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Medical Marijuana Legalization and Marijuana Use Among Youth in Oregon

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Abstract

While the legalization of marijuana for medical and recreational use has raised concerns about potential influences on marijuana use and beliefs among youth, few empirical studies have addressed this issue. We examined the association between medical marijuana patients and licensed growers per 1,000 population in 32 Oregon counties from 2006 to 2015, and marijuana use among youth over the same period. We obtained data on registered medical marijuana patients and licensed growers from the Oregon Medical Marijuana Program and we obtained data on youth marijuana use, perceived parental disapproval, and demographic characteristics from the Oregon Healthy Teens Survey. Across 32 Oregon counties, the mean rate of marijuana patients per 1,000 population increased from 2.9 in 2006 to 18.3 in 2015, whereas the grower rate increased from 3.8 to 11.9. Results of multi-level analyses indicated significant positive associations between rates of marijuana patients and growers per 1,000 population and the prevalence of past 30-day marijuana use, controlling for youth demographic characteristics. The marijuana patient and grower rates were also inversely associated with parental disapproval of marijuana use, which decreased from 2006 to 2015 and acted as a mediator. These findings suggest that a greater number of registered marijuana patients and growers per 1,000 population in Oregon counties was associated with a higher prevalence of marijuana use among youth from 2006 to 2015, and that this relationship was partially attributable to perceived norms favorable towards marijuana use.

Keywords

marijuana legalization; marijuana use; adolescents

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Compliance with Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Conflict of Interest

Dr. Mallie J. Paschall declares that he has no conflict of interest. Dr. Joel W. Grube declares that he has no conflict of interest. Dr. Anthony Biglan declares that he has no conflict of interest.

Introduction

In recent years there has been a significant move toward the legalization of marijuana in the United States. As of January 2017, it is legal for medical use in 28 states and the District of Columbia and for recreational use in eight states and the District of Columbia (National Conference of State Legislatures, 2017). The liberalization of marijuana laws raises public health concerns, especially related to the potential effects on marijuana use by adolescents. Marijuana use during adolescence has been associated with a variety of negative consequences, including increased risk of fatal motor vehicle crashes (Asbridge, Hayden & Cartwright, 2012; Asbridge, et al., 2014); accidental injury, respiratory illness, and psychotic disorders (Hall, 2009; Hall & Degenhardt, 2009); impairment of cognitive functioning and brain development (Volkow, et al., 2016); and problems in adulthood such as low educational attainment, greater risk of drug dependence, involvement in crime and incarceration (Chen, Storr, & Anthony, 2009; Green, Doherty, Stuart, & Ensminger, 2010; Hall & Degenhardt, 2009). Despite the potential risks, marijuana is a widely used drug among adolescents. The 2015 Monitoring the Future survey shows that 35% of 12th graders and 25% of 10th graders reported past year marijuana use and 21% and 15%, respectively, reported past 30 day use (Johnston et al., 2016). About 80% of 12th graders and 66% of 10th graders reported that marijuana is “fairly easy” or “very easy” to get. Only 32% of 12th graders and 43% of 10th graders perceived “great risk” in regular marijuana use.

Although adolescents rarely obtain marijuana directly from medical dispensaries (Boyd, Veliz, & McCabe, 2015), the legalization of medical marijuana may nonetheless affect adolescents’ use by increasing its availability through diversion from social sources, by fostering social norms that are favorable to marijuana use, or by reinforcing beliefs that marijuana use is not harmful. Research on the effects of legalizing medical marijuana, however, is inconclusive. Although some studies have found positive associations between medical marijuana legalization and adolescents’ marijuana use and related beliefs (e.g., Cerdá, Wall, Keyes, Galea, & Hasin, 2012; Schuermeyer, Salomonsen-Sautel, Price, et al., 2014; Stolzenberg, D’Alessio, & Dariano, 2016; Wen, Hockenberry, & Cummings, 2015; Willams & Bretteville-Jensen, 2014), other studies have found no evidence of a relation between legalization and either adolescents’ marijuana use or beliefs (e.g., Choo, et al., 2014; Hasin, et al., 2015; Lynne-Landsman, Livingston, & Wagenaar, 2013). Notably, however, one study found that although dichotomous measures of the presence or absence of medical marijuana legalization were not related to increases in adolescents’ marijuana use, more nuanced measures taking into account specific provisions of medical marijuana laws (e.g., home cultivation is allowed) were related to changes in marijuana use among adolescents (Pacula, Powell, Heaton, & Sevigny, 2015).

Questions may also be raised as to the nature of the observed relationship between the legalization of medical marijuana and adolescents’ use. A national study using data from the National Household Survey on Drug Use and Health from 2002 to 2008 found that the average past-month prevalence of marijuana use was 8.7% in states that had legalized medical marijuana and 6.9% in other states (Wall et al., 2011). This study also found a significantly lower level of perceived riskiness of marijuana use among youth in states with legalized medical marijuana versus other states. These differences, however, were present

before medical marijuana laws were passed. Other studies have similarly found that the differences in marijuana use and beliefs between states with and without medical marijuana predate legalization (Hasin, et al. 2015; Wall, et al., 2016). These findings raise questions about whether use and perceived risk were influenced by the legalization of marijuana for medical use or reflect pre-existing underlying differences among the states. Consistent with the latter interpretation, a study by Friese and Grube (2013) found no association between the number of marijuana patients per 1,000 population in Montana counties and youth marijuana use. However, the percentage of voters supporting medical marijuana legalization in each county was positively related to lifetime and 30-day marijuana use by adolescents, suggesting that marijuana use among youth may be influenced more by broader social norms favorable to marijuana legalization and use than by legalization *per se*. Similarly, a recent national study by Hasin et al. (2015) using data from the Monitoring the Future study from 1991 to 2014 also found higher rates of past-month marijuana use and lower perceived risk among youth living in states prior to and after passing medical marijuana laws, but no changes in marijuana use after medical marijuana laws were passed.

Given these inconclusive findings and interpretations, further research on the association between medical marijuana legalization and adolescents' marijuana use and beliefs is needed. In particular, little research has examined potential associations between increases in the number of people using marijuana for medical reasons and growing marijuana for medical use, and marijuana use among youth. Increases in the number of people using marijuana for medical reasons and the number of licensed marijuana growers may also reflect changes in norms favorable to marijuana use among adults, which may in turn be related to normative beliefs among youth. Thus, legalization of medical marijuana may be associated with marijuana use among youth directly or indirectly through changes in beliefs that marijuana use is acceptable and normative.

Our study further investigates possible associations between medical marijuana legalization and marijuana use among youth by examining mechanisms through which legalization may affect this behavior. We examined changes in the number of registered medical marijuana patients and licensed growers in Oregon counties from 2006 to 2015 as indicators of norms favorable to marijuana use, and the associations between county-level rates of registered medical marijuana patients and licensed growers and trends in marijuana use and normative beliefs (i.e., perceived parental disapproval of marijuana use) among Oregon youth. We also examined whether perceived parental disapproval of marijuana use may mediate the associations among medical marijuana patients, growers and marijuana use. We hypothesized that increases in rates of medical marijuana patients and licensed growers at the county level would be associated with increases in the prevalence of marijuana use among youth and inversely related to perceived parental disapproval of marijuana use. We also hypothesized that perceived parental disapproval of marijuana use would mediate relationships between county-level rates of medical marijuana patients, licensed growers and marijuana use among youth.

Methods

Data Sources and Measures

Medical Marijuana Patients and Growers—We obtained county-level counts of registered medical marijuana patients and licensed growers from the Oregon Medical Marijuana Program office, which began reporting this information in 2005 for patients and in 2006 for growers, subsequent to the legalization of marijuana for medical use in 1998. Based on the availability of student-level data from the Oregon Healthy Teens Survey, we secured patient and grower counts for 32 Oregon counties from 2006 to 2015. We also obtained corresponding county population data for each of these years from the Portland State University Center for Public and Urban Affairs Population Research Center (Portland State University, 2016). We then computed rates for number of medical marijuana patients/1,000 population and licensed growers/1,000 population for each county and year.

Oregon Healthy Teens Survey—We obtained survey data for 8th and 11th grade students from the statewide Oregon Healthy Teens Survey (OHT), which was administered annually from 2006 to 2009, and in 2011, 2013 and 2015 (Oregon Health Authority, 2016). The OHT is an anonymous, voluntary self-administered survey modeled after the Youth Risk Behavior Survey (YRBS) and Student Drug Use Survey that were previously administered in Oregon.

The OHT is conducted during spring semester from February through May on scannable forms administered by trained teachers in classrooms. Students do not write any personal information on the survey form, and completed surveys are placed into an envelope. The OHT survey takes about 40 minutes to complete.

The OHT sampling frame is based on the YRBS, and comprises public middle and high schools sampled within each county. The sample is intended to be representative of 8th and 11th graders in each county and the state. Post-hoc sample weights were developed for each county and the state based on the actual number of 8th and 11th graders in each school, county and the entire state (OHA, 2016).

Marijuana Use: From 2006 to 2013, youth were asked how many times they used marijuana in the past 30 days, with six possible response options from “zero times” to “40 or more times.” In 2015, the question was, “During the past 30 days, on how many days did you use marijuana?” with five response options from “0 days” to “10 or more days.” Because over 80% of respondents indicated no past 30-day use of marijuana in each survey year, a dichotomous measure for any past 30-day use was created for each OHT year.

Normative Beliefs: From 2006 to 2015, youth were asked, “How wrong do your parents feel it would be for you to smoke marijuana?” with four possible responses ranging from “Not at all wrong” to “Very wrong.”

Demographics: Youth reported their age, gender, ethnicity (Hispanic/non-Hispanic) and race, which was treated as a dichotomous variable (0 = *non-White*, 1 = *White*) because over 80% of respondents indicated their race as white in most survey years.

Data Analysis

Descriptive statistics were first obtained for all study variables by survey year using post-hoc sample weights provided with the OHT data sets. Because student-level observations (level 1) were nested within counties (level 2), multi-level logistic and linear regression analyses were conducted in HLM version 7.0 software, allowing for random effects at the county level to adjust for nesting (Raudenbush et al., 2011). We first conducted analyses separately for 8th and 11th graders to examine possible relationships between change in the rate of medical marijuana patients and growers per 1,000 population and the prevalence of past 30-day marijuana use and parental disapproval of marijuana use over time. Two-level models included a cross-level survey year \times marijuana patients (and growers)/1,000 population interaction term and corresponding main effects, as well as demographic characteristics as covariates. Inclusion of the cross-level survey year \times marijuana patients (and growers)/1,000 population interaction term allowed us to examine whether changes in past 30-day marijuana use and parental disapproval of marijuana use over time were moderated by the county-level rate of registered medical marijuana patients and growers/1,000 population. Nonsignificant interactions were dropped from regression models. We also examined differences in the annual prevalence of past 30-day marijuana use and parental disapproval of marijuana use over time in counties categorized by high, medium and low rates of registered medical marijuana patients and growers/1,000 population. Multi-level logistic regression models were also run to examine the extent to which parental disapproval of marijuana use may have acted as a mediator. Significant associations between the rate of marijuana patients or growers/1,000 population and parental disapproval of marijuana use combined with a reduction in the associations between past 30-day marijuana use and these county-level rates after including parental disapproval of marijuana use in the models would provide evidence for mediation (MacKinnon & Dwyer, 1993). We evaluated the significance of indirect associations using the Sobel Test (MacKinnon & Dwyer, 1993). Because the results were very similar for 8th and 11th graders, we ran the same regression models controlling for grade for the total sample and report those results.

Results

Sample Characteristics

Sample characteristics by survey year are provided in Table 1. The state-level prevalence of marijuana use changed little over the 10-year period. The prevalence rate for past 30-day marijuana use was approximately 14% in 2015, and was lower among eighth-graders (9%) than 11th graders (20%). Youth reported a fairly high level of parental disapproval of marijuana use across all survey years. The mean rate of marijuana patients per 1,000 county population increased substantially from 2.9 in 2006 (range: 0 – 10.9) to 18.3 in 2015 (range: 5.7 – 44.9). The mean rate of licensed marijuana growers also increased from 3.8 (range: 0 – 13.1) in 2006 to 11.9 (range: 4.7 – 28.2) in 2015.

Multi-level Analyses

As noted above, we initially ran separate multi-level regression analyses for 8th and 11th graders. Because the results were very similar for 8th and 11th graders, we ran the same regression models controlling for grade for the total sample and report those results.

Results of multi-level logistic regression analyses for past 30-day marijuana use are provided in Table 2. The survey year \times marijuana patients and growers per 1,000 population interaction terms were not statistically significant in initial regression models, and were therefore dropped from analyses. Both the rate of marijuana patients and growers per 1,000 population were positively associated with the prevalence of past 30-day marijuana use, controlling for youth demographic characteristics. Odds ratios indicate that each additional marijuana patient or grower is associated with a one percent increase in the prevalence of marijuana use among youth. These relationships were further examined by classifying counties based on the average rate of marijuana patients and growers per 1,000 from 2006 to 2015, and then plotting trends in past 30-day marijuana use for counties falling into low, medium and high categories. Approximately one-third of the counties fell into each category. Figure 1 indicates generally higher levels of marijuana use over the 10-year period among youth in counties with higher rates of medical marijuana patients per 1,000 population; this pattern was very similar for categories of marijuana growers per 1,000 population.

Results of the multi-level linear regression analyses for perceived parental disapproval of marijuana use are provided in Table 3. The survey year \times marijuana patients and growers per 1,000 population interaction terms were not significantly related to perceived parental disapproval of marijuana use and were dropped from subsequent analyses. Both the rate of marijuana patients and growers per 1,000 population were inversely associated with perceived parental disapproval of marijuana use, controlling for youth demographic characteristics. These relationships are illustrated in Figure 2, which indicates lower levels of parental disapproval in counties with higher rates of medical marijuana patients per 1,000 population, and a downward slope for counties in all three categories of marijuana patients per 1,000 population from 2006 to 2015. This pattern was very similar for categories of marijuana growers per 1,000 population. Mean parental disapproval values for years when the OHT was not administered (2010, 2012, 2014) were averaged from the previous and following year.

Results of the multi-level regression analysis (Table 4) indicate that the associations between marijuana patients and growers per 1,000 population were attenuated, but remained statistically significant when perceived parental disapproval was included in the regression models, providing evidence for partial mediation. Sobel tests indicated that the indirect associations between marijuana patients and growers per 1,000 population and past 30-day marijuana use through perceived parental disapproval of marijuana use was significant, $z = 4.00$, $p < .001$. As expected, perceived parental disapproval was inversely associated with any past 30-day marijuana use.

Discussion

Our findings suggest that higher rates of registered medical marijuana patients and licensed growers per 1,000 population in Oregon counties are associated with a higher prevalence of marijuana use among adolescents living in those counties. However, our expectation that increases in rates of marijuana patients and growers per 1,000 population would be associated with increases in the prevalence of marijuana use among youth was not

supported. Results also indicated lower levels of parental disapproval of marijuana use in counties with higher rates of medical marijuana patients and growers, and decreases in perceived parental disapproval of marijuana use across all 32 Oregon counties from 2006 to 2015. Our findings further suggest that the associations between rates of medical marijuana patients and growers per 1,000 population and past 30-day marijuana use were partially mediated through perceived norms favorable to marijuana use.

The substantial increases in registered medical marijuana patients and licensed growers in Oregon may reflect an increasing acceptance of cannabis as a therapy for chronic pain, as this was by far the most common reason for referral and registration (OMMP, 2016). This upward trend may continue with the legalization of marijuana for recreational use in 2014, and the opening of local dispensaries across the state that offer cannabis for both medical and recreational use.

Similar to two recent national studies (Hasin et al., 2015; Wall et al., 2011) our findings indicated higher levels of marijuana use and perceived norms favorable towards marijuana use from 2006 to 2015 in counties with the highest rates of marijuana patients and growers per 1,000 population. This may indicate mechanisms through which legalization of marijuana for medical and recreational use may contribute to marijuana use among youth. In particular, youth may be more likely to use marijuana if they are exposed to more adults who use it and do not disapprove of marijuana use. Marijuana is also more likely to be available through commercial and social sources after legalization for medical or recreational use, and subsequent increases in the number of medical marijuana patients, recreational users, and growers who do not need a license.

Findings of this study should be considered in light of several possible limitations. First, the samples of adolescents who participated in the Oregon Healthy Teens Survey (OHT) from 2006 to 2015 may not be representative of all adolescents in Oregon or the Oregon counties included in this study. Change in the frequency of OHT administration after 2009 may have influenced our results, though OHT survey year was included as a covariate in multi-level regression analyses. Single-item measures of marijuana use and normative beliefs may not have adequate reliability and validity. Self-report survey questions may also be subject to recall and social desirability biases (e.g., underreporting marijuana use), though prior studies have shown that self-reported measures of drug use among adolescents have good validity and reliability (Bachman et al., 2011). Unfortunately, potentially important factors related to marijuana use (e.g., perceived availability of marijuana, perceived marijuana use among friends and adults, marijuana sources) were not included in the OHT from 2006 to 2015. Mediation analyses were limited by the cross-sectional design of the study and reporting of perceived parental disapproval of marijuana use by adolescents instead of their parents. Finally, the number of registered medical marijuana patients and growers reported for Oregon counties does not accurately reflect the number of people in each county illicitly using or growing marijuana.

Further research is needed to better understand whether and how the legalization of marijuana for medical and recreational use may affect perceived norms and availability of marijuana and marijuana use among youth. Additional longitudinal studies are needed to

evaluate the effects of marijuana legalization policies and enforcement activities on marijuana availability, use and related consequences, such as driving while impaired and co-use of marijuana with alcohol and other drugs. Such research will help to improve our understanding of the potentially negative consequences of marijuana legalization among youth, and identify effective prevention strategies.

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References

- Asbridge M, Hayden JA, Cartwright JL. Acute cannabis consumption and motor vehicle collision risk: Systematic review of observational studies and meta-analysis. *British Medical Journal*. 2012; 344:e356. Retrieved from <http://www.bmj.com/content/344/bmj.e536.long>. [PubMed: 22279115]
- Asbridge M, Mann R, Cusimano MD, Trayling C, Roerecke M, Tallon JM, Whipp A, Rehm J. Cannabis and traffic collision risk: Findings from a case-crossover study of injured drivers presenting to emergency departments. *International Journal of Public Health*. 2014; 59:395–404. [PubMed: 24061594]
- Bachman, JG., Johnston, LD., O'Malley, PM., Schulenberg, JE. The Monitoring the Future Project After Thirty-Seven Years: Design and Procedures; Occasional paper No. 76. 2011. p. 43-47. Retrieved from <http://monitoringthefuture.org/pubs/occpapers/mtf-occ76.pdf>
- Boyd CJ, Veliz PT, McCabe SE. Adolescents' use of medical marijuana: A secondary analysis of Monitoring the Future data. *Journal of Adolescent Health*. 2015; 57:241–244. [PubMed: 26206447]
- Cerdá M, Wall M, Keyes KM, Galea S, Hasin D. Medical marijuana laws in 50 states: investigating the relationship between state legalization of medical marijuana and marijuana use, abuse and dependence. *Drug and Alcohol Dependence*. 2012; 120:22–27. [PubMed: 22099393]
- Chen C-Y, Storr CL, Anthony JC. Early-onset drug use and risk for drug dependence problems. *Addictive Behaviors*. 2009; 34:319–322. [PubMed: 19022584]
- Choo EK, Benz M, Zaller N, Warren O, Rising KL, McConnell KJ. The impact of state medical marijuana legislation on adolescent marijuana use. *Journal of Adolescent Health*. 2014; 55:160–166. [PubMed: 24742758]
- Friese B, Grube JW. Legalization of medical marijuana and marijuana use among youths. *Drugs: Education, Prevention and Policy*. 2013; 20:33–39.
- Green KM, Doherty EE, Stuart EA, Ensminger ME. Does heavy adolescent marijuana use lead to criminal involvement in adulthood? Evidence from a multiwave longitudinal study of urban African Americans. *Drug and Alcohol Dependence*. 2010; 112:117–125. [PubMed: 20598815]
- Hall W. The adverse health effects of cannabis use: What are they, and what are their implications for policy? *International Journal of Drug Policy*. 2009; 20:458–466. [PubMed: 19362460]
- Hall W, Degenhardt L. Adverse health effects of non-medical cannabis use. *Lancet*. 2009; 374:1383–1391. [PubMed: 19837255]
- Hasin DS, Wall M, Keyes KM, Cerdá M, Schulenberg JE, O'Malley PM, Galea S, Pacula RL, Feng T. Medical marijuana laws and adolescent marijuana use in the USA from 1991 to 2014: Results from annual, repeated cross-sectional surveys. *The Lancet Psychiatry*. 2015; 2:601–608. [PubMed: 26303557]
- Johnston, LD., O'Malley, PM., Miech, RA., Bachman, JG., Schulenberg, JE. Monitoring the Future National Survey Results on Drug Use: 1975–2015: Overview, Key Findings on Adolescent Drug Use. Ann Arbor: Institute for Social Research, The University of Michigan; 2016.

- Lynne-Landsman SD, Livingston MD, Wagenaar AC. Effects of state medical marijuana laws on adolescent marijuana use. *American Journal of Public Health*. 2013; 103:1500–1506. [PubMed: 23763418]
- MacKinnon DP, Dwyer JH. Estimating mediated effects in prevention studies. *Evaluation Review*. 1993; 17:144–158.
- National Conference of State Legislatures. State Medical Marijuana Laws. 2017. (<http://www.ncsl.org/research/health/state-medical-marijuana-laws.aspx>)
- Oregon Health Authority. Oregon Health Teens Survey. 2016. Documentation for OHT survey methodology was also provided by the OHA (<https://public.health.oregon.gov/BirthDeathCertificates/Surveys/OregonHealthyTeens/Pages/index.aspx>)
- Pacula RL, Powell D, Heaton P, Sevigny EL. Assessing the effects of medical marijuana laws on marijuana use: The devil is in the details. *Journal of Policy Analysis and Management*. 2015; 34:7–31. [PubMed: 25558490]
- Portland State University College of Urban and Public Affairs, Population Research Center. Annual Population Estimates. 2016. (<https://www.pdx.edu/prc/population-reports-estimates>)
- Raudenbush, S., Bryk, A., Cheong, YF., Congdon, R., du Toit, M. HLM 7: Hierarchical Linear and Nonlinear Modeling. Lincolnwood, IL: Scientific Software International; 2011.
- Schuermeyer J, Salomonsen-Sautel S, Price RK, Balan S, Thurstone C, Min SJ, Sakai JT. Temporal trends in marijuana attitudes, availability and use in Colorado compared to non-medical marijuana states: 2003–11. *Drug and Alcohol Dependence*. 2014; 140:145–155. [PubMed: 24837585]
- Stolzenberg L, D’Alessio SJ, Dariano D. The effect of medical cannabis laws on juvenile cannabis use. *International Journal of Drug Policy*. 2016; 27:82–88. [PubMed: 26123892]
- Volkow ND, Swanson JM, Evinsm AE, DeLisi LE, Meier MH, Gonzalez R, Bloomfield MA, Curran HV, Baler R. Effects of cannabis use on human behavior, including cognition, motivation, and psychosis: A review. *JAMA Psychiatry*. 2016; 73:292–297. [PubMed: 26842658]
- Wall MM, Mauro C, Hasin DS, Keyes KM, Cerdá M, Martins SS, Feng T. Prevalence of marijuana use does not differentially increase among youth after states pass medical marijuana laws: Commentary on and reanalysis of US National Survey on Drug Use in Households data 2002–2011. *International Journal of Drug Policy*. 2016; Advance online publication. doi: 10.1016/j.drugpo.2016.01.015
- Wall M, Poh E, Cerdá M, Keyes KM, Galea S, Hasin DS. Adolescent marijuana use from 2002 to 2008: Higher in states with medical marijuana laws, cause still unclear. *Annals of Epidemiology*. 2011; 21:714–716. [PubMed: 21820632]
- Wen H, Hockenberry JM, Cummings JR. The effect of medical marijuana laws on adolescent and adult use of marijuana, alcohol, and other substances. *Journal of Health Economics*. 2015; 42:64–80. [PubMed: 25863001]
- Williams J, Bretteville-Jensen AL. Does liberalizing cannabis laws increase cannabis use? *Journal of Health Economics*. 2014; 36:20–32. [PubMed: 24727348]

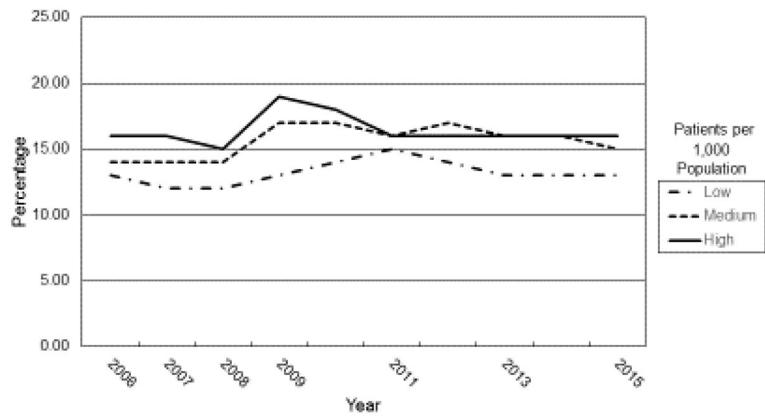


Figure 1. Past 30-day marijuana use prevalence by rate of marijuana patients per 1,000 county population, adjusted for age, gender, and race/ethnicity. The marijuana patients per 1,000 population categories (ranges) are low (1.9 – 6.3), medium (7.1 – 8.8), and high (9.2 – 56.1).

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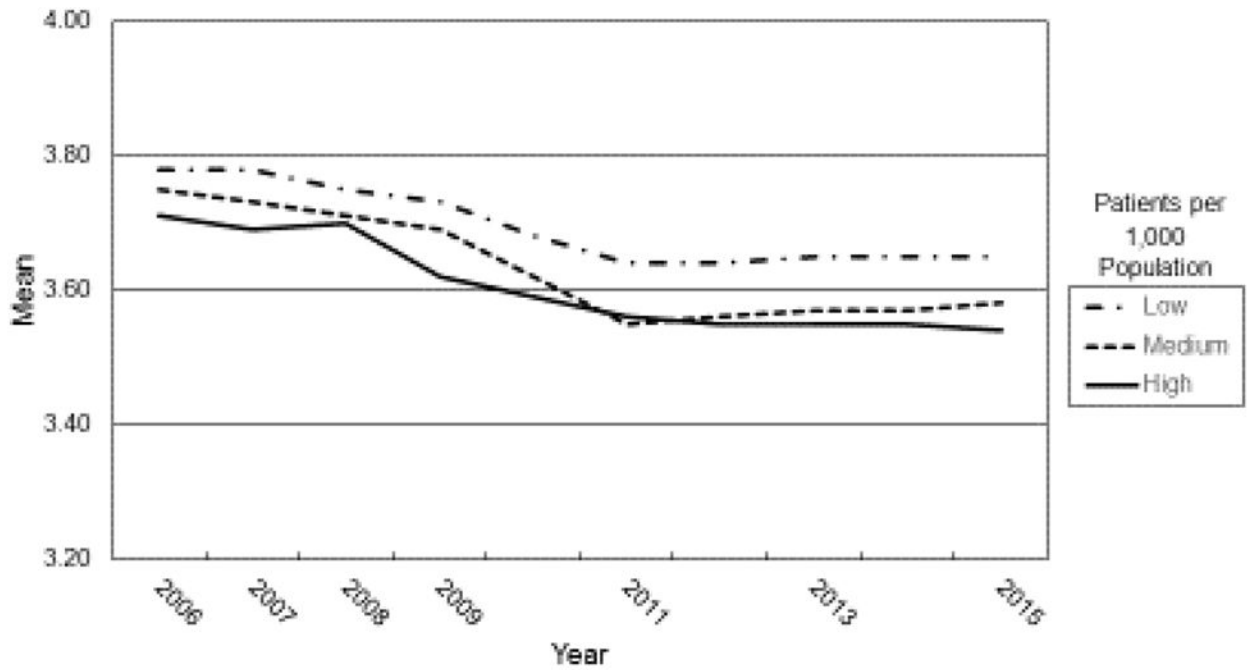


Figure 2. Perceived parental disapproval of marijuana use by rate of marijuana patients per 1,000 county population, adjusted for age, gender, and race/ethnicity. The marijuana patients per 1,000 population categories (ranges) are low (1.9 – 6.3), medium (7.1 – 8.8), and high (9.2 – 56.1).

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Table 1

Sample characteristics by year, mean (*SD*) or percent^f

Variable	2006 (N=25,967)	2007 (N=26,448)	2008 (N=28,346)	2009 (N=14,338)	2011 (N=11,600)	2013 (N=28,540)	2015 (N=29,819)
Any past 30 day marijuana use (%)	14.3	13.6	13.8	16.4	15.9	15.4	13.9
Demographic characteristics							
Age	15.1 (1.5)	15.0 (1.5)	15.1 (1.5)	15.2 (1.6)	15.2 (1.6)	15.1 (1.6)	15.1 (1.6)
Male	50.4	48.9	48.5	48.7	51.3	49.6	49.8
Hispanic	14.5	17.8	17.8	19.7	17.7	22.8	25.1
White	74.5	84.7	85.4	84.5	86.4	85.2	86.6
Parental disapproval of marijuana use	3.7 (0.6)	3.7 (0.6)	3.7 (0.7)	3.7 (0.7)	3.6 (0.7)	3.6 (0.8)	3.6 (0.8)
Marijuana patients/1,000 county population	2.9 (2.7)	3.9 (3.4)	5.5 (3.6)	5.4 (3.3)	16.0 (7.9)	16.4 (9.5)	18.3 (8.9)
Marijuana growers/1,000 county population	3.8 (3.4)	4.3 (3.2)	5.4 (3.4)	7.0 (3.9)	12.6 (6.2)	15.3 (10.4)	11.9 (5.3)

^f Survey sample sizes are unweighted, but descriptive statistics were obtained with state sample weights.

Table 2

Multi-level logistic regression models predicting any past 30-day marijuana use, odds ratio (95% confidence interval)

Variable	Model 1	Model 2
Student level		
Age	1.32 (1.27, 1.38) **	1.32 (1.27, 1.38) **
Male	1.16 (1.07, 1.25) **	1.16 (1.07, 1.25) **
Hispanic	1.32 (1.14, 1.53) **	1.32 (1.14, 1.53) **
White	1.01 (0.81, 1.28)	1.01 (0.81, 1.28)
Survey year	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)
County level		
Marijuana patients/1,000	1.01 (1.005, 1.02) **	---
Marijuana growers/1,000	---	1.01 (1.004, 1.02) **

**
p < .01.

Table 3

Multi-level linear regression models predicting parental disapproval of marijuana use, beta (standard error)

Variable	Model 1	Model 2
Student level		
Age	-.062 (.002)**	-.062 (.002)**
Male	-.029 (.007)**	-.029 (.007)**
Hispanic	.007 (.011)	.007 (.011)
White	-.015 (.009)	-.015 (.009)
Survey year	-.018 (.0009)**	-.018 (.0009)**
County level		
Marijuana patients/1,000	-.004 (.001)**	---
Marijuana growers/1,000	---	-.003 (.0009)**

**
 $p < .01$.

Table 4

Multi-level logistic regression models to assess mediating effects of parental disapproval of marijuana use, odds ratio (95% confidence interval)

Variable	Model 1	Model 2
Student level		
Age	1.26 (1.22, 1.30) **	1.26 (1.22, 1.30) **
Male	1.10 (1.03, 1.18) **	1.10 (1.03, 1.18) **
Hispanic	1.42 (1.26, 1.61) **	1.42 (1.26, 1.61) **
White	1.00 (0.84, 1.21)	1.00 (0.84, 1.21)
Survey year	0.97 (0.96, 0.99) *	0.97 (0.96, 0.99) *
Parental disapproval of marijuana use	0.34 (0.33, 0.35) **	0.34 (0.33, 0.35) **
County level		
Marijuana patients/1,000	1.006 (1.001, 1.01) *	1.006 (1.002, 1.01) **
Marijuana growers/1,000	---	---

*
 $p < .05$.

**
 $p < .01$.