Letters

Association of Marijuana Laws With Teen Marijuana Use: New Estimates From the Youth Risk Behavior Surveys

In the United States, 33 states and the District of Columbia have passed medical marijuana laws (MMLs), while 10 states and the District of Columbia have legalized the recreational use of marijuana. Policy makers are particularly concerned that legalization for either medicinal or recreational purposes will encourage marijuana use among youth. Repeated marijuana use during adolescence may lead to long-lasting changes in brain function that adversely affect educational, professional, and social outcomes.[1]

A 2018 meta-analysis[2] concluded that the results from previous studies do not lend support to the hypothesis that MMLs increase marijuana use among youth, while the evidence on the effects of recreational marijuana laws (RMLs) is mixed. For instance, using data from Monitoring the Future, Cerdá et al[3] found increased marijuana use among 8th and 10th graders after it was legalized for recreational use in Washington State. However, these authors found no evidence of an association between legalization and adolescent marijuana use in Colorado. Using data from the Washington Healthy Youth Survey, Dilley et al[4] found that marijuana use among 8th and 10th graders fell after legalization for recreational purposes.

Here, we report estimates of the association between the legalization of marijuana and its use, simultaneously considering both MMLs and RMLs. Using data from the Youth Risk Behavior Surveys (YRBS) from 1993 to 2017, more policy variation was captured than in any previous study in the literature, to our knowledge. Between 1993 and 2017, 27 states and Washington, DC, contributed data to the YRBS before and after MML adoption; 7 states contributed data to the YRBS before and after RML adoption.

Methods | Following previous researchers,[5] we pooled the national and state YRBS from 1993 to 2017. These surveys are administered biennially to US high school students (grades 9-12) and are used by government agencies to track trends in behaviors such as unhealthy eating, sexual activity, and substance use. Data analysis began in December 2018. Institutional review board approval and participant consent were not required because of the secondary nature of the data.

Multivariate logistic regression analysis was used to estimate the associations between medical and recreational marijuana legalization and the likelihood of marijuana use in the past 30 days. Frequent marijuana use (ie, use at least 10 times in the past 30 days) was also considered as an outcome. Two-sided hypothesis tests were used, and results were considered statistically significant if the P value was less than .05. All analyses were conducted with the statistical software package Stata, version 14 (StataCorp).

Results | The final sample size was 1 414 826. The first and second columns of the **Table** report estimated odds ratios (ORs) of marijuana use and frequent marijuana use, respectively, adjusted for indicators for 50 states and 12 years. In the remaining columns, the ORs were further adjusted for individual- and state-level covariates. In the fully adjusted models, MMLs were not statistically associated with either measure of marijuana use, but RMLs were associated with an 8% decrease (OR, 0.92; 95% CI, 0.87-0.96) in the odds of marijuana use and a 9% decrease (OR, 0.91; 95% CI, 0.84-0.98) in the odds of frequent marijuana use.

In the **Figure**, the MML indicator was replaced with a series of its leads and lags. Consistent with the parallel trends assumption, there was no evidence of an association between MMLs and marijuana use prior to year 0. The lack of pretreatment trends suggests the estimated ORs of the lags can be interpreted in a causal fashion, but they were, with 1 exception,

Table. Logistic Estimates of the Association of Marijuana Legalization With Teen Marijuana Use[a]

Variable	OR (95% CI)			
	Marijuana Use[b]	Frequent Marijuana Use[b]	Marijuana Use[b,c]	Frequent Marijuana Use[b,c]
MML	0.95 (0.90-1.00)[d]	0.93 (0.86-1.00)[d]	0.95 (0.89-1.01)	0.94 (0.87-1.03)
RML	0.91 (0.85-0.98)[d]	0.91 (0.83-0.99)[d]	0.92 (0.87-0.96)[d]	0.91 (0.84-0.98)[d]

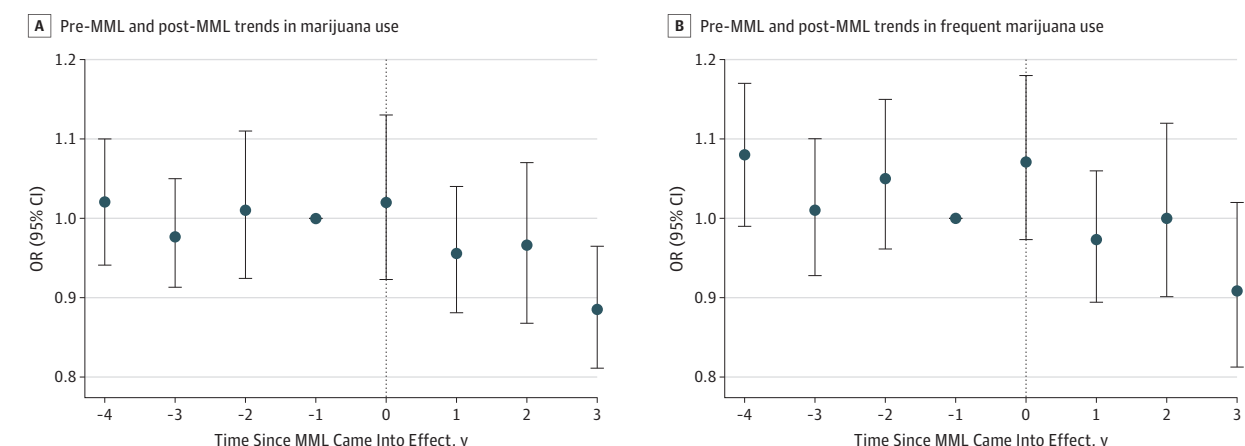Abbreviations: MML, medical marijuana laws; RML, recreational marijuana laws.

[a] Each column reports unweighted estimates from a separate logistic regression based on biennial data from the Youth Risk Behavior Surveys (1993-2017). Specifically, estimated odds ratios (ORs) of marijuana use and frequent marijuana use (ie, use at least 10 times in the past 30 days) are reported. Standard errors, which were used to construct the 95% CIs, were corrected for clustering at the state level. All models were adjusted for indicators for 50 states and 12 years. Estimated average marginal effects were qualitatively similar to the estimated ORs. N = 1 414 826.

[b] Estimated ORs were adjusted for state and year indicators.

[c] Estimated ORs were adjusted for individual-level characteristics (age, sex, grade in school, and race/ethnicity), whether marijuana use and possession were decriminalized in the respondent's state, the presence of a state level 0.08 blood alcohol concentration law, the state beer tax, state income per capita, state unemployment rate, and indicators for 50 states and 12 years.

[d] Statistically significant ($P < .05$).

Figure. Event Study Analysis

A Pre-MML and post-MML trends in marijuana use

B Pre-MML and post-MML trends in frequent marijuana use

Unweighted estimates from separate logistic regressions based on biennial data from the Youth Risk Behavior Surveys (1993-2017) are reported. Specifically, estimated odds ratios (ORs) and 95% CIs of marijuana use and frequent marijuana use are reported. Odds ratios were adjusted for individual-level characteristics (age, sex, grade, and race/ethnicity), whether marijuana use and possession were decriminalized in the respondent's state, the presence of a state-level 0.08 blood alcohol concentration law, the state beer tax, state income per capita, state unemployment rate, and indicators for 50 states and 12 years. The omitted category was 1 year prior to a medical marijuana law (MML) going into effect. N = 1 414 826.

statistically insignificant. An event study figure for RMLs was not included owing to lack of posttreatment data.

Discussion | Consistent with the results of previous researchers,[2] there was no evidence that the legalization of medical marijuana encourages marijuana use among youth. Moreover, the estimates reported in the Table showed that marijuana use among youth may actually decline after legalization for recreational purposes. This latter result is consistent with findings by Dilley et al[4] and with the argument that it is more difficult for teenagers to obtain marijuana as drug dealers are replaced by licensed dispensaries that require proof of age.[6]

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