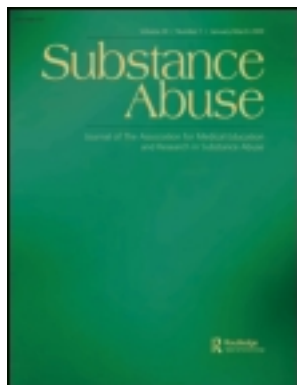


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Trends in Detection Rates of Risky Marijuana Use in Colorado Health Care Settings

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ABSTRACT. *Background:* Over the past several years, many states, including Colorado, have approved medical marijuana legislation. There is concern that increased access to and visibility of medical marijuana may lead to harmful use. *Methods:* This study examined changes in patients' marijuana use in 12 health care settings through a statewide screening, brief intervention, and referral to treatment (SBIRT) initiative. *Results:* Beginning in 2009, the odds of screening positive for risk-prone marijuana use significantly increased, coinciding with dramatic increases in use of Colorado's medical marijuana program. Young males were most likely to screen positive. Among users, there was a small, statistically significant increase in severity of use over time. *Conclusions:* Findings suggest that health care providers may be serving increasing numbers of patients using marijuana for medical or recreational purposes.

Keywords: Health care, illicit substances, marijuana use, SBIRT

INTRODUCTION

Cannabis is the most widely used illicit substance in the United States (1). According to the 2010 National Survey on Drug Use and Health (NSDUH), past-month marijuana use has steadily increased since 2007, from 5.8% to 6.9%, and the number of users increased from 14.4 million to 17.4 million (1). Nationally, rates of individuals seeking treatment for dependent marijuana use also increased by 32% between 1996 and 2006, from 91 to 120 per 100,000 population aged 12 and older (2). The National Institute on Drug Abuse (NIDA) estimates that 9% of people who use marijuana will become dependent, a risk that increases to 25% to 50% among daily users (3).

Medical marijuana is now legal in 16 states and the District of Columbia, and recent literature suggests that states

with medical marijuana laws are more likely to have higher rates of marijuana use than states without such laws (4). These findings suggest that health care providers may be encountering a substantial number of patients who are using cannabis for recreational or medical use and that these numbers may be increasing, especially in states with medical marijuana legislation. There is a dearth of studies examining associations between changes in cannabis policy, marijuana use and abuse, and impact on health care systems. In this article, we present findings from data collected as a part of a state prevention and intervention initiative to explore whether there have been changes in patterns of marijuana use among patients seeking health care in Colorado, a state that has seen dramatic changes in the marijuana landscape over the past few years.

In the November 2000 general election, Colorado passed Amendment 20, legalizing marijuana for medicinal use and appointing the Colorado Department of Public Health and Environment (CDPHE) to implement and administer the medical marijuana program (5). In 2009, the United States Department of Justice released new guidelines indicating that it would not be a priority to prosecute patients or caregivers complying with state laws on medical marijuana. This announcement is widely recognized as a key event that allowed states such as Colorado to develop the medical marijuana industry without fear of a federal consequence. Since the shift

SBIRT Colorado is a statewide initiative of the Office of the Governor, funded by Substance Abuse and Mental Health Services Administration (5U79TIO18302-02), administered by the Colorado Department of Human Services, Office of Behavioral Health, and managed by Peer Assistance Services, Inc. (www.improvinghealthcolorado.org). The authors would like to thank Dr. Fred Pampel for his consultation on the statistical analyses.

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in federal guidelines in 2009, there has been a dramatic increase in both applications for and individuals with medical marijuana cards (patients), from approximately 5000 patients in January 2009 to 121,476 as of August 2011. Moreover, in Colorado, the state Department of Revenue is responsible for licensing medical marijuana dispensaries and their data indicate that the number of dispensaries and producers in Colorado has increased from approximately 24 in January 2009 to 972 in July 2011 (6). Although these dispensaries are set up to serve patients with medically necessitated and physician-approved conditions for marijuana, local context suggest that they also market to the general population through visible advertising in local media.

The rapid growth of this industry in Colorado in recent years is accompanied by concerns that harmful use of marijuana will increase and result in negative health and other consequences. Substance use prevention research has shown that increased use of a substance is related to increased availability, decreased price, and increased advertisement (7, 8). Additionally, factors such as perception of harm and social norms have been shown to have a significant impact on individual use (7, 9). Colorado has experienced significant changes in increased access and visibility over the past few years. Furthermore, it is expected that changes in legislation reflect population level acceptance of use, indicating shifts in perception of harm and social acceptability. These factors together led us to hypothesize that Colorado will see increased use of marijuana among patients seeking health care in Colorado.

One means to explore these trends at the local level is to utilize state data available through prevention and treatment programs. Colorado has a screening, brief intervention, and referral to treatment (SBIRT Colorado) program that screens patients during health care visits to identify individuals who are engaging in harmful use of tobacco, alcohol, marijuana, and other illicit substances. Screening data from the SBIRT Colorado program present a unique opportunity to quantify the changes seen by health care professionals in the prevalence and severity of use of marijuana in the context of Colorado's rapidly changing medical marijuana industry.

The study had the following 3 aims: (1) to examine trends in rates of patients screening positive in health care settings for risk-prone patterns of marijuana use in Colorado; (2) to assess trends in severity of use at the time of screening among marijuana users; and (3) to examine the extent to which trends in use, or severity of use, differ as a function of patient gender and age. We included the third aim because research has shown that age and gender are strong predictors of use. National data indicate a higher prevalence of marijuana use among males compared with females, and for individuals aged 18–25 and 26–34 (1). It remains unknown whether changes in use in a state with a medical marijuana program will follow the same pattern. For example, two thirds of the medical marijuana card holders in Colorado are male (5), but it is unclear whether prevalence or severity of use in general is increasing to a greater degree for males than females,

or whether changes are restricted to younger adult males. Specifically, it may be that use is increasing most dramatically for young adult males who live in states with highly visible marijuana programs because they tend to use marijuana more frequently in general and now have increased access; alternatively, other groups may be increasing at a greater rate than young males due to increased normalization and social acceptance of marijuana through the medical marijuana program. Thus, this study also examined whether changes over time varied by gender and age.

METHODS

Participants and Setting

From January 2008 through August 2011, health educators screened 108,907 unduplicated patients in 12 health care sites in urban and rural locations as part of SBIRT Colorado, funded by the Substance Abuse and Mental Health Services Administration (SAMHSA). The goal of SBIRT Colorado is to implement universal screening for substance use as a standard health care practice. The 12 SBIRT Colorado health care sites included hospitals, federally qualified health centers, primary care clinics, urgent care clinics, trauma units, and one dental care clinic. Although not a representative sample of all health care settings in Colorado, the sites were chosen to include a diverse selection of health care professionals and their patients, with a focus on lower-income and under- and uninsured patients. Patients sought services for a variety of preventative, emergency, chronic, or other medical issues. Screening data from all 12 grant-funded SBIRT sites were included in this study. The mean age of patients screened was 44.2 years old (SD: 17.7; range: 18–85) and 53% were female. Over half (59.3%) of patients identified as white, 28.4% as Hispanic, and 8.7% as black. (Patients could indicate yes or no to multiple race/ethnicity categories.)

Procedures and Measures

Through standard intake procedures, patients were administered prescreen questions on substance use: 1 on current tobacco use, 3 on alcohol use developed by the National Institute on Alcohol Abuse and Alcoholism, and 1 on any illicit drug use, or misuse of prescription drugs, in the past year. When patients prescreened positive for tobacco, alcohol, or illicit drug use, health educators verbally consented patients to administer the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST version 3.0) to assess the degree of risky use across multiple substances (10). If patients indicated that they were using marijuana for medical reasons at the prescreen, health educators were also instructed to administer the ASSIST. The ASSIST was administered to patients for medical or nonmedical use because SBIRT Colorado is a federally funded initiative, and cannabis is classified as a Schedule I controlled substance, indicating that the federal government considers cannabis to have a high potential for abuse and no accepted medical use.

The ASSIST is an 8-question tool designed to be administered by a health care worker to screen for problem use of 10 substance categories, including cannabis (11, 12). On the ASSIST, patients are assigned a risk score for each substance category from 0 to 39. Patients who prescreened negative were assigned a score of 0 on the ASSIST. Questions ask about lifetime use of substances, past-90-day use, and associated consequences (e.g., "During the past 3 months, how often has your use of [FIRST DRUG, SECOND DRUG, ETC] led to health, social, legal or financial problems," with the following response options: never, once or twice, monthly, weekly, or daily/almost daily). Following classification of the World Health Organization (10), scores of 4 or higher on the Cannabis Specific Substance Involvement Scale indicate that patients are at least at moderate risk of experiencing negative consequences from their pattern of cannabis use. A score of 4 or higher on the Cannabis Specific Substance Involvement Scale indicated a positive marijuana screen. Health educators also administered the Government Performance and Results Act (GPRA) tool as part of grant funding requirements, which included patient demographic information. Data were collected through an electronic computer tablet or desktop computer and uploaded to a secure database for analysis. Patients were assigned a unique identifier to protect confidentiality.

Analytic Plan

Positive screens

Logistic regression analyses were used to examine whether the prevalence of positive marijuana screens was increasing over time, and whether trends over time varied by patient gender and/or age. The dependent variable was whether or not an individual screened positive for marijuana (1 = positive screen). The independent variables were time (month of screening), age, and gender. Month of screening was coded from 0 (January 2008) to 43 (August 2011). In order to provide for easier interpretation of the regression coefficients, month was divided by 12 so that 1 year represented 1 unit and 1 month represented 1/12 of a unit. This variable was then squared to detect any accelerations or decelerations in the odds of screening positive for marijuana over time. Age was centered around its mean (44.2) and divided by 10 so that 1 unit represented 10 years. Finally, gender was dummy coded (1 = female; 0 = male).

Severity of use

Multiple regression analyses were conducted to examine whether severity of marijuana use (i.e., scores on the ASSIST Cannabis Specific Substance Involvement Scale) among users was increasing over time, and whether any changes over time varied as a function of patient gender

and/or age. Patients with a score of 1 or higher were included in the analyses ($N = 13,340$). Because scores were positively skewed, the log base 10 of the ASSIST score served as the dependent variable. The same predictor variables that were used in the logistic regression analyses described above were used in these analyses.

For both positive screens and severity of use, a 2-step process was used. First, the time variables were entered in the model to assess whether there were changes in positive screens or severity of use over time, and whether those changes were best characterized by a linear or quadratic model. (Cubic models were also tested but results of model fitting did not suggest that cubic terms improved model fit in either the logistic or multiple regression models.) Thereafter, full models were tested in which all predictor variables and their interactions were entered simultaneously to assess whether changes over time in positive screens, or severity of use, differed as a function of age and/or gender. Significance was set to $P < .01$ because of the large sample sizes ($N = 108,907$ for probability of use; $N = 13,340$ for severity of use). All analyses were conducted using SPSS version 20 (SPSS, Chicago, IL).

RESULTS

Positive Marijuana Screens: Logistic Regression Analyses

Over the study period, 8748 patients (8.0%) screened positive for risky marijuana use (i.e., 4 or higher on the ASSIST Cannabis subscale).

Results of logistic regression analyses indicated a significant and nonlinear relationship between time and screening positive for risky marijuana use, and that a quadratic model best captured change. The model with the linear and quadratic terms was significant ($\chi^2(2, N = 108,862) = 125.2, P < .001$). Results of the full model, including a 3-way interaction between time, gender, and age, and all lower-order terms, indicated a significant 2-way interaction between age and time and a significant main effect of gender. Table 1 presents results of the final model, excluding nonsignificant terms.

TABLE 1
Logistic Regression Coefficients (Logged Odds and Odds Ratios) for Positive Marijuana Screen

| Predictor | B (SE) | OR | 95% CI for OR |
|---------------------------|---------------|---------|---------------|
| Constant | -2.262 (.048) | | |
| Month | -.284 (.057) | .753** | 0.674–0.841 |
| Month ² | .118 (.015) | 1.126** | 1.094–1.159 |
| Female | -.928 (.024) | .395** | 0.377–0.414 |
| Age | -.433 (.029) | .649** | 0.613–0.686 |
| Age by month | -.105 (.034) | .901** | 0.842–0.964 |
| Age by month ² | .033 (.009) | 1.034** | 1.016–1.052 |

** $P < .01$. $N = 108,760$.

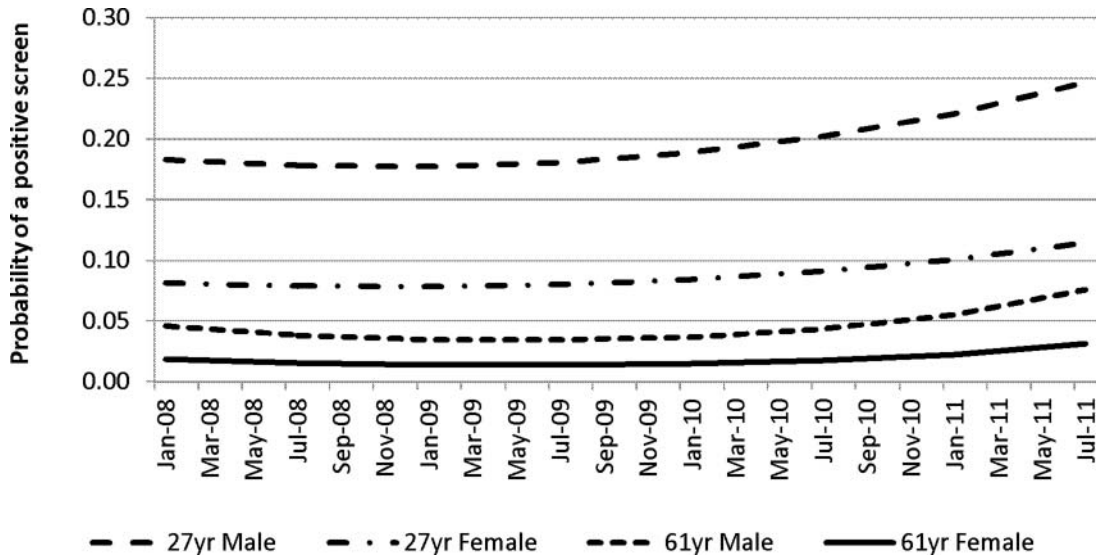


FIGURE 1 Results of logistic regression analyses predicting probability of positive marijuana screen.

At the average age, results indicated a significant nonlinear trend for the odds of screening positive for marijuana, with the odds accelerating upward in early 2009. However, the nonlinear trend differed as a function of patient age, with odds of screening positive changing more for older than younger patients. The trend in the predicted probabilities of a positive screen are graphed for younger (1 SD below the mean, about 27 years old) and older (1 SD above the mean, about 61 years old) males and females (see Figure 1). The graph illustrates that although the probability of a positive screen for older individuals almost doubled and changed at a greater rate than for younger individuals, overall probabilities remained much lower for older than younger patients in general. For example, the probability of a positive screen for a 61-year-old female changed from 1.8% to 3.1% between January 2008 and July 2011 (72% increase). The probability of a positive screen for a 27-year-old male was 18.3% in January 2008 and 24.7% in July 2011 (35% increase). Finally, we removed the interaction terms and reran the logistic regression to calculate the odds ratio for the main effects of age and gender. Controlling for time and age, the odds of a positive screen for females was 60% lower than for males; controlling for time and gender, for every 10-year increase in age, the odds of a positive screen decreased by 38%.

As mentioned, the ASSIST was administered to patients who were using marijuana for medicinal or recreational purposes. Increased rates of positive marijuana screens over time could be attributed to increases in medical marijuana use that is not considered “risky” within the context of state medical marijuana legislation (e.g., using weekly for medicinal purposes). To examine this issue further, we changed the cutoff criterion for risky use on the Cannabis subscale on the ASSIST to the one that is used for the Alcohol subscale. Specifically, scores of 11 or higher on the Alcohol subscale indicate

that patients are experiencing negative consequences from their pattern of use of a legal substance. This same criterion was applied to cannabis use and the logistic regression analysis was conducted to assess whether changes in risky use over time were similar as to what was found with the lower threshold. Using an 11 or higher on the Cannabis subscale as the criterion for a positive screen, 3531 (3.2%) patients screened positive for risky use.

Results of logistic regression analyses, using 11 or higher as the criterion for risky cannabis use, indicated a significant and nonlinear relationship between time and screening positive for marijuana use ($\chi^2(2, N = 108,862) = 71.2, P < .001$), similar to results presented above. In contrast to results presented above, the full model including a 3-way interaction between time, gender, and age, and all lower-order terms, indicated no significant interactions. Results of the final model, excluding nonsignificant terms, are presented in Table 2; Figure 2 provides a graph of the predicted probability of a positive screen over time for a 27-year-old male and a 27-year-old female, and a 61-year-old male and a 61-year-old female. Overall, results indicate that risky cannabis

TABLE 2
Logistic Regression Coefficients (Logged Odds and Odds Ratios) for Positive Marijuana Screen, Using 11 or Higher on the ASSIST

| Predictor | B (SE) | OR | 95% CI for OR |
|--------------------|---------------|---------|---------------|
| Constant | -3.464 (.060) | | |
| Month | -.094 (.069) | .910 | 0.795-1.042 |
| Month ² | .074 (.018) | 1.077** | 1.039-1.117 |
| Female | -.903 (.037) | .405** | 0.377-0.435 |
| Age | -.522 (.014) | .593** | 0.578-0.609 |

** $P < .01$. $N = 108,760$.

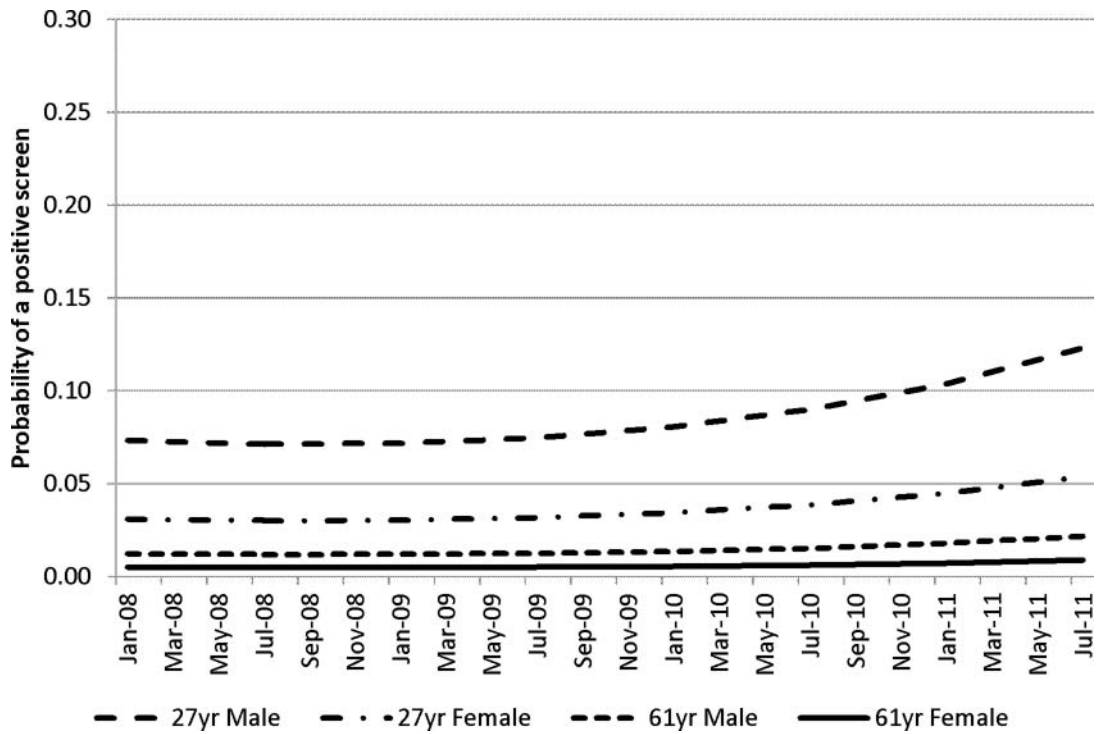


FIGURE 2 Results of logistic regression analyses predicting probability of positive marijuana screen, using 11 or higher on the ASSIST.

use increased over time beginning in July 2008; however, changes did not differ as a function of patient age, as was found when using 4 or higher as the criterion for a positive screen. Similar to the results reported above, controlling for time and age, the odds of a positive screen for females was 60% lower than for males; controlling for time and gender, for 10-year increase in age, the odds of a positive screen decreased by 40%.

Severity of Use: Multiple Regression Analyses

Among marijuana users (i.e., 1+ on the Cannabis subscale), the average score on the ASSIST Cannabis subscale was 7.5 (SD: = 6.0; range: 2–39—Note that a score of 1 on the ASSIST is unlikely for marijuana because it would only occur if someone indicated that they had injected the substance for nonmedical reasons more than 3 months ago, with no other indications of use).

Results of the multiple regression¹ indicated a significant linear relationship between time and logged severity of use among users ($F(1, 13, 338) = 63.5, P < .001$). The quadratic term was not associated with change in the outcome and

was therefore not included in any subsequent analyses. A full model was tested including the 3-level interaction term (month by gender by age), and all lower-order terms. Results of these analyses indicated significant main effects of time, age, and gender, but no significant interaction effects. Thus, all interaction terms were removed from the final model (see Table 3). Holding other predictors constant, severity of use among users increased each year by .026 points on the logged Cannabis subscale. Additionally, severity was .026 points lower with a 10-year increase in age, and was .04 points lower for females compared with males. Overall, although significant, only 1.6% of the variance in severity of use was explained by the model ($F(3, 13,324) = 73.4, P < .001$).

DISCUSSION

The current study examined whether patterns of marijuana use among patients seeking health care in Colorado were

TABLE 3
Multiple Regression Coefficients Predicting (log of) Severity of Use Among Users

| Predictor | B (SE) | 95% CI for B | Standardized beta |
|-----------|----------------|------------------|-------------------|
| Constant | .695 (.007)** | 0.682 to 0.708 | |
| Month | .026 (.003)** | 0.020 to 0.031 | .078 |
| Age | -.026 (.002)** | -0.030 to -0.021 | -.096 |
| Gender | -.040 (.006)** | -0.052 to -0.028 | -.058 |

** $P < .01. N = 13,328$.

¹To avoid having the vast majority of nonusers overwhelm the results on level of usage, we use regression only for those reporting some marijuana use. We also used zero-inflated negative binomial regression as a way to include the full sample while separating nonusage from severity of usage. Both methods give essentially the same results. However, because negative binomial regression is designed for count outcomes rather than for a scale, we report the regression results.

changing during a period that coincided with dramatic changes in the number of medical marijuana distributors and patient use of the medical marijuana program. Although the study could not directly link rates of marijuana use to changes in medical marijuana legislation, we were able to show that a period of rapid increases in access to marijuana coincided with increases in the proportion of patients screening positive for risky cannabis use in participating SBIRT Colorado health care settings. These findings suggest that Colorado's medical marijuana program may be associated with increased marijuana use.

We examined the data using 2 different definitions of risk-prone use: namely, using scoring criteria from the World Health Organization (10) for use of an illicit substance (4+), and using scoring criteria for risk-prone use of a legal substance (11+). Consistent across scoring methods, results indicated that positive marijuana screens were increasing over time. These findings, in combination with national estimates of increases in marijuana use by the general population (1), suggest that health care professionals may be encountering more patients using marijuana than previously across all age groups and gender. Further, across both scoring methods, compared with other gender and age groupings, young males were found to have the highest probabilities of a positive screen across the study period. For example, by the end of data collection, using the lower threshold for risky use, about 1 in 4 young adult males would screen positive in participating health care sites; using the higher threshold for risky use, about 1 in 8 would.

Interestingly, when using the low threshold for risky use, older patients saw greater proportional increases in the odds of a positive screen over time compared with younger patients. Changes in the odds of a positive screen over time did not differ for older and younger adults when using the higher threshold. We can only speculate on reasons for the discrepant findings. It is possible that older adults were increasing their use of marijuana to a greater degree than younger users; however, they were not experiencing negative consequences to a greater degree than younger users over time. These findings may indicate that older adults were increasing weekly or daily use of marijuana for medical purposes, whereas they did not differ from younger adults in more risk-prone use over time. It is important to note that the probability of a positive screen using both scoring methods was increasing over time for all individuals, and probabilities for older adults across the study period were very low, especially when using the higher score threshold for a positive screen.

Among users, severity of marijuana use was higher for males than females, and was higher for younger age groups. At the national level, increases in individuals seeking treatment for dependent marijuana use suggest that these trends may not be limited to Colorado, with males and individuals under the age of 30 representing the vast majority of total marijuana treatment admissions (2). Severity of use increased over time similarly for males and females and across all ages. These findings suggest that over time, a greater proportion of

patients may be engaging in risky levels of use. It is important to note that the model predicting severity of use examined only a few predictors. Other research examining associations between medical marijuana policies and marijuana use, abuse, and dependence found that associations between medical marijuana laws and marijuana abuse/dependence were explained by increases in use (4). This suggests that other factors should be considered when examining predictors of severity. For example, the literature indicates that having parents or siblings with past or current drug use or excessive drinking (13), peer drug use (13, 14, 15), poor academic performance, adolescent delinquency, stressful life events (16), and use of other illicit substances (16, 14) are all related to cannabis abuse or dependence in adulthood. Some research has also suggested that genetics may play a role in cannabis abuse or dependence (13, 16).

Universal screening provides a unique opportunity for health care providers to intervene with patients about risk-prone marijuana use. Although there remains controversy in the literature on the medical value of marijuana (17, 4) and much of the research on the adverse effects of long-term cannabis use is inconclusive (18, 19), studies have found negative health consequence from its use (20–22). Furthermore, marijuana contains similar levels of tar and more carcinogens compared with cigarettes (23–25), indicating a significant health risk with high consumption. In addition, cannabis may interact with other illicit substances as well as some prescription medications, and pharmacists and physicians may be less likely to warn against these interactions than with traditional prescription medications (26). Finally, cannabis use has been associated with injury (27) and increased risk of motor vehicle crashes (28). Given the breadth of associated impacts, many individuals may not be aware of all of the potential health risks from medical or recreational use of marijuana.

Substance use screening provides a systematic, structured approach to intervening with patients when they are misusing alcohol and drugs. Screening tools such as the ASSIST that specifically address cannabis use provide the opportunity to begin a conversation between a health care provider and a patient about use in a noncontroversial, nonjudgmental manner (10). These “teachable” moments provide the opportunity for health care providers to discuss patients’ marijuana use and provide an intervention around potential health impacts so that patients can make better informed decisions around their use, and seek treatment for dependence if needed. Research to date supports the positive impact of brief interventions on reducing marijuana use (29–32), although additional studies are needed (33).

The current study sought to utilize screening data from the SBIRT Colorado initiative to determine whether the prevalence of risky marijuana use was increasing among patients seeking health care in a state with a rapidly changing medical marijuana landscape. As many of the policy changes around medical marijuana use occurred after implementation of the SBIRT project, data were not collected on whether patients

were using marijuana for recreational or medicinal reasons, and therefore cannot distinguish across types of use. In 2011, SBIRT Colorado received a second federal award to expand its SBIRT program. The project is currently asking patients whether they have a medical marijuana card. Future data from this program will be able to separate out medical from nonmedical use. Furthermore, this study was not designed to isolate the mechanism underlying increased marijuana use. Modest, but significant, increases in marijuana use nationwide suggest that there may be multiple driving factors in rising rates of use, and separating out the impact from medical marijuana policies will be challenging. Findings cannot be generalized to other health care sites, as the initiative generally targeted underserved populations. It is also possible that the 2-phase screening procedure missed some marijuana users. For example, if patients did not indicate any tobacco, alcohol, or illicit drug use on the prescreen questions, we assumed a zero score on the ASSIST screening tool. If a patient was only using marijuana and did not consider marijuana an illicit substance, he or she would have been treated as a nonuser.

Despite the above study limitations, there is evidence that marijuana use is increasing among individuals seeking health care in Colorado and that these increases are concurrent with increasing visibility of medical marijuana in the state. More work is needed to fully understand the impact of these changes on the health care system, and on changes in use more generally. Results from this study suggest that health care providers may be serving increasing numbers of patients who use marijuana for medical or illicit purposes, and it is unlikely that these same health care providers are the ones "authorizing" marijuana for medical use. According to the Colorado Department of Public Health and Environment, about 900 of Colorado's licensed physicians have signed for patients to use marijuana for medical purposes (5). This only represents a small portion (about 5%) of the total number of licensed physicians in Colorado. Furthermore, because of federal laws, the dispensary distribution system for marijuana lacks rigorous regulations around manufacturing, distribution, and dosage typically seen with prescription drugs. Given the interactions with marijuana on other licit and illicit substances, it is important for all physicians to be aware of changing trends. Moreover, there are concerns about diversion of medical marijuana and appropriate oversight of patient use. Future research on screening protocols for patients using marijuana through state-approved medical marijuana programs is sorely needed to help health care providers address risk-prone use.

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