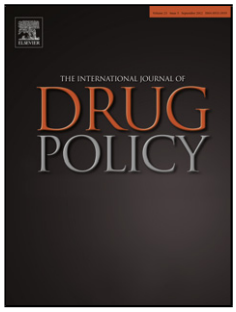

Title: THE EFFECT OF MEDICAL MARIJUANA LAWS ON JUVENILE MARIJUANA USE

Author: Lisa Stolzenberg Stewart J. D'Alessio Dustin Dariano

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Highlights

- We investigate whether medical marijuana laws influence marijuana and illicit drug use among juveniles.
- Results suggest that medical marijuana laws escalate juvenile marijuana use.
- Findings also show that medical marijuana laws have little effect on juvenile illicit drug use.

THE EFFECT OF MEDICAL MARIJUANA LAWS ON JUVENILE MARIJUANA USE*

Lisa Stolzenberg

Florida International University

Stewart J. D'Alessio

Florida International University

Dustin Dariano

Florida International University

*Direct correspondence to Lisa Stolzenberg, Department of Criminal Justice, Florida International University, 11200 SW 8th Street - PCA 257, Miami, FL 33199. E-mail: stolzenb@fiu.edu.

THE EFFECT OF MEDICAL MARIJUANA LAWS ON JUVENILE MARIJUANA USE

Abstract

Background: A number of states in the United States legally allow the use of marijuana as a medical therapy to treat an illness or to alleviate symptoms. Concern persists as to whether these types of laws are increasing juvenile recreational marijuana use. It is also plausible that medical marijuana laws engender an escalation of illicit non-marijuana drug use among juveniles because marijuana is frequently considered to be a gateway drug.

Methods: This study uses longitudinal data drawn from the National Survey on Drug Use and Health for the 50 U.S. states and a cross-sectional pooled-time series research design to investigate the effect of medical marijuana laws on juvenile marijuana use and on juvenile non-marijuana illicit drug use. Our study period encompasses five measurement periods calibrated in two-year intervals (2002-03 to 2010-11). This research design is advantageous in that it affords us the ability not only to assess the effect of the implementation of medical marijuana laws on juvenile drug use, but also to consider other state-specific factors that may explain variation in drug use that cannot be accounted for using a single time series.

Results: Findings show that medical marijuana laws amplify recreational juvenile marijuana use. Other salient predictors of juvenile marijuana use at the state-level of analysis include perceived availability of marijuana, percent of juveniles skipping school, severity of perceived punishment for marijuana possession, alcohol consumption, percent of respondents with a father residing in household, and percent of families in the state receiving public assistance. There is little empirical evidence to support the view that medical marijuana laws affect juveniles' use of illicit non-marijuana drugs.

Conclusion: Based on our findings, it seems reasonable to speculate that medical marijuana laws amplify juveniles' use of marijuana by allaying the social stigma associated with recreational marijuana use and by placating the fear that marijuana use could potentially result in a negative health outcome.

Keywords: Medical marijuana laws; Juvenile marijuana use; Juvenile illicit drug use; Panel analysis; Youth

Background

Because of its purported medicinal value (Clark, 2000; Kramer, 2015; Lynch & Ware, 2015; Watson, Stanley, Benson, & Joy, 2000), both the nationwide and worldwide popularity of legalizing marijuana for medical purposes has reached epic proportions. A 2010 Gallup poll found that approximately 70% of Americans are in favor of allowing doctors to prescribe marijuana to mitigate pain (Mendes, 2010), whereas a survey of 1,446 physicians from 72 countries revealed that 76% of the physicians supported the use of marijuana for medical purposes (Adler & Colbert, 2013). Twenty states in the U.S. since 1999 and the District of Columbia have legalized the use of marijuana for medicinal purposes, and a number of additional states are expected to follow suit. The number of registered medical marijuana identification card holders in the United States (U.S.) as of April 2013 stands at 1,029,325, and this number is expected to grow in the coming years (Procon.org, 2014).

Debate as to whether the labeling of marijuana as non-harmful not only facilitates its acceptability (Miech et al., 2015), but also ameliorates the perceived riskiness of its use continues to escalate as more states allow medical marijuana use (Schuermeyera et al., 2014; Khatapoush & Halfors, 2004; Wall et al., 2011). Some argue that marijuana use is a tangible health risk (Hall, 2015), that alternative medications currently exist to deal with ailments typically treated with marijuana (Watson et al., 2000) and that medical marijuana laws amplify the recreational use of marijuana in the population (Clark, 2000; Gorman and Huber, 2007; Joy et al., 1999).

A number of studies find evidence that medical marijuana laws amplify marijuana use in the population, particularly among youth. Wall et al. (2011) examined marijuana use among adolescents (12-17 year olds) in states with and without medical marijuana laws and found that on average marijuana use was higher among youths living in states that legalized medical marijuana. They also observed a marked decline in the perceived riskiness of marijuana use among youth following the passage of a medical marijuana law. In a cross-sectional study, Cerdá, Wall, Keyes, Galea, & Hasin (2012) evinced evidence that adults had a substantially higher likelihood of marijuana use in states that allowed the use of medical marijuana. Salomonsen-Sautel, Sakai, Thurstone, Corley, & Hopfer (2012) found that 73.8% of the individuals admitted to substance abuse treatment in the Denver metropolitan area reported that they had used the marijuana prescribed to another individual for medicinal purposes, although these medical marijuana users did admit that they were also more apt to use non-medicinal marijuana on a regular basis.

Despite the findings generated in these research studies, not everyone is fully convinced that medical marijuana laws influence the recreational use of marijuana (Clark, 2000). Katapoush & Halfors (2004) investigated whether attitudes regarding perceived dangers of marijuana use changed over time in California and 10 other comparable states. Although they noted a significant decrease in people's perceived harm of marijuana from 1995 to 1999, the rate of marijuana use in the population remained relatively stable. Gorman & Huber (2007) endeavored to establish whether marijuana use rose following legislation to legalize medical marijuana in several cities and metropolitan areas in four states from 1994 to 2002. Their interrupted time series analysis showed that marijuana use among criminal arrestees and

people admitted to emergency rooms for drug overdoses did not increase substantially following the legalization of medical marijuana for any of the areas studied. In a replication of the Wall et al. (2011) study, Harper, Strumpf & Kaufman (2012) used a difference-in-difference regression model to discern whether medical marijuana laws influenced recreational marijuana use. In contrast to the results reported in the Wall et al. study, Harper and his colleagues found that medical marijuana laws did not substantially elevate marijuana use among youth between the ages of 12 to 17. Finally, Lynne-Landsman, Livingston & Wagenaar (2013) used data drawn from the Youth Risk Behavior Surveillance System to measure statewide prevalence rates of marijuana use. They examined four states -- Montana, Delaware, Rhode Island, and Michigan -- that each passed a medical marijuana law sometime between 2003 and 2011. Using logistic regression difference-in-difference models, Lynne-Landsmen and her associates found no statistically discernible rise in either self-reported prevalence or frequency of marijuana use among adolescents following the legislation of medical marijuana.

Methodological Problems with Prior Research

Although certainly informative, much of the prior research examining the effect of medical marijuana legislation on attitudes toward marijuana use and on recreational marijuana use is problematic for a number of reasons making any conclusions tentative at best. Methodological problems include small and unrepresentative samples, an overreliance on cross-sectional data, inappropriate statistical methodology, and a general failure to investigate the possibility that medical marijuana laws increase non-marijuana drug use. First, many previous studies were based on small and non-representative samples often drawn from a few select geographical

locations. For example, Salomonsen-Sautel et al. (2012) analyzed 164 cases, Thurstone, Lieberman & Schmiege (2011) 80 cases, Lynne-Landsman et al. (2013) studied four states and Gorman & Huber (2007) examined only high-risk urban populations. The unrepresentiveness of these samples not only hinders one's ability to generalize the results generated in these studies, but it is also plausible that appreciable changes in sample composition might alter some or all of the effects observed in these studies.

Second, with a few noteworthy exceptions, most of what we currently know about the effect of medical marijuana laws on attitudes toward marijuana and marijuana use among youth comes from the examination of survey data collected at a single point in time (Cerdá et al., 2012; Salmulsonne-Sautel et al., 2012; Thurstone et al., 2011). The analysis of cross-sectional data cannot easily identify the specific causal processes at work. To illustrate, just because a person living in a state with a medical marijuana law has a greater likelihood of marijuana use than an individual living in a state without such a law does not necessarily mean that the implementation of the medical marijuana law engendered this difference in the probability of marijuana use. People living in medical marijuana states might have always used more marijuana. In fact, more liberal attitudes in regards to marijuana use in these states might have been the initial impetus for the passage of the medical marijuana law. An analysis of longitudinal data is needed to determine more accurately the effect of medical marijuana laws on juvenile marijuana use. As Cerdá et al. (2012:25) note, "Future studies should use large-sample survey data collected in years prior to and after enactment of marijuana laws in states with and without such laws, to compare prevalences and trends."

Third, while a few studies have heeded the call to analyze longitudinal data, these studies also have shortcomings that limit their ability to draw definitive conclusions. To determine whether marijuana use increased following legislation to legalize medical marijuana in several cities and metropolitan areas in different states, Gorman & Huber (2007) conducted an Autoregressive Integrated Moving Average (ARIMA) interrupted time series analysis with fewer than 50 pre-intervention quarterly time-periods. However, while an interrupted time series ARIMA analysis is generally considered a robust statistical procedure for interpreting aggregate change (McCleary & Hay, 1980), there needs to be an adequate number of pre-intervention periods so that trend and seasonality can be modeled appropriately. It is generally accepted that at least 50 measurement periods are needed in the pre-intervention series to model accurately trend and seasonality. Otherwise, ARIMA results can become unstable (McCain & McCleary, 1979:235). Other longitudinal research studies were also problematic in that they had too short a post-intervention period to draw firm conclusions (Wall et al., 2011) or they had a limited time-period for evaluation purposes (Harper et al., 2012).

Finally, current research remains surprising silent on whether medical marijuana laws amplify juveniles' use of illicit drugs. An expansive literature suggests that marijuana use is correlated, at least in the short term, with an increase in the probability of an individual using other illicit drugs (Hall & Lynsky, 2005). For example, using a sample of young persons from the National Household Survey on Drug and Abuse, Kandel & Yamaguchi (2002) found that 90% of respondents reported using marijuana prior to cocaine. Fergusson, Boden, & Horwood (2006) analyzed data on 1,200 New Zealand children from the Christchurch Health and Development Study over a 25-year period. They found that of those who reported using illicit drugs other

than marijuana, 98% admitted to using marijuana within the same year or before using the illicit drug(s). However, it was also noted that the relationship between marijuana use and other drug use weakened as the respondents grew older. Van Gundy & Rebellon (2010) generated similar findings in their study of 1,286 young adults living in South Florida. Using logistical regression and controlling for stress and life perspective variables, they observed that illicit drug use was higher for respondents who reported using marijuana in grades eight and nine. Despite the possibility of marijuana acting as a gateway drug, current research has not fully investigated the effect of medical marijuana laws on juveniles' use of illicit drugs.

The primary objective of this study is to examine the relationship between medical marijuana laws and juvenile marijuana use, correcting for some of the methodological problems encountered in earlier studies. Specifically, we use panel data drawn from the 50 U.S. states to probe the effect of the passage of medical laws on juvenile marijuana use. This research design is ideally suited for studying both the temporal and spatial patterns of marijuana use because it allows for the analysis of multiple units across multiple time-periods. In addition to exploring the relationship between medical marijuana laws and juvenile marijuana use, an attempt is made to verify empirically whether medical marijuana laws result in the escalation of illicit drug use among juveniles. This issue has been overlooked in previous research.

Data and Methods

We analyze data for juveniles from 2002 to 2011 for the 50 U.S. states, which constituent political entities that share sovereignty with the United States federal government. Juveniles

are defined as persons, 12 to 17 years of age. The data, which encompass five measurement periods calibrated in two-year intervals (2002-03, 2004-05, 2006-07, 2008-09, and 2010-11), are derived from two different sources. These two sources include the National Survey on Drug Use and Health and Progcon.com. The National Survey on Drug Use and Health is a nationally representative sample of the U.S. population that is conducted by Substance Abuse and Mental Health Services Administration. This survey is uniquely suited for our purposes because it contains information on marijuana use and other drug use among the population along with individual demographic characteristics of the respondent. The dataset also contains geocode information that identifies the respondent's state of residence, which is the smallest geographical unit for which the data are made available to the public. These geographic identifiers can be used to determine whether or not a respondent resides in a state that passed a medical marijuana law. All relevant data on survey respondents were aggregated to the state-level. Our study period was determined by the online availability of the National Survey on Drug Use and Health data, which can be accessed at http://www.icpsr.umich.edu/icpsrweb/content/SAMHDA.

We obtained data pertaining to medical marijuana laws from Progcon.com. These data include the year that a given state passed a medical marijuana law and the amount of medical marijuana a person is legally allowed to possess in a state.

Dependent Variables

Two dependent variables are analyzed in this study. The first dependent variable, the percent of juveniles reporting that they used marijuana in the month prior to being surveyed

about their drug use, captures the prevalence of marijuana use among juveniles in the states. The second dependent variable is the percent of illicit drug use among juveniles in the month prior to being surveyed. These illicit drugs, which include cocaine, heroin, methamphetamines, hallucinogens, inhalants, and psychotherapeutics, are typically considered more dangerous than marijuana to a person's health.

Independent Variables

The theoretically relevant independent variable in our analysis is the year that medical marijuana legislation was implemented in a state. This variable is coded one for the year that a state passed a medical marijuana law, zero otherwise. The following 16 states allowed the sale of medical marijuana during the study period: Alaska (1998), Arizona (2010), California (1996), Colorado (2000), Delaware (2011), Hawaii (2000), Maine (1999), Michigan (2008), Montana (2004), Nevada (2000), New Jersey (2010), New Mexico (2007), Oregon (1998), Rhode Island (2006), Vermont (2004), and Washington (1998). Seven states including Connecticut (2012), Illinois (2013), Maryland (2014), Massachusetts (2012), Minnesota (2014), New Hampshire (2013), and New York (2014) passed a medical marijuana law after 2011.

In addition to the medical marijuana law variable, several control variables are incorporated into our state-level analyses to help us avoid basing our conclusions on spurious or suppressed relationships. These variables include the medical marijuana possession limit, marijuana availability, percent juveniles believing that mandatory prison is the maximum penalty for marijuana possession, alcohol use, percent juveniles enrolled in a drug class, whether the respondent was previously arrested for a crime, percent of families receiving public assistance

income, percent of juveniles who skipped school within the past 30 days, percent of families where the father resides in the household, percent of male juveniles and percent of white juveniles. The means, standard deviations and definitions for all the variables are displayed in Table 1.

We include the medical marijuana possession limit variable, which measures the number of ounces of medical marijuana that an individual is legally permitted to possess in a state, as a control variable because research finds that drug use is correlated strongly with the supply of a drug (Stolzenberg & D'Alessio, 2003). The greater the availability of an illicit drug in the population, the more apt an individual is to test positive for that drug. Marijuana availability is another indicator of the supply of marijuana. However, in contrast to the medical marijuana possession limit variable, marijuana availability is a measure based on perception. Respondents were queried whether they felt that marijuana was fairly or very easy for them to obtain. As the perception in regards to the ease of obtaining marijuana rises, juvenile marijuana use should also increase. Another potentially salient control variable included in this study is the perceived severity of the criminal sanction for marijuana possession. This variable measures deterrence. Advocates of the deterrence thesis maintain that individuals are free-will actors who rationally weigh the probable benefits and potential liabilities before engaging in criminal activities. They also argue that this individual calculation hinges on the severity of criminal sanctions imposed by law (Grasmick & Bryjak, 1980).

We also felt it appropriate to include alcohol use as a control variable because prior research demonstrates that marijuana and alcohol act as substitutes for each other (Anderson et al., 2013). Based on findings generated in this research, we expect that juvenile marijuana use will

be lower in states where juveniles consume a greater amount alcohol. There is also an expectation that there will be a positive relationship between the percent of respondents enrolled in a special class about drugs or alcohol in the previous 12 months and juvenile marijuana use. The percent of respondents arrested and booked previously for a criminal offense (Tripodi & Bender, 2011), as well as socioeconomic status (Rogeberg, 2013), should both be associated with juvenile drug use. Finally, skipping school and family structure are reported by researchers to be correlated with increased substance abuse among juveniles. Roebucka et al. (2004) reports that marijuana use is associated positively with school truancy, whereas Barrett and Turner (2006) evince evidence that adolescents and young adults from single-parent families have greater problems with substance use than those from families with a mother and father. Gender and race are also used as control variables. While studies find that male adolescents have an enhanced proclivity to use marijuana (Schepis et al., 2011), the literature on the relationship between race and marijuana use is more inconclusive. Although surveys indicate that marijuana use among blacks and whites is similar in the general population (Substance Abuse and Mental Health Services Administration, 2011), research based on the drug testing of urine finds that blacks are significantly more likely than whites to use marijuana (D'Alessio, Stolzenberg, & Flexon, 2015). Despite this inconsistency in the literature, we still felt it warranted to include a race control variable in our analyses.

(Insert Table 1 about here)

We use the panel regression procedure in LIMDEP to ascertain the effect of medical marijuana laws and the control variables on the two dependent variables (Greene, 2007). This type of analytic design is ideally suited for studying both the temporal and spatial patterns of recreational juvenile marijuana use because it can analyze multiple units across multiple time periods. This methodological strategy accounts for both cross-sectional and temporal complications of the data by enabling the consideration of variation across both state and time. We are thus able to account for state-specific variables that may explain variation in recreational marijuana use among juveniles that cannot be considered with a national time series. Another advantage is that the analysis of panel data does not require a large number of temporal observations, which is typically needed in a time series analysis.

A random effects model is used to estimate our equations. An important consideration when determining whether a fixed effects model or random effects model should be used in an analysis is whether the predictor variables vary or do not vary over time. If one or more of the predictor variables included in the equation are time-invariant, the fixed effects model cannot be estimated because its variance-covariance matrix cannot be inverted (Greene, 2007:E11-44). The inclusion of time-invariant variables in the equation also precludes estimation of a Hausman test (Hausman & Taylor, 1981), which assess whether the fixed effects model and the random effects model produce statistically similar results (Greene, 2007:E11-36). While the medical marijuana law variable is not time-invariant, it does have limited variability during the study period. Of the 16 states that passed a medical marijuana law before 2012, eight states implemented their medical marijuana law during the study period. Thus, because the dummy

coded medical marijuana law variable has reduced variability, the random effects model is the appropriate choice for our estimation procedure.

Results

Figure 1 shows the percent of marijuana use among juveniles in the 16 medical marijuana states before and after they passed a medical marijuana law. This figure also depicts the percent of juvenile marijuana use for the remaining states that did not pass a medical marijuana law during the observation period. A visual inspection of Figure 1 reveals that juvenile marijuana use was consistently higher in states that passed, or that would eventually pass a medical marijuana law than and in states that did not pass a medical marijuana law. Although it is certainly plausible that the prevalence of marijuana use in a state is a causal factor in whether or not a state implements a medical marijuana law, Figure 1 also shows that with the exception of the 2002-03 period juvenile marijuana use was consistently higher in states following the passage of a medical marijuana law than in states that would eventually pass such a law. This finding suggests that the implementation of medical marijuana laws increase juvenile marijuana use rather than marijuana use influencing the passing of medical marijuana laws.

(Insert Figure 1 about here)

Table 2 reports the results of the equations estimating the influence of the control variables and the medical marijuana law variable on juvenile marijuana use over time for the 50 U.S.

states. Model 1 is a baseline equation that includes the effects of only the control variables. A visual inspection of the Model 1 of Table 2 reveals that six of the 11 control variables reach statistical significance in the equation. One pronounced effect in the model is marijuana availability. Results show that as the perception of marijuana availability increases among juvenile respondents, so does marijuana use. Prior research suggests that drug availability measured by the price of a drug is correlated strongly with drug use (Stolzenberg & D'Alessio, 2003). A substantive positive relationship also exists between skipping school and the dependent variable, suggesting that juveniles who skip school are more apt to use marijuana. The observed relationship between mandatory prison sanction and marijuana use is consistent with deterrence theory since the severity of criminal punishment is related to juvenile marijuana use in the negative direction. Alcohol use and whether a father resides in household are also associated positively with juvenile marijuana use. Another pronounced effect in this model is the percent of families receiving public assistance. As the percent of families receiving public assistance rises in a state, juvenile marijuana use also climbs.

In Model 2 of Table 2 the dummy coded medical marijuana law variable was added to the baseline equation. Results for this model show a statistically discernible relationship between the dummy coded variable measuring whether a state has a medical marijuana law and the percent of juveniles reporting that they used marijuana during the past month prior to being surveyed. The coefficient for the medical marijuana law variable is statistically significant and in the positive direction, thereby indicating that medical marijuana laws elevate juvenile marijuana use even after accounting for the other independent variables included the equation. One can interpret this effect as compelling evidence supporting the assertion that medical

marijuana legislation amplifies recreational juvenile marijuana use because the percent of juveniles using marijuana increased substantially following the passage of a medical marijuana law, controlling for other factors. The effects of the control variables in Model 2 are compatible with those reported in Model 1, except for the lack of statistical significance for the father in the household variable. The R^2 for this model is .60, whereas the R^2 for Model 1 was .56.

(Insert Table 2 about here)

Another question of policy relevance is whether a noteworthy relationship exists between medical marijuana laws and juvenile use of drugs typically considered to be more dangerous than marijuana such as cocaine, heroin, and methamphetamines. It is plausible that juveniles' use of non-marijuana illicit drugs may be more pronounced in states that passed a medical marijuana law because of prior research indicating that marijuana acts as a gateway drug.

Model 1 of Table 3 shows the effects of the control variables on the prevalence of illicit drug use among juveniles, whereas in Model 2 the dummy coded medical marijuana law variable is added to the equation. The results reported in Model 1 of Table 3 show that several control variables have consequential effects. Mandatory prison sanction for marijuana possession, alcohol use, prior arrest, and skipping school all increase the use of illicit drugs among juveniles. Enrollment in a special class pertaining to drug and alcohol use also has a substantive effect on the dependent variable but in the negative direction.

Model 2 of Table 3 adds the medical marijuana law variable. The results generated for this analysis show that while the coefficient for the medical marijuana law variable is positive, it is

not sizable. This finding suggests that juvenile illicit drug use is not more pronounced in states that allow the use of medical marijuana. The effects of the control variables are similar to those reported in Model 1. The R^2 for this model is .32.

(Insert Table 3 about here)

Conclusion

Several prior studies link medical marijuana laws to amplified levels of marijuana use among juveniles and our analysis finds further credible evidence to support this research. The strong effect of the medical marijuana law variable persists even after controlling for a variety of potential rival causal factors. Such a finding supports opponents of medical marijuana laws who often argue that these laws lead to an intensification of recreational marijuana use among juveniles. That said we find no convincing evidence that medical marijuana laws engender a rise in juvenile non-marijuana illicit drug use.

One might wonder why the passage of medical marijuana laws results in an escalation of marijuana use among juveniles. It seems plausible to speculate that medical marijuana laws act to diminish the social stigma frequently associated with the recreational use of marijuana. By affiliating with medical marijuana users either directly or vicariously, people are themselves freed from the existing societal constraints against marijuana use. Furthermore, as time passes and the number of medical marijuana users living in an area grows increasingly larger in size, the social stigma attached to marijuana use is further weakened because of the greater chance that an individual will encounter or become aware of the fact that people are using marijuana

legally for medical purposes. The fear that marijuana use could potentially result in a negative health outcome is also mollified in this scenario. Prior research buttresses this position by showing that medical marijuana laws attenuate the perceived riskiness of using marijuana (Khatapoush & Halfors, 2004; Wall et al., 2011) and that the decriminalization of marijuana increases its acceptance among juveniles (Miech et al., 2015). It is also salient to note that a conglomeration of people with a similar interest in medical marijuana creates a fertile environment for the proliferation of specialized institutions such as organizations, newsletters and retail outlets related to medical marijuana use. The propagation of these types of specialized institutions in turn helps to further weaken the social stigma attached to marijuana use. The public's tolerance for recreational marijuana use is also magnified in these situations.

The current study has several advantages over previous research in this area. First, the National Survey on Drug Use and Health data are collected from a nationally representative sample of people living in the 50 U.S. states, so our findings are not likely the result of geographic or sampling bias. Second, our use of longitudinal data and a pooled cross-sectional research design helps to support a stronger inference about the effect of medical marijuana laws on juvenile marijuana use than is possible using a cross-sectional design. Our data and research design allow for the robust testing and elimination of alternative explanations of our results. We feel confident that the visually striking increase in juvenile marijuana use depicted in Figure 1 is not the result of changes in extraneous factors such as poverty or marijuana availability. Finally, in contrast to previous research in this area, we felt it appropriate to examine whether these laws escalate juveniles use illicit drugs such as cocaine, heroin, and

methamphetamines. These types of drugs are typically considered to be more deleterious to an individual's health and wellbeing than marijuana.

However, despite these advantages, this study still has a few limitations that warrant some consideration. There remains the chance that our model was incorrectly specified and that the exclusion of some influential variable from the analysis might have influenced our findings and conclusions. Notwithstanding this possibility, we believe that our model is accurate given the current knowledge on this topic. Second, because of sample size constraints, we were unable to disaggregate the data by a respondent's demographic characteristics. Thus, we cannot say whether our findings would vary by the sex or race of the juvenile. Finally, because we only assessed the effect of medical marijuana laws on the longitudinal prevalence of marijuana and non-marijuana illicit drug use, we were unable to determine the effect of these laws on the frequency or quantity of drug use. Future research might wish to investigate this issue further. These limitations are relatively minor, and we remain confident that the results rendered in this study represent the relationship between the medical marijuana laws and juvenile marijuana use.

At the outset of this study, we elaborated on the dearth of available research on the possibility that an escalation in marijuana use among juveniles occurs following the implementation of a medical marijuana law. The lack of research on this topic is more than of trivial concern because of the large number of states that have recently passed medical marijuana laws. Since 2011, which is the last year included in this study, seven states have passed medical marijuana laws and more states are expected to pass such laws in the immediate future. Additionally, Colorado and Washington recently passed laws to legalize

marijuana, and the number of legalized marijuana states is expected to grow in the coming years. It is still unknown what effect the legalization of marijuana will have on juvenile use of marijuana. The federal government has also intimated that no attempt will be made to challenge the legality of these laws because marijuana use is illegal at the federal level (Perez, 2013).

We show in this study that medical marijuana laws provide some utility in explaining state differences in juvenile marijuana use. We emphasize, however, that the current study is only preliminary. Every study has shortcomings including the current study, but we feel that the research presented here furnishes a good starting point for future inquiries in this area. Until further analyses are conducted, it would premature to accept our findings and conclusions without some healthy skepticism. The effect of medical marijuana laws on juvenile marijuana use is a salient policy question that deserves additional attention. We hope that this study stimulates further research on this noteworthy topic.

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Conflict of Interest

There are no conflicts of interest associated with this publication.

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Table 1
Means, standard deviations, and definitions for the variables used in the analysis.

	Mean	SD	Definition
Marijuana use	7.617	2.226	Percent marijuana use during past month (ages 12-17).
Illicit drug use	4.978	1.280	Percent illicit drug use except for marijuana during past month (ages 12-17). Includes hallucinogens, heroin, cocaine, inhalants and psychotherapeutics.
Medical marijuana state	0.236	0.425	Coded 1 if state enacted law to legalize medical marijuana, 0 otherwise.
Possession limit	1.522	4.832	Number of ounces permitted.
Marijuana availability	50.376	5.355	Percent responding that marijuana was fairly or very easy to obtain (ages 12-17).
Mandatory prison	11.912	2.354	Percent responding that mandatory prison is the maximum penalty for first offense possession of an ounce or less of marijuana for personal use (ages 12-17).
Alcohol use	7.662	2.309	Percent who consumed alcohol at least once per week in past 12 months (ages 12-17).
Drug class	47.117	5.457	Percent enrolled in special class about drugs or alcohol in past 12 months (ages 12-17).
Prior arrest	7.592	1.971	Percent arrested and booked previously for breaking the law.
Public assistance	3.952	1.968	Percent with family receiving public assistance income (ages 12-17).
Skipped school	11.418	2.665	Percent skipped school during past 30 days (ages 12-17).
Father in household	74.822	4.953	Percent with father residing in household (ages 12-17).
Male	51.127	0.188	Percent male (ages 12-17).
White	67.964	16.911	Percent white non-Hispanic (ages 12-17).

N=50 states covering 5 2-year time periods: 2002-03, 2004-05, 2006-07, 2008-09, and 2010-11. Because the amount of medical marijuana a person was legally allowed to possess in Connecticut had not been determined when Connecticut passed its medical marijuana law, the mean for the medical marijuana possession amount variable was assigned to Connecticut.

Table 2
Two-way random-effects models estimating the impact of state legalized medical marijuana laws on past month marijuana use among youth 12 to 17 years of age.

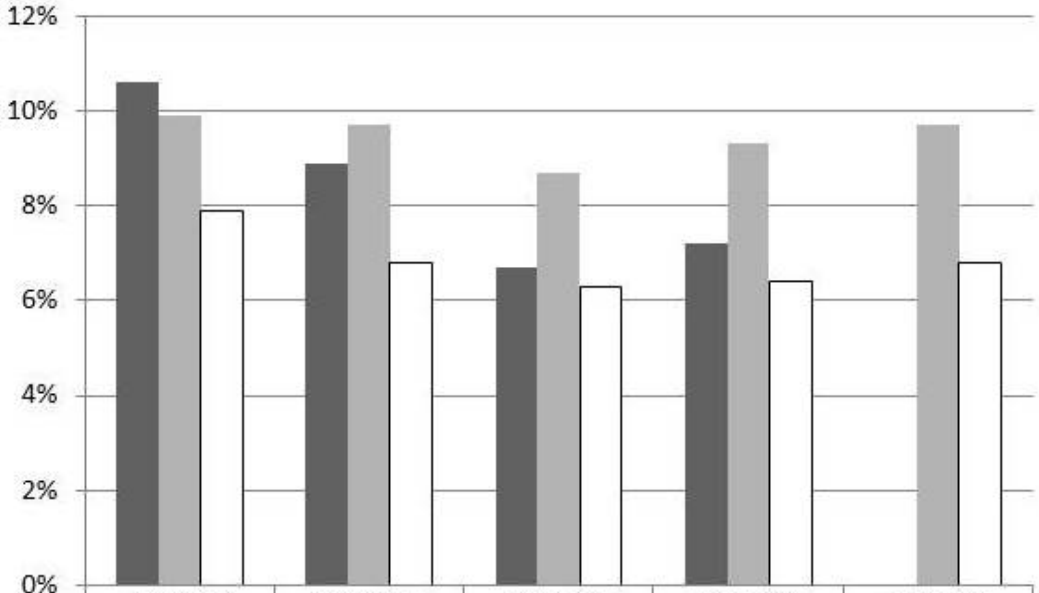
	Model 1 Controls Only		Model 2 With Medical Marijuana Law	
	Coefficient	Std. Error	Coefficient	Std. Error
Medical marijuana state	--	--	0.861**	0.298
Possession limit	0.008	0.021	-0.029	0.024
Marijuana availability	0.224***	0.022	0.217***	0.022
Mandatory prison	-0.110**	0.039	-0.094*	0.039
Alcohol use	0.187***	0.043	0.179***	0.043
Drug class	-0.013	0.019	-0.011	0.019
Prior arrest	0.050	0.050	0.058	0.050
Public assistance	0.191***	0.047	0.170***	0.047
Skipped school	0.120***	0.036	0.092**	0.037
Father in household	0.050*	0.022	0.040	0.022
Male	0.516	0.479	0.396	0.475
White	0.005	0.007	0.010	0.007
Constant	-36.158	23.892	-29.249	23.716
R^2	0.563		0.597	

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001 (two-tailed tests).

Table 3
Two-way random-effects models estimating the impact of state legalized medical marijuana laws on past month illicit drug use among youth 12 to 17 years of age.

	Model 1 Controls Only		Model 2 With Medical Marijuana Law	
	Coefficient	Std. Error	Coefficient	Std. Error
Medical marijuana state	--	--	0.190	0.245
Possession limit	0.018	0.016	0.010	0.019
Marijuana availability	0.033	0.018	0.031	0.018
Mandatory prison	0.072*	0.033	0.076*	0.034
Alcohol use	0.125***	0.037	0.123***	0.037
Drug class	-0.063***	0.015	-0.063***	0.015
Prior arrest	0.120**	0.042	0.122**	0.042
Public assistance	0.044	0.038	0.038	0.039
Skipped school	0.072**	0.030	0.066*	0.031
Father in household	0.005	0.017	0.002	0.018
Male	-0.660	0.400	-0.689	0.402
White	0.004	0.005	0.005	0.005
Constant	35.596	19.908	37.328	20.047
R^2	0.323		0.323	

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001 (two-tailed tests).



	2002-03	2004-05	2006-07	2008-09	2010-11
Before law	10.6%	8.9%	6.7%	7.2%	
After law	9.9%	9.7%	8.7%	9.3%	9.7%
No law	7.9%	6.8%	6.3%	6.4%	6.8%

NOTE: There is no data bar for the 2010-11 time period because all the states that were going to pass a medical marij law had done so by 2011.

Figure 1

Percent marijuana use during past month among youth 12 to 17 years of age in states with and without legalized medical marijuana laws