

Marijuana Use Among Justice-Involved Youths After California Statewide Legalization, 2015–2018


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Objectives. To determine the impact of California’s recreational marijuana legalization on marijuana use among justice system-involved (JSI) adolescents and young adults, and to distinguish whether any changes resulted from legalization (passing the law) or from implementation of the law.

Methods. We compared changes in JSI youths’ marijuana use in 2 states: California ($n = 504$), where recreational marijuana use was recently legalized, and Pennsylvania ($n = 478$), where recreational use is still prohibited. Furthermore, we examined changes in marijuana use across 3 key time periods (October 2015–June 2018): before legalization, after legalization but before implementation, and after implementation.

Results. California JSI youths did not demonstrate a significant increase in marijuana use after legalization ($b = -0.010$; $P = .950$) or implementation ($b = -0.046$; $P = .846$). However, in Pennsylvania, rates of marijuana use increased significantly after legalization ($b = 0.602$; $P = .001$) but not after implementation ($b = 0.174$; $P = .533$).

Conclusions. Although recreational marijuana legalization was not associated with changes in marijuana use among youths in California, we observed increased rates of use in Pennsylvania after legalization in California. Recreational marijuana laws may be indirectly related to youths’ marijuana use by supporting more permissive national attitudes toward marijuana. (*Am J Public Health.* 2020;110:1386–1392. doi:10.2105/AJPH.2020.305797)

 See also Miech, p. 1268, and Hall and Leung, p. 1270.

In the past 7 years, 11 US states and Washington, DC, have legalized recreational marijuana use (Table 1; Figure A, available as a supplement to the online version of this article as <https://www.ajph.org>). Although the debate over marijuana laws has been ongoing since medical use was first legalized in 1996, now that recreational use is legal in several states, the public is even more concerned about how these recent laws will affect young people.^{1,2} Advocates argue that marijuana is less harmful than alcohol or tobacco and that legalization will reduce the “forbidden fruit” effect.³ Opponents of these laws are concerned that rates of use will increase substantially because of the greater availability of marijuana.⁴ Furthermore, critics contend that marijuana could be a “gateway drug” for more serious substance use and may lead to greater delinquency.^{5–8} Marijuana use during adolescence has also been linked to neurocognitive deficits,

disruptions in brain development, and depressive symptoms.^{9–11} Most prior studies examining the impacts of recreational marijuana laws have not determined whether observed changes in use occurred over and above age-related developmental changes and have primarily focused on community youth. Using a sample of high-risk youths who have had justice system contact, the present study assessed potential changes in rates of marijuana use resulting from recreational marijuana laws while accounting for expected age-based increases. Given that

substance use is generally higher among justice-involved youths compared with their noninvolved counterparts,¹² we assessed recreational legalization’s impact among the highest-risk youths. Furthermore, use of a sample of justice-involved youths allows for an examination of whether changes in recreational marijuana’s legal status or implementation would affect use among youths who have shown a disregard for the law and who likely already had access to illegal drug markets. Although legal status alone may not change the prevalence of use for this population, implementation and availability may have an effect.

Existing studies have also not distinguished whether changes in youth marijuana use occurred after laws were passed or after they were implemented. The passage of recreational marijuana laws and implementation of those laws are 2 critical, distinct time points in the process of legalization. After California passed the law legalizing recreational marijuana on November 9, 2016, individuals aged 21 years or older could legally use, possess, share, and grow marijuana. However, no legal dispensaries selling marijuana for recreational use had been opened yet, making it still illegal to purchase marijuana for recreational purposes. January 1, 2018, marked the day when California’s recreational marijuana law was actually implemented and when retail shops were first allowed to open. As such, implementation, not the law’s passage, opened an additional avenue for people to obtain marijuana.

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TABLE 1—State Marijuana Laws in 2020: United States

| Type of Law | States |
|----------------------------------|--|
| Recreational marijuana use legal | AK, CA, CO, IL, ME, MA, MI, NV, OR, VT, WA, DC |
| Medical marijuana use legal | AZ, AR, CT, DE, FL, HI, LA, MD, MN, MO, MT, NH, NJ, NM, NY, ND, OH, OK, PA, RI, UT, WV |
| No marijuana use legal | AL, GA, ID, IN, IA, KS, KY, MS, NE, NC, SC, SD, TN, TX, VA, WI, WY |

Note. Eleven states and Washington, DC, have legalized recreational marijuana use for adults (aged 21 years or older), 22 states have legalized medical marijuana use but not recreational use, and 17 states prohibit any marijuana use.

Despite key differences between the law's passage (referred to here as legalization) and implementation, previous studies have not distinguished changes in marijuana use across both time points. In particular, some studies assessed changes in marijuana use only before and after implementation. This method ignores any potential impacts that legalization could have on marijuana use and may inflate rates of use in the comparison group, making it difficult to see any changes due to implementation if marijuana use had already increased after legalization. For example, a cross-sectional study compared pre- and postimplementation changes in marijuana use in Oregon versus nonlegalized states.¹³ Researchers found that, among college students, increases in past-month use were not greater in Oregon than in nonlegalized states.¹³

Another study that compared pre- and postimplementation marijuana use investigated changes only within Colorado.¹⁴ The authors found no evidence that college students' past 2-month use increased after implementation. Unfortunately, because neither study examined prelegalization rates of marijuana use, it is unclear whether their null findings mean that state recreational marijuana laws truly did not affect use, or that rates of use had already increased after legalization and therefore were not significantly affected by implementation.

Other studies investigated changes in marijuana use solely before and after legalization. This method also has limitations. Analyzing use only before versus after legalization might not capture the time period after implementation at all, and these prior studies may have missed any changes in marijuana use linked to greater access from legal dispensaries. Using cross-sectional data from the Monitoring the Future study on 8th

through 12th graders, researchers examined rates of past-month marijuana use before and after Colorado and Washington State passed laws to legalize recreational marijuana.¹⁵ They found no differences in use between youths in Colorado and those in nonlegalized states; however, they did find greater increases in use among 8th and 10th graders in Washington compared with students in nonlegalized states. Many other studies did not specify the time periods during which they were comparing changes in marijuana use,^{16,17} making it difficult to understand the differential impacts that legalization versus implementation of recreational marijuana laws can have.

To expand on existing research, the present study investigated changes in rates of marijuana use across 3 time periods: before legalization, after legalization but before implementation, and after implementation. It is important to distinguish whether legalization—which permits recreational marijuana use but does not provide another avenue to purchase the drug—or implementation—which allows legal dispensaries to sell marijuana for recreational use—is the primary driver of youth marijuana use. To further add to prior literature, the current investigation was longitudinal and accounted for both within-person and between-person changes in marijuana use over time. In addition, we accounted for age-based increases in marijuana use, and we were thus able to assess whether marijuana use changed over and above age-related changes. Furthermore, we examined changes in rates of marijuana use among justice system-involved (JSI) adolescents and young adults. Marijuana use tends to be initiated during adolescence and to peak in young adulthood.^{18–20} This is an important topic of research given that some prior studies

have shown that frequent marijuana use may be associated with negative outcomes such as greater risk taking, delinquency, and later substance use disorders.^{6,7,21}

Not only are adolescence and young adulthood critical developmental time periods to examine, but within these age groups, those who are involved in the justice system are at especially high risk of marijuana use.¹² Approximately 38% of JSI youths reported past-month marijuana use,²² compared with only 22% of their non-JSI counterparts.²³ The present study is the first to investigate JSI youths who are at the highest risk of marijuana use. We tracked patterns of marijuana use among Californian adolescents and young adults before legalization, after legalization but before implementation, and after implementation. For comparison, we also tracked patterns of use among similar youths in Pennsylvania, a state that has not yet legalized recreational marijuana. We did not expect to see changes in marijuana use among JSI youths due solely to legalization given that these youths had already shown a disregard for the law.²⁴ However, we hypothesized that implementation might contribute to increased rates of use among JSI youths in California, potentially by adding an avenue through which youths could obtain marijuana or perhaps through reducing its cost.³ However, in Pennsylvania, we did not expect to see increases greater than expected age-related changes across any time period.

METHODS

The present work took advantage of existing, multisite, longitudinal data from the Crossroads Study (<http://sites.uci.edu/crossroadsinfo>), which enabled a prospective analysis of marijuana use at 3 time points. The study began in July 2011 and examines the development of 1216 male adolescents after their first juvenile justice system contact. Participants were eligible for the study if they had been arrested only once, for one of the moderate offenses listed in Table A, available as a supplement to the online version of this article as <https://www.ajph.org>.

Recruitment was conducted by students working with P. J. F., L. S., and E. C. in 3 locales: Orange County, California; Philadelphia, Pennsylvania; and Jefferson Parish,

Louisiana. However, because of sample size constraints in Louisiana, the present study was only able to compare marijuana use among participants in California (n = 504) and Pennsylvania (n = 478). Detailed descriptive statistics and demographics are displayed in Table 2.

Procedure

Participants were interviewed by Crossroads project staff using a secure, computer-assisted program. Interviews lasted 2 to 3 hours and were conducted in the youth’s home, in the community (e.g., coffee shop), or in a secure facility (e.g., detention center; jail) if the youth was housed there. Participants were first interviewed within 6 weeks

after their first arrest (July 2011–June 2013, followed by 6 biannual interviews (January 2012–June 2016) and 2 annual interviews (July 2015–June 2018). For the purposes of the present study, we focused on data collected from October 2015 to June 2018 to capture changes in marijuana use before legalization (observations = 1102), after legalization but before implementation (observations = 859), and after implementation (observations = 148).

Retention rates were high, and the proportion of missing data was low in both states: 90.73% of participants in California and 87.50% in Pennsylvania remained during the 5-year study period. If a youth was incarcerated at the time of his interview, his marijuana use score was coded as missing

because we did not know whether the law would have affected his marijuana use, since the facility would have prohibited access to it.

Measures

Time. Recreational marijuana use was legalized in California on November 9, 2016, and the law change was implemented on January 1, 2018. The 3 key time periods were therefore as follows:

- T1: before legalization (October 1, 2015–November 8, 2016);
- T2: after legalization but before implementation (November 9, 2016–December 31, 2017);

TABLE 2—Descriptive Statistics and Demographics: California and Pennsylvania, 2015–2018

| | Prelegalization, Mean (SD) or % | Postlegalization, Preimplementation, Mean (SD) or % | Postimplementation, Mean (SD) or % |
|---|---------------------------------|---|------------------------------------|
| California^a (n = 504) | | | |
| Marijuana use | 28.54 | 35.63 | 30.77 |
| Age, y | 19.24 (1.37) | 20.16 (1.28) | 20.62 (1.18) |
| Day of week | | | |
| Monday | 18.20 | 16.67 | 19.51 |
| Tuesday | 13.15 | 14.12 | 12.20 |
| Wednesday | 22.88 | 19.44 | 17.07 |
| Thursday | 12.61 | 13.89 | 6.10 |
| Friday | 16.58 | 17.82 | 21.95 |
| Saturday | 9.55 | 9.95 | 9.76 |
| Sunday | 7.03 | 8.10 | 13.41 |
| Incarcerated | 4.68 | 5.79 | 4.88 |
| Pennsylvania^a (n = 478) | | | |
| Marijuana use | 14.93 | 26.18 | 36.36 |
| Age, y | 19.04 (1.50) | 19.98 (1.44) | 20.05 (1.21) |
| Day of week | | | |
| Monday | 22.89 | 19.42 | 31.67 |
| Tuesday | 13.70 | 19.90 | 16.67 |
| Wednesday | 16.89 | 19.17 | 8.33 |
| Thursday | 14.82 | 14.81 | 6.67 |
| Friday | 16.14 | 14.32 | 10.00 |
| Saturday | 10.51 | 8.01 | 15.00 |
| Sunday | 5.07 | 4.37 | 11.67 |
| Incarcerated | 8.26 | 7.28 | 8.33 |

Note. Because our data were aligned and chunked by interview date (instead of interview wave), the final data set resembled an overlapping cohort design. As such, some participants had data during only 1 of the key time periods whereas others had data at each of the 3 key time periods. Specifically, 208 participants were interviewed during only 1 of the time periods, 640 were interviewed during 2 of the time periods, and 135 were interviewed during 3 of the time periods. All analyses statistically controlled for the repeated measurement design (i.e., the nesting of interviews within individuals).

^aRace/ethnicity (% White, Latino, and Black, respectively) was as follows: California: 17.60, 81.54, and 0.78; Pennsylvania: 10.16, 22.87, and 66.97. Parental education (% with less than a high school [HS] diploma, a HS diploma, and more than a HS diploma, respectively) was as follows: California: 41.89, 22.95, and 35.16; Pennsylvania: 19.05, 39.96, and 40.99.

- T3: after implementation (January 1, 2018–June 11, 2018).

Marijuana use. To identify rates of marijuana use, we used items from a subset of the Substance Use/Abuse Inventory.²⁵ Consistent with prior work and to ensure that the recall period fell within the time periods of interest, we assessed participants' past 24-hour marijuana use. As in prior studies that used past 24-hour measures,^{26,27} we found significant, strong correlations between past 24-hour marijuana use and use over longer recall periods (e.g., past 6-month or 12-month use; T1: $r = 0.72$, $P < .001$; T2: $r = 0.70$, $P < .001$; T3: $r = 0.77$, $P < .001$).

Covariates. Participants self-reported their age and race/ethnicity. They also provided self-reports of their parents' highest level of education, which was used as a proxy for socioeconomic status.²⁸ We also controlled for the day of the week on which participants were interviewed, as it could have had an impact on whether they engaged in marijuana use in the past 24 hours (Table B, available as a supplement to the online version of this article as <https://www.ajph.org>). In our analyses, we also included as a covariate the assessment time point during which participants were interviewed.

Analytic Strategy

As a preliminary step, we used 2 generalized estimating equation (GEE) population-averaged models to investigate rates of marijuana use by age. First, we examined the main effect of age (linear, quadratic) while also controlling for race/ethnicity, site, socioeconomic status, day of week, and interview time point. Next, we examined whether patterns of marijuana use by age differed by site by including product terms between age and site in the preliminary model described here. These preliminary models indicated that marijuana use followed a quadratic growth pattern for both sites; we therefore included linear and quadratic age variables in all primary models.

For the primary models, a GEE model examined the main effects of time (T1 vs T2 vs T3) on marijuana use, controlling for linear and quadratic age and other covariates. Next, we examined whether the impact of time varied by site by rerunning the primary model

and including a product term between site and time. We conducted analyses in Stata 15 (StataCorp LP, College Station, TX).

RESULTS

As shown in Table 2, the prevalence of past 24-hour marijuana use was fairly similar during the 3 time periods in California (range = 29%–36%). In Pennsylvania, however, the prevalence was much higher in T2 (26%) and T3 (36%) than in T1 (15%). In addition, although the prevalence of marijuana use was higher in California than in Pennsylvania at T1, the difference between the 2 states was essentially eliminated by T3.

Marijuana Use by Age

The first preliminary set of models showed that rates of use significantly varied by age. Specifically, rates increased steadily from age 17 to 20.5 years and remained somewhat stable thereafter (Figure 1). The developmental trajectory of marijuana use followed a similar pattern in California and Pennsylvania, although the intercept was higher in California.

The Impact of Legalization on Marijuana Use

There was no main effect of time on marijuana use when we controlled for all covariates. When we looked at the combined sample, there were no changes in use at T1 versus T2 ($b = 0.229$; $P = .095$), T2 versus T3 ($b = 0.022$; $P = .908$), or T1 versus T3 ($b = 0.251$; $P = .318$). However, there was a significant main effect of site on marijuana use, such that Californian participants were more likely to use marijuana than were Pennsylvanian participants ($b = 0.364$; $P = .049$).

Next, we observed a significant site-by-time interaction ($\chi^2 = 13.10$; $P = .001$), and we proceeded to probe specific contrasts by rotating the time reference groups. These post hoc analyses revealed no significant changes in marijuana use in California across any of the time contrasts (Figure 2). In California, rates of use at T1 versus T2 ($b = -0.010$; $P = .950$), T2 versus T3 ($b = -0.046$; $P = .846$), and T1 versus T3 ($b = -0.056$; $P = .848$) were not statistically different. However, marijuana

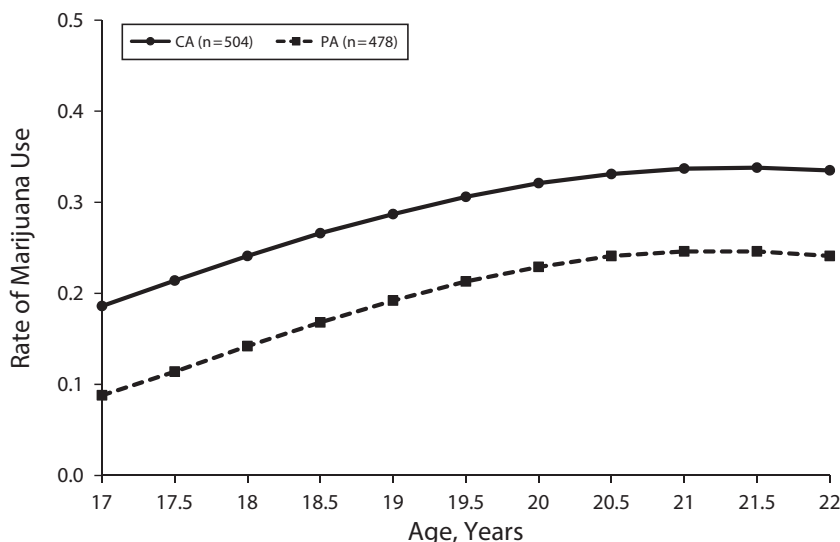
use changed significantly over time in Pennsylvania. Rates of use in Pennsylvania were significantly higher in T2 than T1 ($b = 0.602$; $P = .001$) and in T3 than T1 ($b = 0.777$, $P = .020$), but the increase from T2 to T3 was not significant ($b = 0.174$, $P = .533$). In addition, the prevalence of past 24-hour marijuana use was higher in California than in Pennsylvania for T1 ($b = 0.768$; $P = .002$), but not for T2 ($b = 0.170$; $P = .452$) or T3 ($b = 0.008$; $P = .919$).

To summarize, results showed that California JSI youths did not demonstrate a significant increase in past 24-hour marijuana use across any of the time periods. However, in Pennsylvania, rates of use increased after legalization in California and remained at this elevated rate. Furthermore, the prevalence of marijuana use was higher in California than in Pennsylvania only after legalization, suggesting that marijuana use in Pennsylvania “caught up” to use in California after legalization in California.

Supplemental analyses examined marijuana use in Pennsylvania using the medical marijuana legalization date, and findings were no different from those in the main analysis (online Figure B). Additional supplemental analyses to the primary GEE models—including a binary indicator of whether a participant was younger than 21 years or was 21 years or older—showed that the primary site \times time interaction was not significantly different on the basis of youths' age status (Table C, available as a supplement to the online version of this article as <https://www.ajph.org>). Lastly, when we conducted the primary analyses with data only from participants who provided data during all 3 time periods, the findings were essentially the same. Results are available from E. K. by request.

DISCUSSION

As recreational marijuana legalization becomes more widespread across the United States, how it affects marijuana use among youths is becoming an increasingly important topic of research. Contrary to our hypotheses, JSI youths in Pennsylvania, but not in California, exhibited increased rates of use after recreational marijuana legalization in California. One potential explanation is that

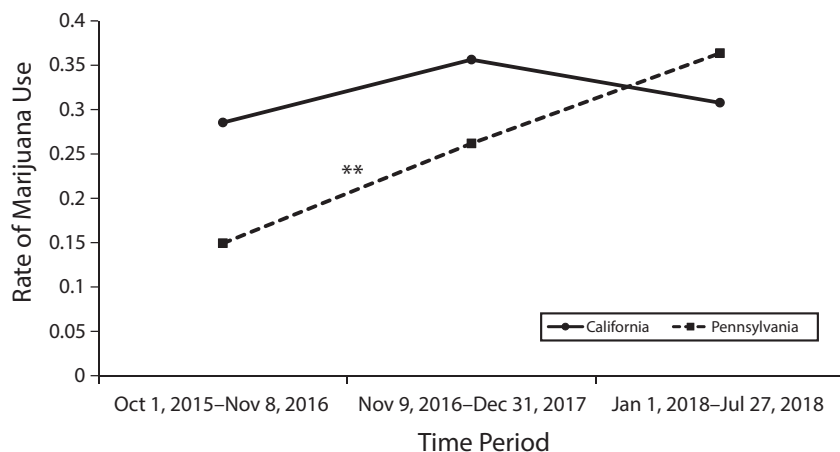


Note. Changes in marijuana use over age were significant for both states (linear age: $b = 0.072$, $P < .001$; quadratic age: $b = -0.001$, $P = .001$). Nonsignificant age-by-state interactions suggest that age-related increases in marijuana use were similar for California and Pennsylvania (linear age: $P = .414$; quadratic age: $P = .757$). Means are depicted. Race/ethnicity, socioeconomic status, day of week, and interview time point were included in the analysis as covariates.

FIGURE 1—Logistic Growth Curve Models of Rates of Marijuana Use, by Age: California and Pennsylvania, 2015–2018

legalization removed the “forbidden fruit” effect: although California youths could use marijuana, they may have been less motivated to use because it was no longer forbidden. Another possible explanation is that states that

pass recreational marijuana laws may have already had more permissive attitudes toward marijuana prior to legalization, which research consistently shows is associated with higher rates of use.^{29,30} However, in



Note. T1 = before legalization; T2 = after legalization but before implementation; T3 = after implementation. There were no significant increases in rates of marijuana use across any time period in California. There was a significant increase in rates of marijuana use from T1 to T2 in Pennsylvania ($P < .01$), but no differences were observed between T2 and T3. Linear age, quadratic age, race/ethnicity, socioeconomic status, day of week, and interview time point were included in the analysis as covariates.

* $P < .01$.

FIGURE 2—Rates of Marijuana Use in California and Pennsylvania: 2015–2018

Pennsylvania, we observed increased rates of use despite there being no changes in recreational marijuana laws in the state. We did not test the precise mechanism accounting for the change in use among Pennsylvanian youths, but a number of explanations are possible. For example, the observed increase could be a result of other policy changes in Pennsylvania that corresponded to the timing of the present study (e.g., decriminalization of marijuana possession in Philadelphia in September 2014 and in Pittsburgh in December 2015; legalization of medical marijuana in April 2016, around the same time as recreational legalization in California) or because Pennsylvania is located within driving distance of jurisdictions where recreational use has been legalized (e.g., Washington, DC; Massachusetts). Furthermore, the fact that more US states have legalized recreational marijuana in recent years might have provided cues to youths that marijuana use is not dangerous and may be as normal as drinking alcohol.

Importantly, our findings also showed that rates of marijuana use among Californian youths did not increase after implementation, when the first legal recreational marijuana dispensaries were opened. This suggests that JSI youths likely already had access to marijuana through illegitimate means, and gaining a legal, additional avenue through which to purchase marijuana did not affect their use. Interestingly, after implementation, the price of marijuana dropped in California, both in legal dispensaries (from an average of \$290 to \$245 per ounce) and among illegal street dealers (from \$256 to \$152 per ounce).^{31–33} Despite these reductions in price, however, rates of marijuana use among JSI youths in California did not differ significantly before and after implementation. Perhaps lower prices make it cheaper for youths who were already using marijuana to continue using, but the price reductions may not be enough to motivate nonusers to initiate.

Strengths and Limitations

There are several strengths to the current study. Because of the multisite, longitudinal design of the Crossroads Study, a prospective analysis comparing rates of use at 2 different sites before legalization, after legalization but before implementation, and after

implementation was possible. To our knowledge, no studies have examined rates of marijuana use across these 3 key time periods and few have compared marijuana use in legalized versus nonlegalized states. If we had only examined marijuana use across 2 time periods, as has been done in prior studies, we may not have seen the change in marijuana use in Pennsylvania before versus after legalization. Notably, the present research also assessed changes in marijuana use longitudinally and was able to test both within-individual and between-individual changes. Additionally, our analyses identified changes in marijuana use beyond expected age-related increases in use, an important confounding factor that has been overlooked in prior research.

Despite these strengths, the present study has several limitations. First, its findings cannot be generalized to females, and although few of the JSI youths in the present sample had committed serious crimes or been incarcerated (<7%), our results may not be generalizable to youths who have not had justice system contact. Second, because the nature of our research question necessitates a prospective analysis, we were only able to assess rates of marijuana use in states where the Crossroads Study had already collected data. We were therefore limited to comparing changes in marijuana use in California and Pennsylvania and were unable to assess changes in other states. Consequently, because medical marijuana use was legalized in Pennsylvania in April 2016 and recreational use was legalized in California in November 2016, we were unable to compare differences in rates of use between a state where all marijuana use is prohibited versus a state where recreational use is legalized. Third, because of state and local restrictions on the number and location of recreational marijuana dispensaries as well as federal prohibition, the scale of legal dispensaries may still have been limited when data collection concluded on June 2018. We were therefore unable to investigate long-term impacts of implementation on youths' rates of use. Future research should assess what may happen in the coming years as marijuana markets grow and if federal laws legalize recreational use.

In addition, future studies should investigate long-term marijuana use trends. The

current study examined past 24-hour use, which is only able to ascertain short-term impacts. Importantly, we found that past 24-hour use is highly correlated with 6-month and 12-month use and serves as a good proxy for examining individuals' marijuana use.²⁵ In fact, utilizing a past 24-hour measure enabled the present study to clearly delineate marijuana use before and after each critical time point (legalization and implementation), which would not have been possible with longer recall periods. However, future research should analyze how legalization might influence rates of use over a longer recall period as well, as both methods provide important information. Furthermore, as in existing studies on the consequences of recreational marijuana legalization, we were limited in sample size and thus unable to comprehensively examine how legalization might differentially affect individuals aged younger than 21 years compared with those 21 years or older. This will be an important distinction to make in future studies because legalization permits recreational marijuana use only for individuals aged 21 years or older.

Public Health Implications

Overall, our findings indicate that when recreational marijuana use is legalized for adults in one state, rates of use can increase even in other states that have not legalized. As recreational use is being legalized in more states, and more states are decriminalizing marijuana possession, these factors could be contributing to a broader cultural shift to greater acceptance of marijuana use that might have begun with medical marijuana legalization. These changes in attitudes toward marijuana may be influencing youths' perceptions of the risks of using marijuana, or perhaps perceptions that more of their peers are using it.³⁴ Practitioners and policymakers aiming to reduce rates of marijuana use among JSI youths might therefore focus their attention on youths' attitudes toward marijuana or their perceptions of peers' marijuana use behaviors. **AJPH**

CONTRIBUTORS

E. Kan conceptualized the study, performed analyses, and interpreted the results. J. Beardslee verified the analytical methods and interpreted the results. P.J. Frick, L. Steinberg, and E. Cauffman secured funding for the

study as the co-principal investigators of the Crossroads Study. All authors contributed to the revision and approval of content.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

HUMAN PARTICIPANT PROTECTION

This study received institutional review board approval from the University of California, Irvine, Louisiana State University, and Temple University.

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