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Trends in Use of and Attitudes Toward Marijuana Among Youth Before and After Decriminalization: The Case of California 2007–2013

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Abstract

Background—This analysis examines decriminalization as a risk factor for future increases in youth marijuana acceptance and use. Specifically, we examine marijuana-related behaviors and attitudes of 8th, 10th, and 12th graders in California as compared to other U.S. states during the years before and after California passed legislation in 2010 to decriminalize marijuana.

Methods—Data come from Monitoring the Future, an annual, nationally-representative survey of 8th, 10th, and 12th grade students.

Results—In 2012 and afterwards California 12th graders as compared to their peers in other states became (a) 25% more likely to have used marijuana in the past 30 days, (b) 20% less likely to perceive regular marijuana use as a great health risk, (c) 20% less likely to strongly disapprove of regular marijuana use, and (d) about 60% more likely to expect to be using marijuana five years in the future. Analysis of 10th graders raises the possibility that the findings among 12th graders may reflect a cohort effect that was set into place two years earlier.

Conclusion—These results provide empirical evidence to support concerns that decriminalization may be a risk factor for future increases in youth marijuana use and acceptance.

Keywords

marijuana; decriminalization; adolescent

Introduction

This analysis examines decriminalization as a risk factor for future increases in youth marijuana acceptance and use. We test competing hypotheses about 2010 decriminalization legislation in California that changed existing laws so that possession of small amounts of

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marijuana is not a misdemeanor or higher-level crime and does not enter an individual's criminal record. Currently, a misdemeanor marijuana possession can disqualify college students from receiving federal student loans (U.S. Department of Education 2014), and disqualifies individuals from a wide range of government and private jobs (Stuart 2010). Typically, in a state that has decriminalized marijuana the use or possession of small quantities is treated as an infraction that is subject to a modest monetary fine. On September 30, 2010 Governor Schwarzenegger of California signed into law S.B. 1449 (California State Legislature 2010), which reduced the penalty for possession of less than one ounce of marijuana to an infraction – a penalty similar to a parking ticket. The law officially took effect January 1, 2011, although it received significant media attention in 2009 and 2010.

The California 2010 decriminalization law may have served as a risk factor for future increases in youth marijuana prevalence. Opponents of decriminalization predict that it sends a signal to youth that marijuana use is not dangerous and thereby leads to increases in youth acceptance and use of marijuana – a proposition we henceforth refer to as the "signaling hypothesis" (DuPont and Voth 1995). In this perspective decriminalization is viewed as a threat to public health (DuPont and Voth 1995, American Academy of Pediatrics 2004, Joffe and Yancy 2004, Svrakic, Lustman et al. 2012) because it is associated with a host of negative health outcomes that will be expected to increase as marijuana prevalence increases (Gordon, Conley et al. 2013, Volkow, Baler et al. 2014). These outcomes include large airway inflammation, symptoms of bronchitis, increased airway resistance, lung hyperinflation (Lee and Hancox 2011), lung cancer (Callaghan, Allebeck et al. 2013), reduced educational attainment (Lynskey and Hall 2000), lower earnings (Ringel, Ellickson et al. 2006), increased probability of progression to "harder" drug use (Lynskey, Heath et al. 2003) and loss of IQ points (Meier, Caspi et al. 2012).

A contrasting view is that decriminalization is not a risk factor and marijuana acceptance and use among youth will remain unchanged across states that have decriminalized marijuana as compared to states that have not. Such a finding would support the case for decriminalization, which argues that adolescent marijuana use and attitudes are largely impervious to anti-marijuana laws (Joy, Watson et al. 1999, MacCoun and Reuter 2001). In this perspective, laws against personal marijuana use are viewed as expensive, ineffective, and unnecessarily detrimental to many young lives. For example, in the year 2012 U.S. arrests for marijuana possession outnumbered arrests for any other drug violation and led to more than 650,000 arrests, at great cost to local communities and individuals (Federal Bureau of Investigation 2013).

The argument that decriminalization is not a risk factor for future increases in marijuana use among U.S. youth has been supported by a flurry of studies based on data from the 1970s and 1980s. In these years "decriminalization" sometimes refers to legislation to remove criminal sanctions for marijuana possession, which California removed in 1975, and presumably the passage of these laws would send a stronger pro-marijuana signal than the current 2010 California legislation. On the basis of analysis of 1975–1979 data from Monitoring the Future Johnston et al. (1981) concluded that "Overall, the preponderance of the evidence which we have gathered and examined points to the conclusion that decriminalization has had virtually no effect either on the marijuana use or on related

attitudes and beliefs about marijuana use among American young people." The lead author of this study delivered this conclusion in testimony to a U.S. Senate Subcommittee (Johnston January 16, 1980). Numerous studies based on U.S. data from the 1970s and 1980s further supported this conclusion (Maloff 1981, Suggs 1981, Thies and Register 1993, Pacula 1998, Single, Christie et al. 2000), or concluded that decriminalization leads to only a small, transitory increase in youth marijuana use (Single 1989).

Research on decriminalization and adolescent marijuana prevalence using more recent data is rarer – perhaps because the research question seemed to have been answered and closed – and suggests that analyses of decriminalization may warrant an update (Damrongplasit and Hsiao 2009). Analysis of nationally-representative data from the late 1980s onward supports the conclusion that decriminalization is associated with a higher likelihood marijuana use, by about 8% (Saffer and Chaloupka 1999) to 16% (Damrongplasit, Hsiao et al. 2010). Analysis of Monitoring the Future data from 1992–1994 led to the conclusion that "youths living in decriminalized states are significantly more likely to report currently using marijuana and may consume more frequently" (Chaloupka, Pacula et al. 1999). Further, analysis of states that have passed decriminalization laws indicates that not all decriminalization is the same, and it is the removal of criminal penalties for small levels of personal marijuana use – which the California legislation enacts – that is a key factor linked to increases in marijuana use among youth (Pacula, Chriqui et al. 2004).

Predicted Patterns of Results

Different predictions about the influence of decriminalization lead to different expected patterns of results that we empirically test in this study and that are summarized in Table 1. Row 1 summarizes the key predictions of the "signaling hypothesis": after decriminalization (a) youth marijuana prevalence will increase as a result of (b) youth developing more accepting attitudes of regular marijuana use. Row 2 summarizes a process through which decriminalization leads to increases in youth marijuana prevalence, but not through an effect of signaling on youth attitudes. This could occur if youth increases in marijuana use are driven by factors such as increased availability or decreased fear of punishment, or if the marijuana attitudes under study are not the key ones linked to marijuana use. Rows 3 and 4 outline empirical predictions if decriminalization is not a risk factor for increases in youth marijuana prevalence. Row 3 summarizes the strongest evidence for lack of an effect: no increase in youth prevalence of marijuana and, as well, no increase in youth acceptance of marijuana. Finally, filling out all the possible combinations in the Table, Row 4 summarizes a variant in which decriminalization increases youth acceptance of marijuana, but is not associated with an increase in youth marijuana prevalence.

Contribution

The present analysis contributes to the literature in five ways. First, to our knowledge it is the first detailed analysis of trends in marijuana prevalence and attitudes both before and after the 2010 California decriminalization legislation. This analysis is of substantial interest for policy and theory, given that decriminalization today may be related to changes in marijuana use in ways that have not been seen in the past. Second, the analysis can discern whether any higher prevalence of marijuana in California is newly emerged or pre-existing,

because the data include measures of marijuana use in California and other U.S. states prior to the 2010 decriminalization legislation. Third, the large sample size allows analysis of the outcome of past 30-day marijuana use, which is sensitive to regular and chronic marijuana use. Fourth, the analysis includes information for multiple years after the enactment of the 2010 California legislation, and can therefore detect both sleeper effects that may take years to develop, as well as any immediate effects that turn out to be transitory. Finally, the analysis includes measures of key attitudes that are strongly linked to marijuana use, such as perceptions of risk of harm from marijuana use and personal disapproval of marijuana use (Bachman, Johnston et al. 1998, Johnston, O'Malley et al. 2014).

Method

Data

Data come from the annual Monitoring the Future study, which since 1975 has used questionnaires administered in classrooms to survey nationally representative samples of American students (Johnston, O'Malley et al. 2013). This analysis uses the annual samples of American 8th, 10th, and 12th graders between 2007 and 2013 (n=~15,000 per grade per year). The time span includes three years before and three years after the 2010 California legislation.

The survey uses a multistage, stratified research design (for more detail see Bachman, Johnston et al. 2006). The first stage is geographic area and consists of 108 primary areas. The second stage is schools, and about 50–70% of originally selected schools participate. For schools that do not participate replacements are chosen carefully to be as similar as possible to the original school being replaced. Given that most regional variation in substance use is within schools and not across them – about 4% to 5% of data variation in 30-day marijuana use is between schools (O'Malley, Johnton et al. 2006) – any bias introduced by replacement schools is expected to be small. The third stage is students within schools, and response rates for surveys from 2007 to 2013 range from 79% to 85%, with almost all nonresponse due to school absenteeism. The sample consists of 320,809 observations and is 51% female, 58% white, 12% black, 16% Hispanic, and 14% other race/ethnicity (percentages calculated using sample weights).

Six randomly distributed forms of the questionnaire are used in 12th grade and four randomly distributed forms are used in in 8th and 10th grade. Marijuana use is measured on all forms but other marijuana questions are asked on only some of the forms, resulting in smaller sample sizes in analyses that include these questions. Analyses accounted for the complex multistage sample design, and the data are weighted to adjust for differential selection probabilities.

Measures

Past 30-day marijuana smoking is coded 1 for respondents who reported 1 or more occasions of marijuana use in the past 30 days and 0 otherwise. *Any past-12-month marijuana use* is coded 1 for respondents who reported at least one occasion of marijuana use during the last 12 months and 0 otherwise. *Any lifetime marijuana use* is coded 1 for

respondents who reported at least one occasion of marijuana use in their life and 0 otherwise.

Perceived great risk of harm in regular marijuana smoking is based on response to the question "How much do you think people risk harming themselves (physically or in other ways) if they smoke marijuana regularly: (1) no risk, (2) slight risk, (3), moderate risk, (4) great risk"; it is coded 1 for respondents who respond "great risk" and 0 otherwise. *Perceived high marijuana availability* is based on response to the question "How difficult do you think it would be for you to get each of the following types of drugs, if you wanted some?: marijuana (1) Probably impossible, (2) Very difficult, (3) Fairly difficult, (4) Fairly easy, (5) Very easy"; it is coded 1 for a response of "fairly easy" or "very easy" and 0 otherwise. *Strong disapproval of regular marijuana use* is based on response to the question "Do YOU disapprove of people (who are 18 or older) smoking marijuana regularly"; it is coded 1 for respondents who respond "great risk" and 0 for responses of "Don't disapprove" or "Disapprove." *Expect to use marijuana five years in the future*is coded 1 for respondents who answered "I definitely will" or "I probably will" to the question "Do you think you will be using marijuana or hashish five years from now?" and is coded 0 for respondents who answered "I probably will not" or "I definitely will not." This question was only asked of 12^{th} graders.

California resident (about 12% of the weighted sample) is coded 1 for respondents surveyed in a California school and 0 otherwise. Each year respondents in California were clustered in approximately 40, randomly-selected schools. Each school is asked to participate in the survey for two successive years. Different schools are used for the 8^{th}, 10^{th} and 12^{th} grade samples.

To evaluate time trends using piecewise regression analyses (Gujarati 1988), we use two variables. The first is (California)×(2010), which is coded 1 for California respondents in 2010, coded 2 for California respondents in 2011, and so on until 2013. It is coded 0 for all other years and for all non-California respondents. Similarly, the second is (California)×(2012), which is coded 1 for California respondents in 2012, coded 2 for California respondents in 2013, and 0 for all other years and for all non-California respondents.

Analysis

The analysis uses generalized estimating equations (GEE, Diggle, Liang et al. 1995) in Stata 12 (StataCorp 2011) to take into account clustering of respondents in schools. Information from respondents within the same school is correlated and therefore not completely independent. GEE models take into account non-independence to calculate correct standard error estimates of the coefficients. All analyses use weights to take into account differential probability of selection into the sample.

The empirical analysis consists of two steps. First, for each year from 2007 to 2013 the analysis presents a separate, bivariate analysis comparing prevalence of observed outcomes among California youth as compared to non-California youth. Of particular interest in these analyses is whether significant differences emerge during or after the 2010 decriminalization legislation.

Second, the analysis then combines years 2007–2013 into one analysis pool to test any lasting time trends suggested in the bivariate analyses. These analyses center on the years when a significant difference emerged in California and then persisted. We test whether these years mark a significant divergence in time trends among California as compared to non-California youth. To do this the analysis uses piecewise linear regression (Gujarati 1988), after first determining whether the functional form of the trend is linear or quadratic.

Results

Results for 12th graders

Table 2 presents results for 12th graders for the time period 2007–2013 by California residency. The first two rows present analyses for 12th graders and indicate a higher prevalence for this outcome emerged in California in comparison to the other states in 2012 and 2013. Specifically, in both 2012 and 2013 the prevalence of any marijuana use in the past 30 days was proportionately about 25% higher in California as compared to the other states ($p<.01$ for each year). In the earlier years California did not differ significantly from the other states in the prevalence of past 30-day marijuana use.

Rows 3–6 of Table 2 present results for the 12th grade outcomes of any past 12-month marijuana use, as well as any lifetime marijuana use. For both these outcomes California youth did not differ from non-California youth until the year 2010, when a significant difference emerged and then persisted in the following years (with the one exception of a non-significant difference in 2011 for the outcome of lifetime marijuana use).

The following rows of Table 2 present information on marijuana attitudes and perceived marijuana availability among 12th graders. The attitudes all follow the same pattern in which significant differences between California as compared to non-California youth emerged in 2012 and 2013, whereas in the 20 comparisons in the earlier years only one reached significance at the .05 level (about what would be expected by chance).

The last two rows of Table 2 present trends in perceived marijuana availability, and indicated no lasting, emerging differences during the analysis period. Between 2007 and 2013 a high percentage of 12th graders (82% – 84%) reported that it would be “fairly easy” or “very easy” to get marijuana. A significant difference between California as compared to non-California youth was present only in the year 2012.

Table 3 presents piecewise logistic regression analyses of a 12th grade analysis pool that combines all years in order to examine time trends suggested by the bivariate analyses. These analyses center on the years when a significant difference emerged in California and then persisted, and test whether these years mark a significant divergence in time trends among California as compared to non-California 12th graders. The first column of results supports the finding that among 12th graders the prevalence of past 30-day marijuana use increased significantly faster in California as compared to non-California states starting in the year 2012, as indicated by the statistically significant multiplicative interaction term (California)×(2012). The second and third columns of results support the finding that among 12th graders the prevalence of annual and lifetime marijuana use increased significantly

faster in California starting in the year 2010, as indicated by a statistically significant interaction term (California)×(2010).

Columns 4 and 5 of Table 3 results support the finding that a disparity emerged in the year 2012 and then persisted for the outcome of perceiving a great risk from regular marijuana use, as well as the outcome of personal disapproval of regular marijuana use. This finding is supported by the significant, multiplicative interaction term (California)×(2012). The results also support a widening gap starting in 2012 for the outcome of "expect to use marijuana five years in the future" although the supporting, interaction term is significant at the .05 level only for a one-tailed test. Time trend analysis using piecewise regression found no support for the emergence of a gap in perceived availability of marijuana in any study year.

Figure 1 graphically presents the findings of Table 3 and 4 for the outcomes of past 30-day marijuana use, expectation to use marijuana five years in the future, perceived risk of regular marijuana use, and personal disapproval of regular marijuana use. These graphs present both observed and predicted prevalence of the selected outcomes. All graphs show disparities that emerged around the year 2012 and then persisted.

Three robustness checks

We performed three additional analyses to test the robustness of the study results for 12^{th} graders. We first examined trends in the schools that contributed 12^{th} grade respondents to MTF in both 2011 and 2012 (n=54 schools, 6 of which were in California), an analysis free from any sampling anomalies potentially introduced by the constant rotation of schools into and out of the sample. In the main analysis across these two years considerable change in marijuana prevalence occurred in California, while in the other states marijuana prevalence remained mostly constant. These analyses focused on effect sizes and not statistical significance, given the much smaller sample size of these analyses compared to the main study.

All trends in the overall sample were present in the subsample of schools that participated in MTF in both 2011 and 2012. Across this one year, the prevalence of marijuana use increased in California across all three marijuana indicators of past 30-day, past 12-month, and lifetime marijuana use, proportionately by 19%, 19%, and 12%, respectively. In contrast, non-California schools these outcomes were virtually unchanged (the proportional increases were 1.0%, −0.1%, and −0.1%). Further, declines in both perceived risk of regular marijuana use, as well as disapproval of marijuana use, were steeper in California (16% and 10%, respectively) as compared to the other states (6% and 4%, respectively).

In the second test we removed from the main analyses states that enacted marijuana decriminalization legislation in 2007 or later, but before the last wave of data collection in the Spring of 2013. Specifically, the second test excluded Massachusetts (which decriminalized marijuana in 2009), Pennsylvania (2010), and Connecticut (2011). The exclusion of these states leads to a tighter theoretical comparison with states that had unchanging marijuana decriminalization laws over the course of the survey. Together these states represent 9% of the total weighted sample, and excluding them had little effect on the study results. For example, for the 2013 results (last column of all rows in Table 2) the mean

results for non-California states never changed more than one percentage point, and significance levels for all comparisons with California did not change.

The third test was similar to the second. In addition to excluding from the comparison group all states that decriminalized marijuana during the study period, we also excluded all states that enacted medical marijuana laws during the study period. Specifically, we also excluded Arizona, Delaware, and New Jersey and these states combined with the previous exclusions totaled 12% of the weighted sample. These exclusions lead to only negligible changes in the empirical results and did not alter any of the significance levels.

Results for 10th and 8th Graders

Table 4 presents results for 10th and 8th graders. In 2013 no significant difference is apparent for California youth as compared to other states for any of the outcomes under study. These results indicate that the 2010 decriminalization did not exert a continued, lasting effect on all subsequent cohorts of 8th and 10th graders.

Results for both 10th and 8th graders point to possible cohort-specific effects, however. Among 10th graders significantly higher marijuana prevalence and acceptance specific to California are apparent only in years 2009 and 2010, although non-significant differences in the same direction are also apparent in 2011. These cohorts would be in 12th grade in 2011–2013, the time period when 12th grade differences first became apparent for California as compared to the other states (documented above).

Among 8th graders significantly higher marijuana prevalence and acceptance specific to California are apparent only in years 2011 and 2012. The 2011 8th grade cohort aged into 10th grade in 2013, but no marijuana differences specific to California were apparent for 10th graders in 2013.

Discussion

A wave of U.S. states have decriminalized recreational marijuana in recent years, including California, Connecticut, Massachusetts, Pennsylvania, Rhode Island, and Vermont, as well as full legalization of recreational marijuana for adults in Colorado and Washington in 2013 (NORML 2014). Part of the rationale to decriminalize is the argument that decriminalization is not a risk factor for future increases in youth marijuana prevalence, an argument supported primarily by studies based on older data from the 1970s and 1980s. This study set out to revisit this argument by comparing 8th, 10th, and 12th graders in California to their peers in other U.S. states in the three years before and three years after decriminalization legislation was passed by California voters in 2010.

Two versions of the signaling hypothesis

These results support two versions of the signaling hypothesis, which posits decriminalization as a risk factor for future increases in youth marijuana prevalence and acceptance. By themselves, the results for 12th graders support a “strong” version of the hypothesis. For these students the results came out as the signaling hypothesis predicted. Youth marijuana use increased at a significantly greater rate in California as compared to the

other U.S. states following decriminalization (i.e. the pattern of results predicted in Row 1 of Table 1). Past 30-day use, which is sensitive to regular marijuana use, became significantly higher among California as compared to non-California youth in 2012 and 2013, and it did not differ in the previous years. For the outcomes of past-year and lifetime marijuana use an increase was apparent earlier, in 2010 when decriminalization was publicly discussed and debated but not yet enacted.

After decriminalization youth attitudes toward marijuana also became significantly more permissive among California 12th graders as compared to their peers in the rest of the U.S., as predicted by the signaling hypothesis. In the year 2012 for the first time California 12th graders reported significantly less perceived harm and personal disapproval of regular marijuana use as compared to their peers in other states. Consistent with broad changes in attitudes toward marijuana, California 12th graders also reported a higher expectancy that they would use marijuana five years in the future.

However, taking into account the results for 10th graders suggests a possible, modified version of the signaling hypothesis in which any effects of decriminalization are limited to a single birth cohort of a narrow age range. It is possible that the increased marijuana prevalence and acceptance of California 12th graders in 2012–13 is simply a continuation of a pattern that was initially established about two years earlier, when the cohort was in 10th grade. When the 12th graders of 2012–13 were in 10th grade they already showed uniquely high levels of marijuana prevalence and acceptance, and birth cohorts tend to maintain their relative level of marijuana prevalence as they age (Miech and Koester 2012).

This cohort interpretation would be consistent with a hypothesis that it was the media coverage in California surrounding marijuana issues in 2009 and 2010 – and not the decriminalization legislation *per se* – that sent a signal to youth and led to increased marijuana prevalence and acceptance. The marijuana issues that generated media attention in California in 2009–10 included both decriminalization and also an initiative to legalize marijuana (Proposition 19, which was defeated, Hoeffel 2010). This cohort interpretation predicts that California-specific increases in youth marijuana prevalence and acceptance should attenuate quickly among future cohorts of 12th graders, to the extent that the California media coverage of marijuana subsided after the 2010 election and did not set into place any more cohort effects.

Whether the results documented in this study are limited to a single cohort or not is likely to be revealed by analyses of years 2014 and beyond. A finding of a California-specific increase in marijuana prevalence and acceptance among 12th graders in the coming years will support the “strong” version of the signaling hypothesis, while a finding of no such increase would be consistent with a cohort effect. In either case the results of this study support the hypothesis that decriminalization puts at stake the marijuana prevalence and acceptance for at least one cohort of youth.

The results of this study suggest that any signaling effect does not extend down to 8th graders. No California-specific increase in marijuana prevalence and/or acceptance among 8th graders emerged around the time of decriminalization (2009–10) or was present in the

last year of the analysis period (2013). Such an emergence did occur in 2011–12, but it is difficult to attribute this directly to decriminalization. In general, 8th graders may have yet to undergo the social and cognitive changes that lead them to gain more interest and knowledge of the broader world (Keating 2004) and to view public debates and discussion of marijuana as personally relevant.

Hypotheses not Confirmed

The results support signaling theory over competing hypotheses that posit an increase in youth marijuana use through other mechanisms (i.e. the predictions in Row 2 of Table 1, which were not supported). One alternative mechanism that was a candidate was marijuana availability. This outcome did not trend differently in California in comparison to the rest of the states during the analysis period, precluding its potential as an intervening mechanism. Youth have long reported that they can readily obtain marijuana (Johnston, O'Malley et al. 2013), and over the period 2007–2013 availability remained high with more than 80% of 12thgraders responding that it was "fairly easy" or "very easy" for them to obtain marijuana. These results suggest that the increased marijuana use associated with decriminalization is not an issue of controlling access to marijuana (which the U.S. government has never done very successfully), but rather may involve the signals that decriminalization send to youth.

Another potential competing hypothesis not supported was that youth marijuana attitudes and/or use in California had already changed before decriminalization entered the media in 2009 (consistent with Rows 3 and 4 of Table 1). This alternative hypothesis posits that decriminalization is more accurately interpreted as a consequence of cultural changes regarding marijuana and not a driver. However, working against this alternative hypothesis is the timing of the study findings: before decriminalization in 2007 and 2008 California youth did not show higher levels of marijuana prevalence or acceptance relative to their peers in other states.

Future research

The concept of "risk factor" includes both causal and non-causal predictors of outcomes (Bhopal 2002), and the findings of this study provide both motivation and justification for future work to examine if decriminalization qualifies as a causal risk factor. Epidemiological studies such as this one cannot prove causation, and an experimental design – the preferred method to establish causation – is not feasible for this research topic. Future analyses can help evaluate whether decriminalization is a causal risk factor by testing specific processes that link decriminalization to the changes observed in youth marijuana attitudes and behaviors. Ideally such analyses would identify processes that are at work today but were not at work in the 1970s and 1980s, when earlier studies found no influence of decriminalization.

One candidate mechanism is increased media exposure of adolescents, which has increased substantially from the 1970s and 1980s and continues its upward ascent today. From just 1997 to 2012 the percentage of U.S. households with home internet access jumped from 18% to 74.8% (U.S. Census Bureau 2014), the percentage of individuals age 25+ using a smartphone has increased from negligible to 45% (U.S. Census Bureau 2014), and from

1999 to 2004 total media exposure among children and adolescents increased by more than an hour (Roberts and Foehr 2008). The media can reach adolescents today much more effectively as compared to the 1970s and 1980s and better deliver publicity about marijuana. This publicity may take the form of debates about ballot initiatives as well as explicit marijuana marketing, which has increased considerably in California in recent years. The California medical marijuana industry has grown to an annual market estimated at $980 million (Arcview Group 2013), giving it substantial resources and motivation to enlist marketing firms to promote marijuana use. In recent years up to 40% of the revenue for classified ads in independent newspapers in California comes from pro-marijuana advertising (Peters 2010), radio ads for medical marijuana are common (Sanchez 2010), and the first-ever television ad touting the benefits of medical marijuana recently aired in some California markets (The Week Staff 2010). Within this recently-developed media context, decriminalization – especially the removal of misdemeanor status for marijuana possession in small amounts (Pacula, Chriqui et al. 2004) – may be interpreted by today's youth as a sign that this pro-marijuana message has won out, leading to greater acceptance and, eventually, use of marijuana among youth who otherwise would not have used it.

Limitations and caveats

We note three limitations and caveats. First, the results of this study do not establish causation between increases in youth marijuana prevalence and decriminalization and/or its associated publicity. With any non-experimental research design it is not possible to rule out all possible confounders. Future research is required to specify the specific mechanisms at work in order to build a case that decriminalization qualifies as a causal risk factor for youth marijuana use. Given that many U.S. states may well decriminalize or outright legalize adult marijuana use in the near future (Wing 2014), it is likely that many future research opportunities will be available. These opportunities can be pursued with new data collection and also through data from existing surveillance systems such as the California Healthy Kids Survey (California Department of Education 2014), the National Survey on Drug Use and Health (Substance Abuse and Mental Health Services Administration 2014), the Drug Abuse Warning Network (Substance Abuse and Mental Health Services Administration 2014), and the Youth Risk Behavior Surveillance System (Centers for Disease Control and Prevention 2014).

Second, the data are self-reported, and are thus subject to bias. Because this study focuses on changes over time, only biases that have grown or diminished during the analysis period threaten the study conclusions. Biases that have remained constant over time will affect the overall level of outcomes under study, but by definition will not by themselves change levels from one year to the next and therefore will not influence trends over time.

Perceived risk of legal consequences is one bias that may have changed over time and could potentially affect the study results. For example, removal of criminal consequences after 2010 may have also removed an underreporting bias among youth who feared that reporting their marijuana use could get them in trouble. If so, an increase in the prevalence of marijuana may reflect the removal of this underreporting bias rather than any actual change in use. However, such an effect would not be expected for trends in youth attitudes, which of

course are not subject to criminal penalties. The finding that 12th grader attitudes also changed in California after in 2012 suggests that marijuana prevalence trends are part of a more general shift toward marijuana, and it is difficult to explain away this shift as a methodological artifact. Further, shifts in marijuana attitudes were not present across all grades in any single year, ruling out the possibility that the study findings are a result of a general, population-wide change in marijuana reporting that occurred after decriminalization.

Third, Monitoring the Future is not specifically designed to provide state-level estimates. Instead, the sample is designed to be representative of the four major census areas of the United States. With this sampling strategy state-level estimates are theoretically unbiased, but in practice the number of schools and respondents in the smaller states is often too low to provide reliable estimates. Analysis of California is possible because it is the U.S. state with the largest population, and also the state with largest number of schools and respondents in the analysis data. Given unbiased estimates, these relatively large numbers of California respondents (more than 12,000 12th graders in 46 schools from 2007–13) support reliable estimation of marijuana use and attitudes in California, even though the study was not specifically designed for state-level analysis.

Conclusion

The results of this study support decriminalization as a risk factor for increases in both marijuana acceptance and use among 12th graders. Following decriminalization both marijuana acceptance and use significantly increased among California 12th graders as compared to their peers in other states. Policymakers and voters should consider the possibility that decriminalization sends a signal that encourages youth marijuana use. The study results both justify and motivate future work to determine whether decriminalization continues to exert an influence on future cohorts of California 12th graders, as well as an examination of intervening mechanisms that are amenable to policy and interventions.

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Highlights

- Decriminalization associated with increased prevalence in marijuana prevalence among U.S. 12th graders
- Decriminalization associated with increase in permissive attitudes toward marijuana among U.S. 12th graders
- These trends among 12th graders were present two years earlier among 10th graders, suggesting results may be a cohort/generational effect.

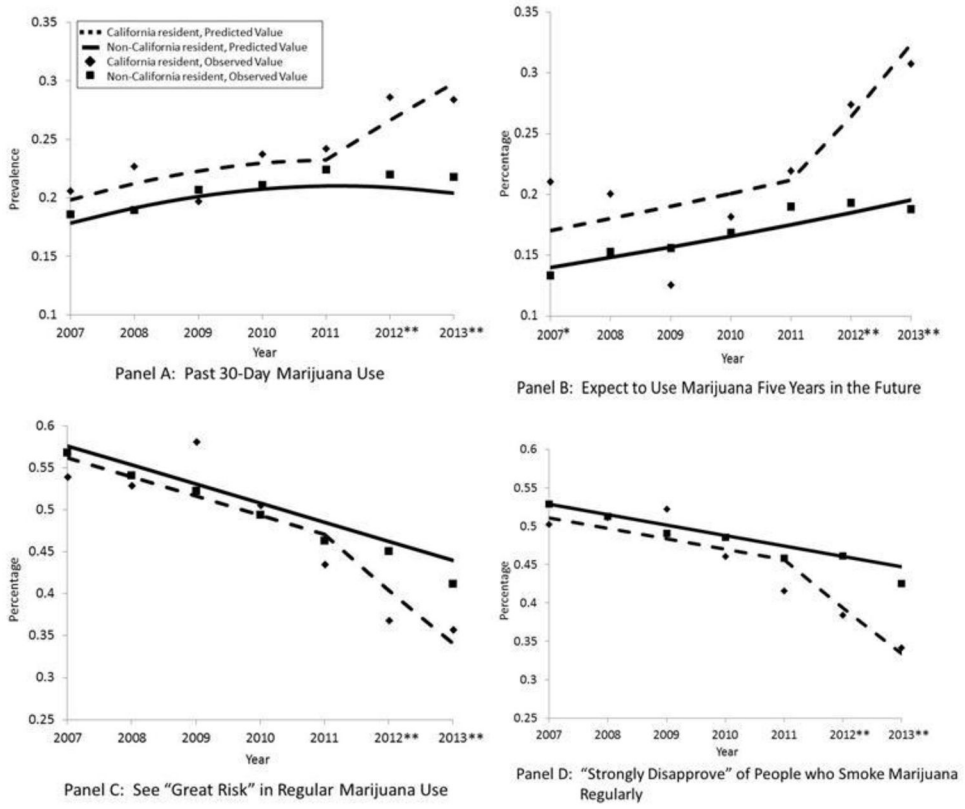

Figure 1.

Marijuana Use and Attitudes among U.S. 12th Graders by Year and California Residency

* p≤.05; prevalence significantly different among California as compared to non-California residents in this year.

** p≤.01; prevalence significantly different among California as compared to non-California residents in this year.

Table 1

Competing, Predicted Patterns of Results for Youth Attitudes and Use of Marijuana After Decriminalization

Prediction	Change in Youth Marijuana Acceptance Specific to California After Decriminalization	Change in Youth Marijuana Prevalence Specific to California After Decriminalization
Decriminalization Changes Behavior		
Signalling Effect	Increase	Increase
Effect, but not through signalling	None	Increase
No Behavioral Effect of Decriminalization		
No Effect	None	None
No Effect on marijuana use	Increase	None

Table 2

Observed Prevalence of Marijuana-Related Behaviors and Attitudes among U.S. Students in 12th Grade, by Year and California Residency (Weighted), Standard Errors in Parentheses

	---Year---						
Outcome	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Marijuana use							
Past 30 days (n=97,238)							
California	.21 (.03)	.23 (.03)	.20 (.02)	.24 (.02)	.24 (.02)	**.29**** (.01)	**.28**** (.01)
Not California	.19 (.01)	.19 (.01)	.21 (.01)	.21 (.01)	.22 (.01)	**.22** (.01)	**.22** (.01)
Past 12 months (n=97,110)							
California	.33 (.04)	.36 (.04)	.32 (.03)	**.39*** (.02)	**.41*** (.02)	**.47**** (.02)	**.43**** (.03)
Not California	.32 (.01)	.32 (.01)	.33 (.01)	**.34** (.01)	**.36** (.01)	**.35** (.01)	**.35** (.01)
Lifetime (n=97,238)							
California	.42 (.04)	.45 (.03)	.43 (.02)	**.49*** (.02)	.51 (.02)	**.55**** (.02)	**.51*** (.03)
Not California	.42 (.01)	.42 (.01)	.42 (.01)	**.43** (.01)	.45 (.01)	**.44** (.01)	**.45** (.01)
Perceive “great risk” in regular marijuana use (n=79,945)							
California	0.54 (.03)	0.53 (.04)	0.58 (.02)	0.51 (.04)	0.43 (.02)	**0.37**** (.03)	**0.36**** (.01)
Not California	0.57 (.01)	0.54 (.01)	0.52 (.01)	0.49 (.01)	0.46 (.01)	**0.45** (.01)	**0.41** (.01)
Strongly disapprove of regular marijuana use (n=61,123)							
California	0.50 (.05)	0.51 (.04)	0.52 (.03)	0.46 (.04)	0.42 (.02)	**0.39**** (.02)	**0.34**** (.02)
Not California	0.53 (.01)	0.51 (.01)	0.49 (.01)	0.49 (.01)	0.46 (.01)	**0.46** (.01)	**0.42** (.01)
Expect to use marijuana five years in the future (n=16,154)							
California	0.21* (.04)	0.20 (.03)	0.13 (.03)	0.18 (.03)	0.22 (.02)	**0.27**** (.03)	**0.31**** (.04)
Not California	0.13 (.01)	0.15 (.01)	0.16 (.01)	0.17 (.01)	0.19 (.01)	**0.19** (.01)	**0.19** (.01)
Perceived availability of marijuana (n=65,655)							
California	0.84 (.03)	0.85 (.01)	0.81 (.01)	0.84 (.01)	0.85 (.02)	**0.89**** (.01)	0.86 (.03)
Not California	0.84 (.01)	0.84 (.01)	0.83 (.01)	0.83 (.01)	0.83 (.01)	**0.82** (.01)	0.82 (.01)

Note: Reported sample sizes are unweighted.

*p<.05; prevalence significantly different among California as compared to non-California residents in this year

** p<.01; prevalence significantly different among California as compared to non-California residents in this year

Table 3

Marijuana Use and Attitudes from 2007–2013 as a Function of Time and California Residency among U.S. Students in 12th Grade (Weighted). Unexponentiated Coefficients from Logistic Regression Equations, with Standard Errors in Parentheses

	30-Day Marijuana Prevalence	Annual Marijuana Prevalence	Lifetime Marijuana Prevalence	"Great risk" in regular marijuana use	Personal disapproval of regular marijuana use	Expect to use marijuana five years in future	Perceived availability of marijuana
Sample size	97,238	97,110	97,238	79,945	61,123	16,154	65,655
California Resident	.13 (.089)	.10 (.12)	.077 (.11)	−.061 (.074)	−.072 (.085)	.23* (.099)	.19** (.084)
Year of survey[a]	.097* (.042)	.017 (.011)	.0047 (.011)	−.090** (.010)	−.055** (.011)	.067** (.015)	−.033** (.013)
(Year of survey)^2	−.012† (.0066)						
Year Rates Begin to Depart in California							
(California)× (2010)		.11* (.049)	.10* (.048)				
(California)× (2012)	.19* (.086)			−.18** (.057)	−.20** (.072)	.22† (.12)	
Constant	−1.53** (.056)	−.78** (.039)	−.34** (.037)	.29** (.034)	.12** (.036)	−1.82** (.052)	1.61** (.043)

[a] Centered at year 2007

† p<.10

* p<.05;

** p<.01 (all tests two-tailed)

Table 4

Observed Prevalence of Marijuana-Related Behaviors and Attitudes among U.S. 10th and 8th Graders, by Year and California Residency (Weighted), Standard Errors in Parentheses

	---Year---						
Marijuana Outcome	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
10th GRADE							
Past 30 day use (n=104,953)							
California	.14 (.01)	.13 (.01)	**.18*** (.01)	**.20*** (.02)	.19 (.02)	.17 (.02)	.18 (.02)
Not California	.14 (.01)	.14 (.01)	**.16** (.01)	**.16** (.01)	.17 (.01)	.17 (.01)	.18 (.01)
Past 12-mo use (n=104,987)							
California	.25 (.01)	.24 (.01)	**.31** (.01)**	.32 (.02)	.30 (.02)	.29 (.03)	.29 (.03)
Not California	.24 (.01)	.24 (.01)	**.26 (.01)**	.27 (.01)	.29 (.01)	.28 (.01)	.30 (.01)
Lifetime use (n=105,143)							
California	.32 (.01)	.30 (.02)	**.36** (.01)**	.37 (.03)	.36 (.03)	.35 (.03)	.35 (.03)
Not California	.31 (.01)	.30 (.01)	**.32 (.01)**	.33 (.01)	.34 (.01)	.33 (.01)	.36 (.01)
Perceived high risk of regular use (n=94,073)							
California	0.65 (.02)	0.64 (.02)	**0.56* (.02)**	0.56 (.02)	0.55 (.03)	0.51 (.02)	0.49 (.03)
Not California	0.66 (.01)	0.67 (.01)	**0.62 (.01)**	0.59 (.01)	0.57 (.01)	0.53 (.01)	0.48 (.01)
Strong disapproval of regular use (n=94,183)							
California	0.61 (.02)	0.62 (.02)	0.55 (.02)	**0.51*(.03)**	0.54 (.03)	0.53 (.02)	0.51 (.02)
Not California	0.63 (.01)	0.63 (.01)	0.60 (.01)	**0.59 (.01)**	0.57 (.01)	0.56 (.01)	0.51 (.01)
Perceived availability (n=96,405)							
California	0.74 (.02)	0.72 (.02)	**0.79**(.02)**	0.77 (.02)	0.75 (.03)	0.74 (.02)	0.74 (.02)
Not California	0.73 (.01)	0.72 (.01)	**0.74 (.01)**	0.74 (.01)	0.73 (.01)	0.73 (.01)	0.75 (.01)
8th GRADE							
Past 30 day use (n=107,772)							
California	.06 (.01)	.05 (.01)	.07 (.03)	.09 (.02)	.10 (.02)	.09 (.02)	.07 (.01)
Not California	.06 (.004)	.06 (.004)	.06 (.004)	.08 (.006)	.07 (.005)	.06 (.005)	.07 (.005)
Past 12-mo use (n=107,814)							
California	.10 (.01)	.10 (.02)	.12 (.04)	.15 (.03)	**.17** (.03)**	**.15* (.02)**	.13 (.02)

	---Year---						
Marijuana Outcome	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Not California	.10 (.01)	.11 (.01)	.12 (.005)	.13 (.01)	**.12 (.01)**	**.11 (.01)**	.13 (.01)
Lifetime use (n=107,898)							
California	.13 (.02)	.12 (.02)	.17 (.05)	.19 (.03)	**.22*(.04)**	.20 (.02)	.16 (.02)
Not California	.14 (.01)	.15 (.01)	.16 (.01)	.17 (.01)	**.16 (.01)**	.15 (.01)	.17 (.01)
Perceived high risk of regular use (n=94,782)							
California	0.76 (.03)	0.70 (.04)	0.68 (.02)	0.65 (.04)	0.65 (.02)	**0.61**** (.03)	0.63 (.01)
Not California	0.77(.01)	0.75 (.01)	0.73 (.01)	0.71 (.01)	0.71 (.01)	**0.71** (.01)	0.64 (.01)
Strongly disapproval of regular use (n=94,846)							
California	0.69 (.04)	0.71 (.05)	0.68 (.06)	0.65 (.04)	0.65 (.04)	**0.65**** (.04)	0.69 (.02)
Not California	0.75 (.01)	0.74 (.01)	0.73 (.01)	0.70 (.01)	0.72 (.01)	**0.71** (.01)	0.68 (.01)
Perceived availability (n=92,703)							
California	0.39 (.03)	0.37 (.02)	0.41 (.06)	0.48 (.03)	**0.51* (.04)**	0.44 (.03)	0.45 (.02)
Not California	0.41 (.01)	0.44 (.01)	0.44 (.01)	0.45 (.01)	**0.41 (.01)**	0.40 (.01)	0.43 (.01)

Note: Reported sample sizes are unweighted.

* p<.05; prevalence significantly different among California as compared to non-California residents in this year

** p<.01; prevalence significantly different among California as compared to non-California residents in this year