolescents, most youth (>95%) attend school. There were gaps in available data across states and years. The YRBS did not have weighted state-level data for Oregon and Washington, and only had post-enactment data for California, Colorado, and Vermont, five crucial MML states with early MML enactment. Seven states in the control group enacted MMLs after our study period (Arkansas, Florida, North Dakota, Ohio, and Pennsylvania in 2016, West Virginia in 2017, and Oklahoma in 2018). These states may have had marijuana use rates and social norms surrounding marijuana that are closer to those of states that had already enacted MMLs during our study years, as indicated by their eventually legalizing medical marijuana. Current literature corroborates this hypothesis: states that passed MMLs already had higher rates of marijuana use before MML enactment.[6] Additionally, this study is not able to examine the pre-post effects of Washington and Oregon, two states that enacted MMLs before 2001, and does not have pre-post data for California, which enacted its MML in 1996. Earlier MML adopter states and MML provisions may differ systematically from recent MML adopter states and MMLs assessed in this study; thus, these results are not generalizable to all states with MMLs.

Although we did not observe significant changes, we did find increases in 2011, 2013, 2015 (results not shown);[27,28] findings that are consistent with nationally representative results from the National Survey on Drug Use and Health. Models stratified by survey year

may provide different results than those based on all survey years combined, differences which may be explained by varying state-year sample participation, delays in policy implementation; dispensaries taking time to open after the law was enacted. As the marijuana policy landscape in the U.S. continues to evolve, along with the heterogeneity inherent in MML design, it is important to continue to monitor adolescent marijuana use behaviors for prevention efforts in states with MMLs and those looking to enact similar MMLs and MML provisions.

Acknowledgments

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Table 1.

Years of Youth Risk Behavior Survey (YRBS) data collection pre-and-post Medical Marijuana Law (MML) Enactment.

State	Year MML Enacted	Years of Data Pre-MML Enactment	Years of Data Post-MML Enactment
States that enacted MML between 1991 and 2015 (Study Years)			
California (CA)[a]	1996	0	1
Alaska (AK)	1998	1	5
Maine (ME)	1999	2	8
Colorado (CO)[a]	2000	0	3
Nevada (NV)	2000	4	7
Montana (MT)	2004	6	6
Vermont (VT)[a]	2004	0	3
Rhode Island (RI)	2006	4	5
New Mexico (NM)	2007	2	5
Michigan (MI)	2008	6	4
Arizona (AZ)	2010	4	3
New Jersey (NJ)	2010	3	2
Delaware (DE)	2011	5	2
Connecticut (CT)	2012	5	2
Massachusetts (MA)	2012	7	2
Illinois (IL)	2013	5	2
New Hampshire (NH)	2013	7	2
New York (NY)	2014	8	1
Maryland (MD)	2014	5	1
States in sample that enacted MML after 2015 (Post-Study Years)[b]			
Arkansas (AR)	2016	8	0
Florida (FL)	2016	7	0
North Dakota (ND)	2016	10	0
Pennsylvania (PA)	2016	2	0
Ohio (OH)	2016	8	0
West Virginia (WV)	2017	10	0

State	Year MML Enacted	Years of Data Pre-MML Enactment	Years of Data Post-MML Enactment
Louisiana (LA)	2017	4	0
Utah (UT)	2018	12	0
Oklahoma (OK)	2018	7	0
Missouri (MO)	2018	10	0

[a] States that only have post-MML-enactment data.

[b] States enacted MML after study years, thus, data cannot infer any changes from policy enactment.

Table 2.

MML dispensary provisions for states with an enacted Medical Marijuana Law (MML) in sample, 1991–2015.

State	Dispensaries	
	Any permitted, 1991–2015	Active by 2015
California (CA)	Yes	Yes
Alaska (AK)	No (2016)	
Maine (ME)	Yes	Yes
Colorado (CO)	Yes	Yes
Nevada (NV)	Yes	Yes
Montana (MT)	No	
Vermont (VT)	Yes	Yes
Rhode Island (RI)	Yes (2009)	Yes
New Mexico (NM)	Yes	Yes
Michigan (MI)	No	Yes
Arizona (AZ)	Yes	Yes
New Jersey (NJ)	Yes	Yes
Delaware (DE)	Yes	Yes
Connecticut (CT)	Yes	Yes
Massachusetts (MA)	Yes	Yes
Illinois (IL)	Yes	Yes
New Hampshire (NH)	Yes	
New York (NY)	Yes	
Maryland (MD)	Yes	
Total	263,581	197,367
Percentage of adolescents living in state with this MML provision out of all states with MMLs (*N* = 308,024)		
%	85.57%	64.08%
Percentage of adolescents living in state with this MML provision out of all observations (N = 1,091,723)		
%	24.14%	18.08%

*
Note. MML provision data obtained from varying sources, including:

1. 2015 Marijuana Policy Project Report: https://www.mpp.org/issues/medical-marijuana/state-by-state-medical-marijuana-laws/state-by-state-medical-marijuana-laws-report/ (accessed July 2018)

2. Medical Marijuana ProCon.org: https://medicalmarijuana.procon.org/view.resource.php?resourceID=000881.

3. NORML http://norml.org/laws/medical-marijuana-2. (accessed July 2018), and

4. National Conference of State Legislatures: http://www.ncsl.org/research/health/state-medical-marijuana-laws.aspx. (accessed July 2018).

Table 3.

Difference-in-difference tests of MMLs and dispensary provisions predicting past 30-day marijuana use among U.S. High School Students, 1991–2015 ($N = 1,091,723$).

	Any use Adjusted OR (95%CI)	Frequent use (20 times) Adjusted OR (95%CI)
Any MML [19 States ($n = 304,952$)]		
All grades	0.94 (0.89–0.99)	0.95 (0.87–1.05)
9th grade	0.91 (0.83–0.99)	0.99 (0.83–1.18)
10th grade	0.95 (0.87–1.02)	0.99 (0.86–1.14)
11th grade	0.92 (0.84–1.01)	0.91 (0.79–1.06)
12th grade	0.96 (0.86–1.06)	0.90 (0.80–1.07)
Dispensaries Permitted [16 States ($n = 259,049$)]		
All grades	0.97 (0.90–1.04)	0.96 (0.85–1.07)
9th grade	0.95 (0.86–1.06)	1.01 (0.83–1.23)
10th grade	1.01 (0.9101.11)	1.01 (0.85–1.20)
11th grade	0.94 (0.84–1.04)	0.95 (0.80–1.13)
12th grade	0.95 (0.84–1.08)	0.88 (0.74–1.04)
Dispensaries Active by 2015 [14 States ($n = 192,835$)]		
All grades	0.93 (0.88–0.99)	0.98 (0.88–1.08)
9th grade	0.92 (0.83–1.01)	1.03 (0.85–1.24)
10th grade	0.93 (0.86–1.01)	1.00 (0.86–1.15)
11th grade	0.91 (0.82–1.01)	0.90 (0.77–1.06)
12th grade	0.95 (0.84–1.07)	0.98 (0.83–1.16)