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Temporal trends in marijuana attitudes, availability and use in Colorado compared to non-medical marijuana states: 2003-2011*

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Abstract

Background—In 2009, policy changes were accompanied by a rapid increase in the number of medical marijuana cardholders in Colorado. Little published epidemiological work has tracked changes in the state around this time.

Methods—Using the National Survey on Drug Use and Health, we tested for temporal changes in marijuana attitudes and marijuana-use-related outcomes in Colorado (2003-2011) and differences within-year between Colorado and thirty-four non-medical-marijuana states (NMMS). Using regression analyses, we further tested whether patterns seen in Colorado prior to (2006-8) and during (2009-11) marijuana commercialization differed from patterns in NMMS while controlling for demographics.

Results—Within Colorado those reporting “great-risk” to using marijuana 1-2 times/week dropped significantly in all age groups studied between 2007-8 and 2010-11 (e.g. from 45% to 31% among those 26 years and older; $p=0.0006$). By 2010-11 past-year marijuana abuse/dependence had become more prevalent in Colorado for 12-17 year olds (5% in Colorado, 3% in NMMS; $p=0.03$) and 18-25 year olds (9% vs. 5%; $p=0.02$). Regressions demonstrated significantly greater reductions in perceived risk (12-17 year olds, $p=0.005$; those 26 years and

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Conflicts of interest: Dr. Sakai received reimbursement in 2012 for completing a policy review for the WellPoint Office of Medical Policy & Technology Assessment (OMPTA), WellPoint, Inc., Thousand Oaks, CA. He also serves as a board member of the ARTS (Addiction Research and Treatment Services) Foundation. All other authors report no conflicts of interest.

older, $p=0.01$), and trend for difference in changes in availability among those 26 years and older and marijuana abuse/dependence among 12-17 year olds in Colorado compared to NMMS in more recent years (2009-11 vs. 2006-8).

Conclusions—Our results show that commercialization of marijuana in Colorado has been associated with lower risk perception. Evidence is suggestive for marijuana abuse/dependence. Analyses including subsequent years 2012+ once available, will help determine whether such changes represent momentary vs. sustained effects.

Keywords

Medical marijuana; legalized marijuana; decriminalization; marijuana policy; cannabis

1. INTRODUCTION

Twenty states and the District of Columbia have legalized marijuana for certain qualifying medical conditions (ONDCP, 2013) and more than 280,000 individuals are registered for medical marijuana in the United States (Bowles, 2012). In 2012, Colorado and Washington state legalized possession of an ounce or less and recreational use of marijuana for those 21 years of age or older (Johnson, 2012; Gurman, 2012). Such ongoing policy shifts underscore the critical need to provide accurate scientific information to the public on the impact of marijuana medicalization/legalization; the potential impact of such legal and policy changes remains hotly debated.

Medical marijuana proponents cite the potential medical benefits of marijuana (Hecht, 2012), the increased tax revenue to states from the medical marijuana industry (Cooper, 2012), potential reduction in traffic fatalities due to alcohol (Anderson and Rees, 2013), potential reduction in criminal activities and criminal justice costs (Warf, 2005; Single, 1989) and the relative safety of cannabis as compared to other substances (SAFER, 2012). Opponents of medical marijuana legalization raise a multitude of concerns including: medical marijuana may lead to increasing adolescent marijuana use (Joffe, 2004; Joffe and Yancy, 2004; Svrakic et al., 2012); medical marijuana may be diverted to adolescents (Thurstone et al., 2011; Salomonsen-Sautel et al., 2012; Thurstone et al., 2013) or may lead to toxic ingestions by children (Wang et al., 2011, 2013); adolescent exposure to marijuana is associated with subsequent psychosis (Moore et al., 2007) and decline in IQ (Meier et al., 2012); and that medical marijuana may negatively impact public health by increasing prevalence of addiction, crimes and motor vehicle accidents (HDFC, 2012).

Only a handful of published findings document changes temporally associated with medical marijuana laws using epidemiological datasets. Using the second wave of National Epidemiologic Survey on Alcohol and Related Conditions collected in 2004-5, Cerdá et al (2012) found that the prevalence of adult marijuana use, abuse and dependence was higher in states with medical marijuana laws compared to those without. Wall and colleagues (2011) using years 2002-8 of the National Survey on Drug Use and Health (NSDUH), showed a higher prevalence of adolescent marijuana use and lower perceptions of riskiness of use in states with medical marijuana laws compared to those without. Harper et al. (2012) replicated and extended the work of Wall et al. concluding that passage of medical

marijuana laws had little impact on the prevalence of marijuana use or perceived risk; however, these results were based on findings from only 5 of the 16 states with existing medical marijuana laws which reduced its generalizability (Wall et al., 2012). Most recently, using the Youth Risk Behavior Survey for Montana, Rhode Island, Michigan and Delaware, Lynne-Landsman and colleagues examined whether medical marijuana laws were associated with changes in adolescent marijuana use; they concluded that such laws had not had a measurable impact on use patterns, at least in the first few years after enactment (i.e., 1-5 years; Lynne-Landsman et al., 2013).

As the scientific community begins to disentangle the effects of marijuana legalization/commercialization, certain US states present unique scientific opportunities. Colorado is a case in point. For example, Colorado not only maintains a medical marijuana registry but also posts summary information to the Colorado Department of Public Health and Environment (CDPHE) website, allowing monitoring of temporal trends. In many other states it is difficult to assess the impact of medical marijuana laws and policy change because they do not maintain a medical marijuana registry (e.g., Washington), the state registry is voluntary (e.g., California), or information from the registry is not made available to the public (e.g., Hawaii; Bowles, 2012). Although in November, 2000, with the passage of Amendment 20 to the state constitution, Colorado legalized marijuana for medical purposes, review of the CDPHE records supports that from June, 2001 through January, 2009 only 6,369 new patient applications were received by the CDPHE. In 2009 there was a confluence of three major policy decisions: (1) Attorney General Eric H. Holder Jr. announced an end to raids on distributors of medical marijuana in states where medical marijuana was legal (Johnston, 2009); (2) the Justice Department noted that federal resources should not be focused on prosecuting medical marijuana patients and caregivers who were operating in “clear and unambiguous compliance with existing state law” (Ogden, 2009); and, (3) a Denver District Court ruling determined that a “caregiver” need only dispense marijuana to a registered patient and was not required to provide any additional care, which opened the way for large-scale retail medical marijuana centers (hereafter referred to as dispensaries; Elliott, 2009).

Following this, the Colorado medical marijuana industry experienced rapid growth. News reports quoting the acting Denver city treasurer indicated that by the beginning of 2010 there were nearly 400 medical marijuana dispensaries in Colorado (Channel 7 news, 2014), though the formal process of state licensing of dispensaries would not begin until that summer (Personal Communication, Julie Postlethwait, Medical Marijuana Enforcement Division). As of April 30th, 2013, there were 376 licensed dispensaries and 132 operating in Colorado under pending applications, bringing the total to 508 (personal communication Julie Postlethwait). During this same period the Colorado media attention to the issue of legal marijuana also rapidly increased (see Supplemental Figure 1). Although very few medical marijuana registry applications were received between 2000–2008, starting in 2009 the number of medical marijuana license holders in Colorado rapidly increased, reaching 116,198 individuals, or about 3% of Colorado's adult population, by the end of 2010 (refer to Supplemental Figure 2¹; CPDHE website; Census, 2010). Colorado's medical marijuana industry quickly matured, accumulating retail sales revenue of more than \$219,000,000 between July, 2011 and June, 2012 (Colorado Department of Revenue, 2014). Instead of

focusing on the point of legalization (pre-post passage of Amendment 20) when the medical marijuana industry in Colorado was relatively quiescent, here we focus on the potential impact of the rapid growth of the commercial medical marijuana industry in Colorado beginning in 2009.

In this study, we utilized the NSDUH to answer three questions: (1) How have marijuana attitudes and marijuana-use-related outcomes changed across time from 2003-4 to 2010-11 within Colorado? (2) Considering these same variables, did Colorado differ from 34 states without medical marijuana laws in years 2003-4, 2005-6, 2007-8, 2009-10 and 2010-11? (3) Do trends in Colorado between 2006-8 and 2009-11 differ from those seen in non-medical marijuana states (NMMS) for the same time periods while adjusting for demographic differences?

2. METHODS

The Colorado Multiple Institutional Review Board approved the study as an exempt protocol.

2.1. Study design and sample

We utilized nine years of data from the NSDUH (2003-2011); each year of the NSDUH survey employs a multistage probability sampling design to recruit a nationally-representative sample of the United States civilian, non-institutionalized population aged 12 and older. Since 1999, most questions in the NSDUH interview are administered as an audio computer-assisted self-interview to provide a private mode for responding to sensitive questions; for other less sensitive items computer-assisted personal interviewing is utilized. The design is state-based with a within-state independent, multistage area probability sampling, which allows estimating generalizable state-level prevalence rates. For each of the eight most populous states (e.g., California) approximately 3,600 respondents are interviewed annually; for each of the remaining 42 states and the District of Columbia, approximately 900 respondents are interviewed per state, per year. The design oversamples youths and young adults such that each state's sample is approximately equally divided into those 12-17 years, 18-25 years and 26 years and older. For Colorado considering year pairings of 2003-4, 2005-6, 2007-8, 2009-10 and 2010-11, sample sizes for 12-17 year olds, 18-25 year olds and those 26 years and older, respectively, ranged from 557-656, 570-681 and 581-650. See Substance Abuse and Mental Health Services Administration (SAMHSA) publications for further details (e.g., SAMHSA, 2008, 2009, 2010a, 2011).

2.2. Outcome measures

2.2.1. Marijuana attitudes—We focused our analyses on these measures of interest: (1) Perceived risk of marijuana use was assessed by asking respondents about the risk of smoking marijuana once or twice a week (no risk, slight risk, moderate risk, great risk). We dichotomized this variable into those reporting no-risk vs. all others, and separately, those reporting great-risk vs. all others; because these variables provide similar results, results for

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no-risk are reported but not discussed. (2) Marijuana availability: respondents reported how difficult it was to obtain marijuana (probably impossible, very difficult, fairly difficult, fairly easy or very easy). We dichotomized this variable into those reporting that marijuana was fairly or very easy to obtain vs. all others. (3) Perceived acceptability of marijuana was assessed by asking adult respondents how they feel about adults trying marijuana once or twice (neither approve nor disapprove, somewhat disapprove and strongly disapprove); adolescents (12-17 years old) were not asked this item. We dichotomized this variable into those reporting somewhat or strongly disapproved vs. all others.

2.2.2. Marijuana–use-related outcomes—(1) Past-year marijuana use: Respondents were asked if they had used marijuana in the past year. (2) Among marijuana users, respondents reported on the number of days they had used marijuana in the past year (range 0-365); due to space limitations, results for this variable are presented in the Tables but not discussed. (3) Among marijuana users, respondents also reported on the number of days they had used marijuana in the past month (range 0-30). All respondents were categorized into those reporting and not reporting at least 20 days of use in the past month. This categorization, sometimes called almost daily or near daily use, is commonly reported in the NSDUH (SAMHSA, 2013, Figure 2.15) and other epidemiological studies (EMCDDA, 2012). (4) To assess marijuana abuse/dependence, respondents were classified with past-year marijuana abuse/dependence (yes/no) based on the DSM-IV criteria.

2.3. Statistical analysis

Analysts from SAMHSA assisted in completing the analyses because state variables were not in the public domain. NSDUH generally requires at least two years of data for precise prevalence estimation at the state level. Because in 2009 and 2010 the Colorado medical marijuana industry experienced rapid growth, we conducted analyses pairing years 2003-4, 2005-6, 2007-8, 2009-10 and 2010-11. We decided *a priori* to conduct our analyses within three age groups (12-17, 18-25 and 26). We focused on an adolescent group (12-17) given that there has been concern about the effects of medical marijuana specifically on adolescents (Thurstone et al., 2011; Salomonsen-Sautel et al., 2012). We divided adults into those 18-25 years (young adults) and those 26 and older (other adults) because new-onset marijuana abuse and dependence is uncommon after age 25 (Stinson et al., 2006). Analyses were performed in SUDAAN based on weighted data to account for the complex survey design, following the established methodology previously described (SAMHSA, 2010b). Within-Colorado and within our pre-specified age groups our estimates are provided for rates or numbers for the perceived risk, availability of marijuana, acceptability of marijuana use, past-year marijuana use, 20+ days of marijuana use in the past month, and past-year marijuana abuse/dependence prevalence for years 2003-4, 2005-6, 2007-8, 2009-10 and 2010-11; we compared percentages for categorical variables and averages for continuous variables between consecutive years (2003-4 vs. 2005-6); because 2009-10 and 2010-11 were non-independent, both were compared to 2007-8 to test for temporal change within Colorado.

Next, we tested whether Colorado differed from other regions of the country that were by 2011 not *directly* affected by medical marijuana laws. NMMS at that time included 34 states

(see Supplemental Table 1² legend for a complete list). We compared Colorado and NMMS within each year pairing (e.g. 2003-4) for separate age groups (12-17 years, 18-25 years and 26 or older) for each outcome variable described above.

Finally, within each age group, we completed a series of regression analyses for each outcome variable (see Section 2.2.) using the combined Colorado and NMMS data and including the following independent variables: state (Colorado vs. NMMS), year (2009-11 vs. 2006-8), exact age, gender, race-ethnicity, high school diploma (for adults only) and a state-by-year interaction. The interaction term was included to identify if time trends in Colorado and NMMS differed.

3. RESULTS

Nine tables are also included as Supplemental Materials, in addition to three tables³. They provide details on prevalence estimates, standard errors, and p-values. Data from those detailed tables are summarized in Figures 1-2. For Figures 1-2 the vertical axis is percentage; the horizontal axis shows combined two year sequences. Each blue line represents estimates across time for Colorado, while a red line represents those in the 34 NMMS.

3.1. Marijuana attitudes

Figure 1 shows results for adolescents (12-17 year olds; Row 1), young adults (18-25 year olds; Row 2) and other adults (those 26+ years of age; Row 3). Figure 1.A.i-iii (Great risk): The perception of “great-risk” of smoking marijuana 1-2 times per week decreased significantly in Colorado for adolescents (56% in 2005-6, 47.7% in 2007-8, 37.9% in 2009-10 and 36.4% in 2010-11), young adults (24.6% in 2007-8 to 16.1% in 2010-11) and other adults (44.9% in 2007-8 to 31.1% in 2009-10 and 31.4% in 2010-11). Coloradans of all three age groups were significantly less likely than individuals from NMMS to perceive “great-risk” for all years studied except for adolescents in years 2003-4 and 2005-6. Figure 1.B.i-iii (Fairly/very easy to get): Within Colorado the percentage of other adults reporting that marijuana was fairly or very easy to obtain increased significantly between 2007-8 and 2010-11 (from 56.7% to 64.6%). Coloradans of all three age groups perceived greater marijuana availability (fairly/very easy to obtain) than NMMS for all years studied, except for adolescents in 2003-04 and 2005-6 and other adults in 2005-6 and 2007-8. Figure 1.C.i-iii (Somewhat/strongly disapprove): Both young and other adult Coloradans had significantly lower rates of disapproval (somewhat/strongly disapprove) of marijuana use compared to NMMS adults for every year studied.

3.2. Marijuana-use-related outcomes

Figure 2 shows results for adolescents (12-17 year olds; Row 1), young adults (18-25 year olds; Row 2) and other adults (26+ years of age; Row 3). Figure 2.A.i-iii (Past year use): among young adult Coloradans, past-year marijuana use increased significantly between 2007-8 and 2010-11 from 35.4% to 42.7%. Coloradans of all age groups had a significantly

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higher rate of past-year marijuana use compared to NMMS except for young adults in 2003-4 and other adults in 2005-6. Figure 2.B.i-iii (20+ days use): for 20+ days of marijuana use in the past month no within-Colorado changes were significant. Young adult Coloradans from 2005-6 through 2010-11 and other adult Coloradans in 2009-10 and 2010-11 had a significantly higher percent of past-month 20+ day users compared to NMMS. Figure 2.C.i-iii (marijuana abuse/dependence): past-year marijuana abuse/dependence was significantly more prevalent among adolescent Coloradans in 2009-10 and 2010-11 and young adult Coloradans in 2010-11 than those from NMMS counterparts.

3.3. Regression analyses

Tables 1-3 show detailed results for separate regression analyses for three age groups. Figure 3 shows significant interactions from those regression analyses for adolescents (12-17 year olds; Row 1) and other adults (26+ years of age; Row 2). Figure 3.A shows that among adolescents (12-17 year olds) a significant state-by-year interaction was seen for great-risk of using marijuana 1-2 times per week and Table 1 shows a trend interaction ($p=0.07$) for past-year marijuana abuse/dependence prevalence. Among young adults (18-25 year olds; Table 2), none of the regression analyses produced a trend or significant state-by-year interaction. Among other adults (26 years of age and older; Table 3), the state-by-year interactions was significant for great-risk of using marijuana 1-2 times per week (see Figure 3.B) and trended toward significance ($p=0.07$) for fairly/very easy to obtain marijuana (see Table 3). Tables 1-3 also provided additional information. For example, Coloradans compared to those from NMMS had lower rates of perception of great risk to using marijuana regularly and higher rates of past-year marijuana use. Associations between outcome variables and demographic variables within age group are also presented.

4. DISCUSSION

We present detailed information on temporal trends within Colorado for multiple marijuana-related variables, and test for Colorado vs. NMMS differences within time (e.g., years 2003-4, 2005-6, etc.). Our findings can be divided into those that represent: (1) Trends associated temporally with changes in 2009; (2) Differences between Colorado and NMMS in 2010-11; (3) Variables without significant change pre-post early 2009; and (4) trends in Colorado pre-post early 2009 that deviate from patterns seen in NMMS.

4.1. Trends associated temporally with changes in 2009

The perceived risk of using marijuana has decreased in recent years in Colorado. In some instances this appeared prior to 2009 (e.g., “no-risk” among young adults, 18-25 year olds), but in others there appears to have been a change in Colorado around 2009. For example, perception of “great-risk” decreased between 2007-8 and 2009-10 for other adults (26 years old or older) from 45 to 31%. In addition, for those adult Coloradans (26 years and older) there was a significant increase in the perception that marijuana was fairly/very easy to obtain and among young adults past-year marijuana use increased significantly from 35% to 43% between 2007-8 and 2010-11. For adolescents and young adults, marijuana abuse/dependence prevalence increased non-significantly in Colorado between 2007-8 and 2009-10; for both groups, by 2010-11 Colorado had significantly higher prevalence of past-

year marijuana abuse/dependence than NMMS. Among other adults (26 years old or older) near daily use of marijuana became significantly more prevalent in Colorado compared to NMMS in 2009-10 and 2010-11.

4.2. Comparisons of Colorado and NMMS in 2010-11

In 2010-11, Coloradans, compared to those in NMMS, were less likely to perceive great risk to marijuana use (all age groups), more likely to report that marijuana was fairly/very easy to obtain (all age groups), were less likely to disapprove of use (young and other adults), had higher rates of marijuana use (all age groups), higher prevalence of 20+ days use in the past month (young and other adults) and higher prevalence of past-year marijuana abuse/dependence (adolescents and young adults). However, examining years 2003-4 onward also demonstrates that while these Colorado-vs.-NMMS differences may be widening, many have been present long term. For example, young adult Coloradans have long differed from NMMS young adults in marijuana availability (fairly or very easy to obtain), disapproval of marijuana use and past-year use of marijuana as shown in Figures 1.Bii, 1.C.ii and 2.A.ii.

4.3. Variables without significant change pre-post early 2009

Although we demonstrate several changes that temporally coincide with the growth of the Colorado medical marijuana industry in 2009, there are several variables that did not show significant change during this period (e.g., 12-17 year old 20+ days of use, 26+ year olds marijuana abuse/dependence prevalence).

4.4 Trends in Colorado pre-post early 2009 that deviate from patterns seen in NMMS

Our regression analyses take into account change in both Colorado and NMMS states prior to and during the time of medical marijuana commercialization. In those analyses, we also controlled for demographic factors which might differ between states and contribute to state-level differences. Those results support the notion that in Colorado changing perception of risk (12-17 year olds, $p=0.005$; those 26 years and older, $p=0.01$), availability of marijuana (those 26 years and older, $p=0.07$) and past-year marijuana use disorder prevalence (12-17 year olds, $p=0.07$), show at least trend deviation from the temporal patterns seen in NMMS.

4.5 Interpretation

These findings taken together raise the possibility that changing policies in Colorado, which were associated with increases in medical marijuana licensure in 2009 (see Supplemental Figure 2⁴), may have impacted perceived harmfulness of marijuana use. Also, it is possible that medical marijuana dispensary advertising and advocacy by groups that profess the relative safety of marijuana over alcohol may have had a measurable impact. Although direct evidence of a link to perceived-risk is lacking, between 2006-2011 SAFER tax returns listed program service expenses of more than \$240,000 to support public speaking, event booths and conferences to educate the public about the harms of alcohol and the “safer”, but illegal, drug marijuana (ProPublica, 2014). While marijuana legalization advocates may

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applaud this change in perceived harmfulness as appropriate, others may see concern that such changes will lead to worsening of marijuana use problems in Colorado.

Because we demonstrate attitudinal shifts (i.e., perception of risk) around the time of medical marijuana expansion in Colorado, a remaining question is whether those attitudinal shifts will subsequently result in strong or persistent behavioral shifts. Past work has supported that changes in perceived risk about drugs may sometimes precede change in actual use by several years (Bachman et al., 1990). We present data for only one post-2009 time period (2010-11) but as additional years of the NSDUH become available they will provide greater clarity on whether these early changes in marijuana-use-related outcomes (e.g., increase in past-year use (18-25 year olds) and recent Colorado-vs.-NMMS differences in marijuana abuse/dependence prevalence (12-17 year olds, 18-25 year olds)) represent minor year to year fluctuations in estimates or portend sustained changes.

4.6. Study strengths and limitations

The study has several strengths. We used an annually-collected survey, which can generate state-level prevalence estimates, to provide timely data on marijuana-related variables in Colorado during a period when the Colorado commercial marijuana industry experienced rapid growth. Given that youths with more serious substance involvement are less likely to attend school and more likely to drop out (Younge et al., 1996), using the NSDUH reduces a potential school-based-survey selection bias. In addition, we focused on a single state where changes in medical marijuana registration are well-documented and examined multiple age groups and multiple use and disorder phenotypes. We also assessed change pre-post growth of medical marijuana commercialization, not pre-post medical marijuana law enactment.

The study also has several limitations. First, our study cannot determine causality. For example, while some changes in perceived risk occurred around 2009, it does not mean that growth of the medical marijuana industry in Colorado was a main cause. States are not randomly assigned to a specific medical marijuana policy. It is likely states with more lenient attitudes toward marijuana are targeted for policy change. Using currently available data we cannot completely disentangle the causal direction from attitudes to policy. Second, the number of medical marijuana registry cardholders increased over the course of both 2009 and 2010. Ideally we could examine a more fine-grained temporal change in our outcomes of interest. However, the NSDUH design requires prevalence estimation using 2-year periods of data for Colorado. Third, examining years 2011-2012, 2013-14 and 2015-16 (instead of 2009-10), once those data are made available, will provide further clarity on temporal trends. However, policy positions are fluid. For example, in 2011 policy statements from the Justice Department (Grim, 2011) contradicted the earlier Ogden memo (Ogden, 2009), and in 2012, as noted earlier, Colorado voters passed Amendment 64, legalizing the recreational use of marijuana and possession of up to one ounce of marijuana for those at least 21 years of age; recreational marijuana sales in Colorado began in January 2014. Such changes would complicate interpretation of any temporal changes seen in these or subsequent years. Fourth, we conducted multiple tests using eight outcome variables and three age groups. Our results should therefore be interpreted cautiously. Lastly, the majority of Colorado's medical marijuana dispensaries are located in the Denver metropolitan area

(CDPHE). Given that some Colorado communities have banned medical marijuana dispensaries or have very few registered patients, considering Colorado as a whole may limit our ability to discern more fine-grained within-state geographic effects.

4.7. Conclusions

While the current study showed relatively consistent differences between Colorado and other states without medical marijuana laws on measures of marijuana attitudes and use-related-outcomes, results in some measures indicate the differences are widening in more recent years, especially since 2009. Those include risk perception, and trend for differences in changes in availability and abuse/dependence in some age groups, even after controlling for demographic differences. Data taken together provide suggestive evidence of diverging changes in marijuana risk perception and some use practices specific to Colorado in 2009 and after. Even though causality cannot be established, Colorado would be wise to implement prevention efforts regarding marijuana and make treatment for those with marijuana use disorders more broadly available in the state.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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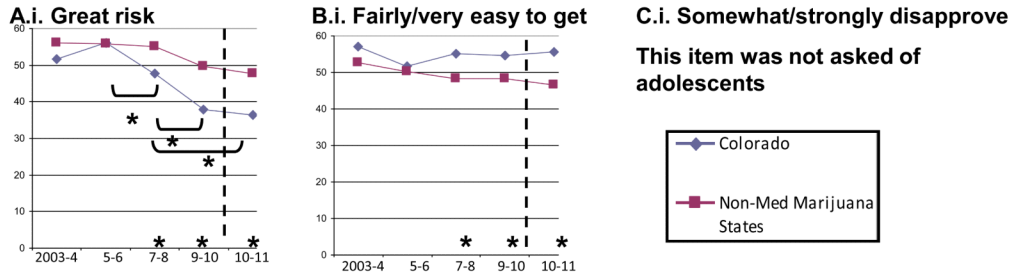
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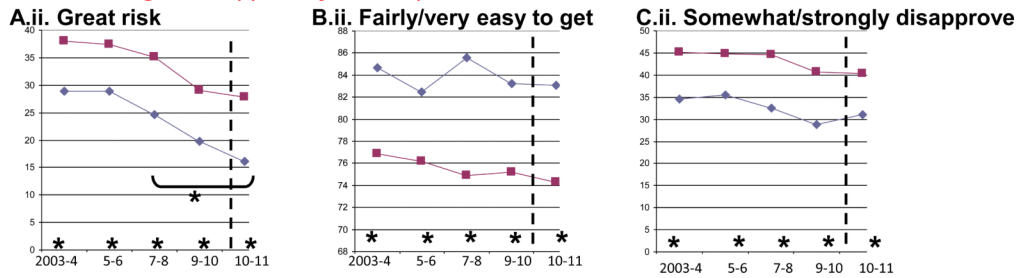
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Row 1. Adolescents (12-17 year olds)



Row 2. Young adults (18-25 year olds)



Row 3. Other adults (26+ years of age)

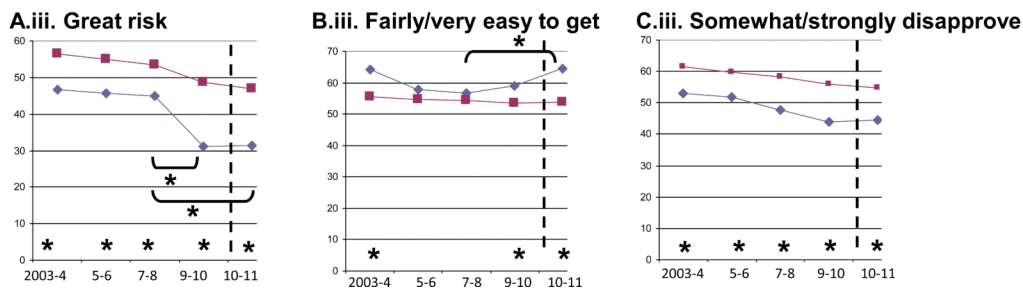


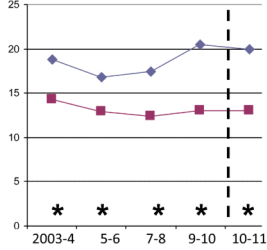
Fig. 1.

Measures of marijuana-related attitudes, change across time (2003-4 to 2010-11) within Colorado (Blue) and within 34 states without medical marijuana laws (NMMS, Red). A. Great risk to smoking marijuana 1-2 times per week. B. Fairly/very easy to obtain marijuana. C. Somewhat or strongly disapprove of adults trying.

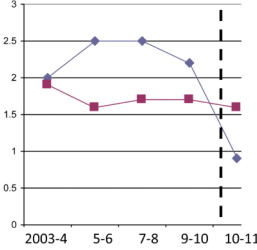
Row 1 represents 12-17 year olds, Row 2 represents 18-25 year olds and Row 3 represents those 26+ years. X-axis indicates year, while y-axis indicates percent of respondents endorsing an item. Dashed line indicates that years 2009-10 and 2010-11 are not independent. Brackets and associated asterisk(s) indicate a significant change within Colorado across years. Asterisk below lines, just above the years (x-axis) indicate that Colorado and 34 non-medical marijuana states significantly differed. * <0.05

Row 1. Adolescents (12-17 year olds)

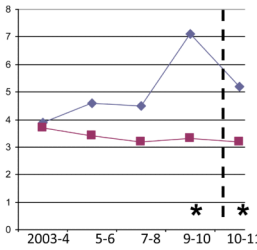
A.i. Past year use



B.i. 20+ days use

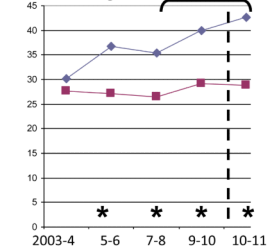


C.i. Marijuana abuse/dependence

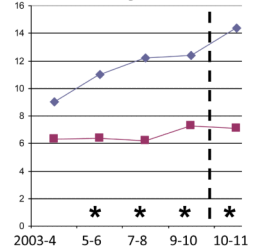


Row 2. Young adults (18-25 year olds)

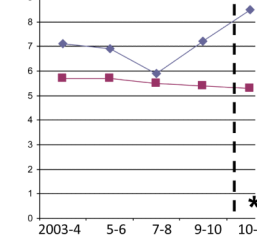
A.ii. Past year use *



B.ii. 20+ days use

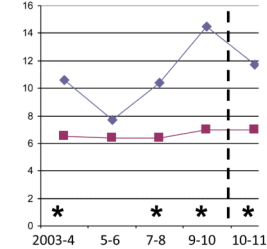


C.ii. Marijuana abuse/dependence

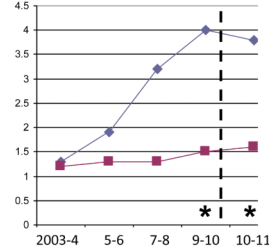


Row 3. Other adults (26+ years of age)

A.iii. Past year use



B.iii. 20+ days use



C.iii. Marijuana abuse/dependence

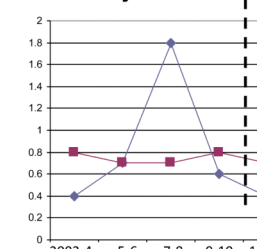
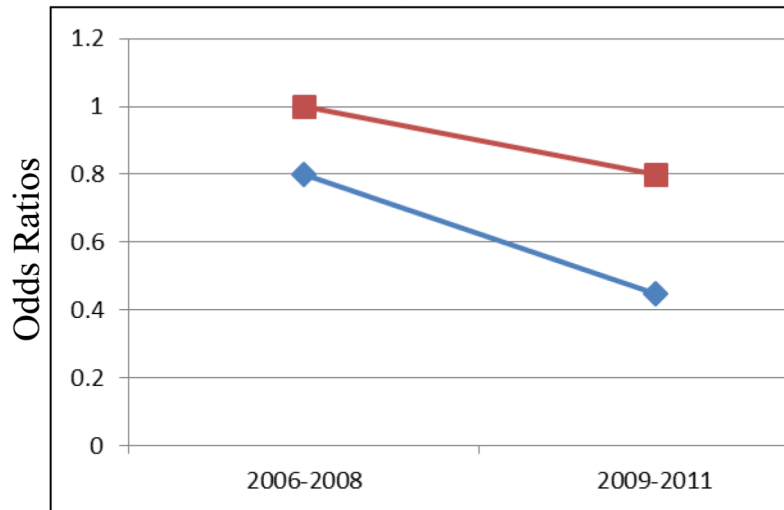


Fig. 2. Measures of marijuana-use-related outcomes, change across time (2003-4 to 2010-11) within Colorado (Blue) and within 34 states without medical marijuana laws (NMMS, Red). A. Past-year marijuana use. B. 20+ days used in the past month among users. C. Marijuana abuse/dependence in the past year. Row 1 represents 12-17 year olds, Row 2 represents 18-25 year olds and Row 3 represents those 26+ years. X-axis indicates year, while y-axis indicates percent of respondents for marijuana use, near daily use and abuse/dependence. Dashed line indicates that years 2009-10 and 2010-11 are not independent. Brackets and associated asterisk(s) indicate a significant change within-Colorado across years. Asterisk below lines, just above the years (x-axis) indicate that Colorado and 34 non-medical marijuana states significantly differed. * <0.05

Row 1. **Adolescents (12-17 year olds)** ◆ Colorado
 A. **Great-Risk (state*year interaction OR 0.72, 95% CI 0.57-0.90; p=0.005)** ■ NMMS



Row 2. **Other adults (26+ years of age)**
 B. **Great-Risk (state*year interaction OR 0.70, 95%CI 0.53-0.92; p=0.01)**

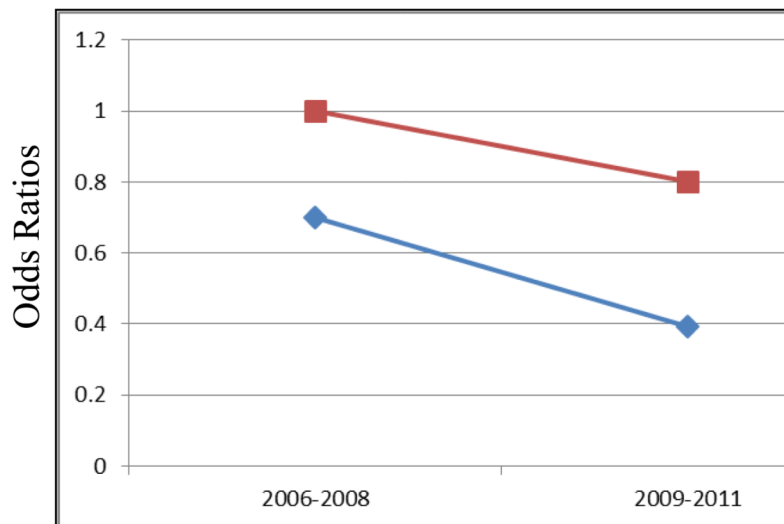


Fig. 3. Significant and trend state-by-year interactions from regression analyses (Tables 1-3) presented as odds ratios within state (NMMS and Colorado) and time (2006-8 and 2009-11). Row 1 represents 12-17 year olds, Row 2 represents those 26+ years. X-axis indicates years (2006-8 and 2009-11), while y-axis indicates odds ratios.

Table 1

Regression Analyses Among Adolescents (Ages 12 to 17) Residing in Colorado and Non-Medical Marijuana States Comparing Changes in 2006-2008 and 2009-2011 Controlling for Demographics: Odds Ratios (95% Confidence Intervals) or Beta Estimates (Standard Errors), and p-values

Independent Variable	Perceive No Risk from Using Marijuana Regularly / (Missing=1.4%)	Perceive Great Risk from Using Marijuana Regularly / (Missing=1.4%)	Fairly/Very Easy to Get Marijuana / (Missing=3.0%)	Somewhat/Strongly Disapprove of Adults Trying Marijuana /	Past Year Marijuana Use	Number of Days Used Marijuana in Past Year Among Past Year Users	20+ Days of Marijuana Use in the Past Month ²	Marijuana Abuse/Dependence in the Past Year ³
State								
Colorado	0.86 (0.59, 1.26) p=0.4418	0.82 (0.69, 0.96) p=0.0181	1.38 (1.14, 1.68) p=0.0014	N/A	1.54 (1.18, 2.00) p=0.0020	-0.1 (0.12) p=0.3053	1.53 (1.00, 2.34) p=0.0485	1.44 (1.04, 1.99) p=0.0272
NMIMS	REF	REF	REF	N/A	REF	REF	REF	REF
Year								
2006-2008	REF	REF	REF	N/A	REF	REF	REF	REF
2009-2011	1.59 (1.48, 1.71) p=0.0000	0.76 (0.73, 0.79) p=0.0000	0.93 (0.90, 0.97) p=0.0007	N/A	1.04 (0.99, 1.10) p=0.1115	0.0 (0.03) p=0.4480	0.97 (0.85, 1.10) p=0.6308	0.98 (0.90, 1.08) p=0.7076
Exact Age	1.34 (1.31, 1.37) p=0.0000	0.79 (0.78, 0.80) p=0.0000	1.78 (1.76, 1.80) p=0.0000	N/A	1.76 (1.74, 1.79) p=0.0000	0.1 (0.01) p=0.0000	2.05 (1.95, 2.14) p=0.0000	1.67 (1.62, 1.72) p=0.0000
Gender								
Male	1.85 (1.73, 1.99) p=0.0000	0.73 (0.71, 0.75) p=0.0000	0.92 (0.89, 0.95) p=0.0000	N/A	1.21 (1.15, 1.27) p=0.0000	0.3 (0.03) p=0.0000	1.84 (1.62, 2.10) p=0.0000	1.24 (1.13, 1.36) p=0.0000
Female	REF	REF	REF	N/A	REF	REF	REF	REF
Race/Ethnicity								
White	REF	REF	REF	N/A	REF	REF	REF	REF
Black	1.40 (1.28, 1.53) p=0.0000	0.62 (0.59, 0.65) p=0.0000	1.03 (0.98, 1.08) p=0.2907	N/A	0.90 (0.84, 0.97) p=0.0045	0.0 (0.04) p=0.2343	0.71 (0.59, 0.85) p=0.0005	0.83 (0.73, 0.95) p=0.0060
Hispanic	0.75 (0.62, 0.90) p=0.0022	1.10 (1.00, 1.21) p=0.0495	0.64 (0.58, 0.72) p=0.0000	N/A	0.74 (0.64, 0.85) p=0.0000	-0.2 (0.08) p=0.0599	0.63 (0.46, 0.87) p=0.0059	0.70 (0.56, 0.87) p=0.0017

Independent Variable	Outcome Variable									
	Perceive No Risk from Using Marijuana Regularly ¹ (Missing=1.4%)	Perceive Great Risk from Using Marijuana Regularly ¹ (Missing=1.4%)	Fairly/Very Easy to Get Marijuana ¹ (Missing=3.0%)	Somewhat/Strongly Disapprove of Adults Trying Marijuana ¹	Past Year Marijuana Use	Number of Days Used Marijuana in Past Year Among Past Year Users	20+ Days of Marijuana Use in the Past Month ²	Marijuana Abuse/Dependence in the Past Year ³		
Other	1.21 (1.08, 1.34) p=0.0009	0.78 (0.74, 0.82) p=0.0000	0.91 (0.85, 0.96) p=0.0017	N/A	0.99 (0.92, 1.07) p=0.8032	0.0 (0.05) p=0.7743	0.78 (0.62, 0.97) p=0.0262	1.00 (0.86, 1.15) p=0.9820		
State*Year Interaction										
Colorado, 2006-2008	REF	REF	REF	N/A	REF	REF	REF	REF		
Colorado, 2009-2011	1.90 (1.22, 2.96) p=0.0054	0.72 (0.57, 0.90) p=0.0048	1.16 (0.90, 1.48) p=0.2493	N/A	1.30 (0.95, 1.79) p=0.1020	0.0 (0.16) p=0.8254	0.70 (0.30, 1.64) p=0.4006	1.45 (0.97, 2.17) p=0.0684		
NMMS, 2006-2008	REF	REF	REF	N/A	REF	REF	REF	REF		
NMMS, 2009-2011	REF	REF	REF	N/A	REF	REF	REF	REF		

N/A: Not applicable; REF=Reference cell.

NOTE: Odds ratios (95% confidence intervals) or beta estimates (standard errors) were obtained from multiple logistic or log-linear Poisson regression models with all independent variables included as covariates.

NOTE: States without medical marijuana laws included: Alabama, Arkansas, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, Wisconsin, and Wyoming.

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2006-2010 (revised 3/12), 2011.

¹ Respondents with unknown data were excluded from model.

² Non-users were coded as using 0 days.

³ Marijuana dependence or abuse is based on definitions found in the 4th edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*.

Table 2

Regression Analyses Among Young Adults (Ages 18 to 25) Residing in Colorado and Non-Medical Marijuana States (NMMS) Comparing Changes in 2006-2008 and 2009-2011 Controlling for Demographics: Odds Ratios (95% Confidence Intervals) or Beta Estimates (Standard Errors), and p-values

Independent Variable	Outcome Variable							
	Perceive No Risk from Using Marijuana Regularly/ ¹ (Missing=0.7%)	Perceive Great Risk from Using Marijuana Regularly/ ¹ (Missing=0.7%)	Fairly/Very Easy to Get Marijuana/ ¹ (Missing=1.5%)	Somewhat/Strongly Disapprove of Adults Trying Marijuana/ ¹ (Missing=1.1%)	Past Year Marijuana Use	Number of Days Used Marijuana in Past Year Among Past Year Users	20+ Days of Marijuana Use in the Past Month ²	Marijuana Abuse/Dependence in the Past Year ³
State								
Colorado	1.80 (1.42, 2.29) p=0.0000	0.59 (0.48, 0.72) p=0.0000	2.01 (1.63, 2.49) p=0.0000	0.61 (0.50, 0.74) p=0.0000	1.63 (1.32, 2.01) p=0.0000	0.2 (0.07) p=0.0036	1.97 (1.41, 2.74) p=0.0002	1.13 (0.75, 1.70) p=0.5633
NMMS	REF	REF	REF	REF	REF	REF	REF	REF
Year								
2006-2008	REF	REF	REF	REF	REF	REF	REF	REF
2009-2011	1.78 (1.69, 1.87) p=0.0000	0.69 (0.66, 0.72) p=0.0000	0.98 (0.94, 1.02) p=0.3512	0.82 (0.79, 0.86) p=0.0000	1.14 (1.09, 1.20) p=0.0000	0.0 (0.02) p=0.3841	1.17 (1.08, 1.26) p=0.0001	0.95 (0.88, 1.03) p=0.2296
Exact Age	1.01 (1.00, 1.02) p=0.0533	0.99 (0.99, 1.00) p=0.1619	0.95 (0.94, 0.96) p=0.0000	0.94 (0.94, 0.95) p=0.0000	0.93 (0.92, 0.94) p=0.0000	0.0 (0.00) p=0.0001	0.97 (0.96, 0.99) p=0.0003	0.90 (0.89, 0.92) p=0.0000
Gender								
Male	2.15 (2.05, 2.26) p=0.0000	0.54 (0.52, 0.56) p=0.0000	1.06 (1.02, 1.11) p=0.0049	0.65 (0.63, 0.67) p=0.0000	1.58 (1.52, 1.64) p=0.0000	0.3 (0.02) p=0.0000	2.46 (2.29, 2.63) p=0.0000	2.00 (1.86, 2.16) p=0.0000
Female	REF	REF	REF	REF	REF	REF	REF	REF
Race/Ethnicity								
White	REF	REF	REF	REF	REF	REF	REF	REF
Black	1.00 (0.93, 1.06) p=0.9021	1.19 (1.13, 1.25) p=0.0000	0.75 (0.71, 0.79) p=0.0000	1.17 (1.11, 1.23) p=0.0000	0.84 (0.79, 0.89) p=0.0000	0.1 (0.02) p=0.0000	0.94 (0.85, 1.03) p=0.1853	1.18 (1.06, 1.31) p=0.0023
Hispanic	0.71 (0.62, 0.82) p=0.0000	1.59 (1.45, 1.75) p=0.0000	0.35 (0.32, 0.38) p=0.0000	1.51 (1.38, 1.65) p=0.0000	0.57 (0.51, 0.65) p=0.0000	-0.1 (0.05) p=0.0537	0.54 (0.44, 0.64) p=0.0000	0.77 (0.62, 0.95) p=0.0172

Independent Variable	Outcome Variable							
	Perceive No Risk from Using Marijuana Regularly ¹ (Missing=0.7%)	Perceive Great Risk from Using Marijuana Regularly ¹ (Missing=0.7%)	Fairly/Very Easy to Get Marijuana ¹ (Missing=1.5%)	Somewhat/Strongly Disapprove of Adults Trying Marijuana ¹ (Missing=1.1%)	Past Year Marijuana Use	Number of Days Used Marijuana in Past Year Among Past Year Users	20+ Days of Marijuana Use in the Past Month ²	Marijuana Abuse/Dependence in the Past Year ³
Other	0.64 (0.59, 0.70) p=0.0000	1.89 (1.79, 2.00) p=0.0000	0.51 (0.48, 0.54) p=0.0000	1.33 (1.26, 1.40) p=0.0000	0.58 (0.54, 0.63) p=0.0000	0.0 (0.03) p=0.9620	0.56 (0.50, 0.64) p=0.0000	0.87 (0.77, 0.99) p=0.0307
High School Diploma								
Received	0.72 (0.68, 0.77) p=0.0000	0.97 (0.92, 1.02) p=0.2840	1.50 (1.42, 1.58) p=0.0000	1.16 (1.10, 1.22) p=0.0000	0.97 (0.92, 1.02) p=0.2505	-0.3 (0.02) p=0.0000	0.69 (0.63, 0.75) p=0.0000	0.74 (0.68, 0.81) p=0.0000
Not Received	REF	REF	REF	REF	REF	REF	REF	REF
State*Year Interaction								
Colorado, 2006-2008	REF	REF	REF	REF	REF	REF	REF	REF
Colorado, 2009-2011	0.84 (0.62, 1.13) p=0.2334	0.87 (0.65, 1.15) p=0.3239	0.90 (0.68, 1.19) p=0.4453	1.06 (0.81, 1.39) p=0.6475	1.11 (0.87, 1.40) p=0.3937	0.0 (0.10) p=0.7205	1.07 (0.67, 1.70) p=0.7692	1.36 (0.83, 2.23) p=0.2112
NMIMS, 2006-2008	REF	REF	REF	REF	REF	REF	REF	REF
NMIMS, 2009-2011	REF	REF	REF	REF	REF	REF	REF	REF

REF=Reference cell.

NOTE: Odds ratios (95% confidence intervals) or beta estimates (standard errors) were obtained from multiple logistic or log-linear Poisson regression models with all independent variables included as covariates.

NOTE: States without medical marijuana laws included: Alabama, Arkansas, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, Wisconsin, and Wyoming.

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2006-2010 (revised 3/12), 2011.

¹ Respondents with unknown data were excluded from model.

² Non-users were coded as using 0 days.

³ Marijuana dependence or abuse is based on definitions found in the 4th edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*.

Table 3

Regression Analyses Among Other Adults (Ages 26 or Older) Residing in Colorado and Non-Medical Marijuana States (NMMS) Comparing Changes in 2006-2008 and 2009-2011 Controlling for Demographics: Odds Ratios (95% confidence intervals) or Beta Estimates (Standard Errors), and p-values

Independent Variable	Outcome Variable							
	Perceive No Risk from Using Marijuana Regularly/ (Missing=1.6%)	Perceive Great Risk from Using Marijuana Regularly/ (Missing=1.6%)	Fairly/Very Easy to Get Marijuana (Missing=4.5%)	Somewhat/ Strongly Disapprove of Adults Trying Marijuana (Missing=0.9%)	Past Year Marijuana Use	Number of Days Used Marijuana in Past Year Among Past Year Users	20+ Days of Marijuana Use in the Past Month ²	Marijuana Abuse/ Dependence in the Past Year ³
State								
Colorado	1.63 (1.19, 2.24) p=0.0032	0.70 (0.59, 0.83) p=0.0001	1.13 (0.95, 1.34) p=0.1493	0.66 (0.57, 0.76) p=0.0000	1.65 (1.31, 2.08) p=0.0001	0.2 (0.14) p=0.1565	2.14 (1.26, 3.63) p=0.0060	2.39 (1.08, 5.27) p=0.0314
NMMS	REF	REF	REF	REF	REF	REF	REF	REF
Year								
2006-2008	REF	REF	REF	REF	REF	REF	REF	REF
2009-2011	1.50 (1.39, 1.61) p=0.0000	0.76 (0.73, 0.79) p=0.0000	0.99 (0.95, 1.03) p=0.6852	0.85 (0.82, 0.88) p=0.0000	1.16 (1.08, 1.24) p=0.0001	0.1 (0.03) p=0.0222	1.32 (1.15, 1.50) p=0.0001	1.08 (0.91, 1.28) p=0.3917
Exact Age	0.96 (0.96, 0.97) p=0.0000	1.03 (1.03, 1.03) p=0.0000	0.97 (0.97, 0.97) p=0.0000	1.03 (1.03, 1.03) p=0.0000	0.94 (0.94, 0.94) p=0.0000	0.0 (0.00) p=0.0000	0.93 (0.93, 0.94) p=0.0000	0.93 (0.92, 0.94) p=0.0000
Gender								
Male	1.98 (1.85, 2.12) p=0.0000	0.51 (0.50, 0.53) p=0.0000	1.22 (1.18, 1.27) p=0.0000	0.68 (0.66, 0.71) p=0.0000	2.05 (1.93, 2.17) p=0.0000	0.3 (0.04) p=0.0000	2.67 (2.34, 3.05) p=0.0000	3.05 (2.53, 3.67) p=0.0000
Female	REF	REF	REF	REF	REF	REF	REF	REF
Race/Ethnicity								
White	REF	REF	REF	REF	REF	REF	REF	REF
Black	1.26 (1.14, 1.40) p=0.0000	1.25 (1.18, 1.33) p=0.0000	1.19 (1.12, 1.26) p=0.0000	1.16 (1.09, 1.23) p=0.0000	1.15 (1.05, 1.26) p=0.0047	0.1 (0.04) p=0.0010	1.09 (0.91, 1.30) p=0.3257	2.01 (1.62, 2.49) p=0.0000
Hispanic	0.85 (0.71, 1.01) p=0.0602	1.83 (1.65, 2.02) p=0.0000	0.38 (0.34, 0.42) p=0.0000	1.79 (1.61, 1.99) p=0.0000	0.54 (0.46, 0.64) p=0.0000	-0.1 (0.09) p=0.2666	0.47 (0.34, 0.65) p=0.0000	0.63 (0.40, 0.98) p=0.0394

Independent Variable	Outcome Variable							
	Perceive No Risk from Using Marijuana Regularly ¹ (Missing=1.6%)	Perceive Great Risk from Using Marijuana Regularly ¹ (Missing=1.6%)	Fairly/Very Easy to Get Marijuana ¹ (Missing=4.5%)	Somewhat/Strongly Disapprove of Adults Trying Marijuana ¹ (Missing=0.9%)	Past Year Marijuana Use	Number of Days Used Marijuana in Past Year Among Past Year Users	20+ Days of Marijuana Use in the Past Month ²	Marijuana Abuse/Dependence in the Past Year ³
Other	0.56 (0.49, 0.64) p=0.0000	2.54 (2.37, 2.71) p=0.0000	0.53 (0.50, 0.57) p=0.0000	1.64 (1.54, 1.75) p=0.0000	0.43 (0.37, 0.49) p=0.0000	-0.1 (0.07) p=0.2905	0.39 (0.30, 0.51) p=0.0000	0.41 (0.29, 0.60) p=0.0000
High School Diploma								
Received	0.68 (0.62, 0.75) p=0.0000	0.86 (0.81, 0.90) p=0.0000	1.06 (1.01, 1.12) p=0.0231	1.12 (1.06, 1.18) p=0.0001	0.66 (0.60, 0.73) p=0.0000	-0.2 (0.04) p=0.0000	0.52 (0.45, 0.61) p=0.0000	0.44 (0.36, 0.54) p=0.0000
Not Received	REF	REF	REF	REF	REF	REF	REF	REF
State*Year Interaction								
Colorado, 2006-2008	REF	REF	REF	REF	REF	REF	REF	REF
Colorado, 2009-2011	1.03 (0.67, 1.57) p=0.8949	0.70 (0.53, 0.92) p=0.0114	1.25 (0.98, 1.58) p=0.0677	1.00 (0.78, 1.29) p=0.9922	1.18 (0.79, 1.76) p=0.4220	0.0 (0.19) p=0.8653	1.10 (0.52, 2.32) p=0.8010	0.32 (0.07, 1.54) p=0.1526
NMIMS, 2006-2008	REF	REF	REF	REF	REF	REF	REF	REF
NMIMS, 2009-2011	REF	REF	REF	REF	REF	REF	REF	REF

REF=Reference cell.

NOTE: Odds ratios (95% confidence intervals) or beta estimates (standard errors) were obtained from multiple logistic or log-linear Poisson models with all independent variables included as covariates.

NOTE: States without medical marijuana laws included: Alabama, Arkansas, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, Wisconsin, and Wyoming.

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2006-2010 (revised 3/12), 2011.

¹ Respondents with unknown data were excluded from model.

² Non-users were coded as using 0 days.

³ Marijuana dependence or abuse is based on definitions found in the 4th edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*.