

THESIS

MARIJUANA USE IMPACTED BY LEGALIZATION AND INDIVIDUAL FACTORS

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Jamie E. Parnes

Department of Psychology

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Colorado State University

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Master's Committee:

Advisor: Bradley T. Conner

Ernest Chavez

Doug Coatsworth

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ABSTRACT

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In 2014, marijuana became legal for recreational use for adults 21 and older in Colorado (Colorado Const. art XVIII § 16., 2012). There are potential health risks related to marijuana dependence, which are more prominent in adolescent users (Volkow, Baler, Compton, & Weiss, 2014). Medical marijuana legalization has not been shown to increase marijuana use or prevalence of dependence (Cerdá, Wall, Keyes, Galea, & Hasin, 2012). Changes related to legalization may include increased availability and social acceptance, as well as decreased price and perceived harm of use (Hopfer, 2014). There also may be increased interest in moving to Colorado related to the changes in marijuana laws (United States Census Bureau, 2015; Institutional Research & Analysis, 2014). The facets of sensation seeking, risk seeking and experience seeking, influence marijuana use (Zuckerman, 2007; Conner & Henson, 2011). Sexual orientation has a quadratic relation to marijuana use (Ford & Jasinski, 2006). Use among bisexuals is higher than use at either end of the spectrum (Eisenberg & Wechsler, 2003). Based on these findings, several hypotheses were made. First, marijuana use would increase in college students after legalization, however just for those 21 and older. Next, risk seeking and experience seeking would both uniquely moderate marijuana use before and after legalization and in underage and of-age students. Third, sexual orientation would have a quadratic relation with marijuana use. Finally, the relation between the influence of marijuana legislation on non-residents decisions to attend a Colorado college and marijuana use was examined. Data was collected from undergraduate students ($N = 5241$) at a Colorado university. Participants were

assessed for marijuana use behavior, sensation seeking, sexual orientation, and influence of marijuana laws on non-resident decision to attend Colorado schools. Pearson's Chi-square, analysis of variance, negative binomial regressions, and polyserial correlations were used to test the hypotheses. Results indicated that marijuana use has increased since legalization for all students, but moreso for those over 21 ($p < .001$). No differences in frequency of past month use was found between pre and post legalization ($p = .615$). Regression analysis found experience seeking to be a significant predictor of past 30 day use ($p < .05$). Additionally, risk seeking predicted use for those under 21 ($p < .01$). A quadratic relation was found between sexual orientation and past month use, where use increased at a decreasing rate from the homosexual end of the spectrum to the heterosexual end ($p < .01$). Correlations were found between degree of marijuana law influence and both past 30 and lifetime use among non-resident college students ($\rho = 0.29, p < .001$; $\rho = 0.17, p < .001$). Overall, legalization, experience seeking, underage risk seeking, sexual orientation, and legislation influence on decision making all predicted marijuana use. These findings may help inform other states considering legalization of potential outcomes and groups at higher risk of marijuana use. Future research should examine longer term effects of legalization, as well as effective interventions.

TABLE OF CONTENTS

ABSTRACT.....	ii
INTRODUCTION.....	1
MARIJUANA’S HARMS AND BENEFITS.....	1
MARIJUANA’S HISTORY IN COLORADO.....	3
MARIJUANA LEGALIZATION IMPLICATIONS.....	4
INDIVIDUAL FACTORS.....	8
HYPOTHESES.....	10
METHODS.....	12
PARTICIPANTS AND PROCEDURES.....	12
MEASURES.....	12
ANALYSIS.....	13
RESULTS.....	17
DISCUSSION.....	20
TABLES.....	27
FIGURES.....	29
REFERENCES.....	30

INTRODUCTION

While it is federally illegal and prohibited by most states to possess marijuana, it is the most widely used illegal substance in the United States of America (Substance Abuse and Mental Health Services Administration, 2014). Marijuana was federally outlawed in 1937 and remained criminal in all states until 1973, when Oregon decriminalized minor possession, reducing the offense from a crime to a violation (National Organization for the Reform of Marijuana Laws, 1997). Many states followed, and presently 18 states have decriminalized laws in effect. Starting with California in 1996, states began recognizing potential therapeutic benefits of marijuana and legalizing its use for patients with certain medical conditions (National Conference of State Legislatures, 2015). Currently, 25 states and Washington D.C. have passed legislation permitting marijuana use for various medical conditions. In 2012, Colorado and Washington passed laws ending prohibition of recreational marijuana use for adults, becoming the first states to legalize casual use of the drug since 1937 (Hopfer, 2014). Since recreational marijuana legalization has only recently been implemented, there is a lack of research on the implications and outcomes of this policy change.

Marijuana's Benefits and Harms

Studies on the medicinal properties of marijuana have implicated the effects as helpful in treating glaucoma, nausea, vomiting, chronic pain, inflammation, epilepsy, multiple sclerosis and more (Volkow, Baler, Compton, & Weiss, 2014). Additionally, marijuana use has been shown to help increase appetite, positive mood, and promote weight gain in individuals with cancer, AIDS and other wasting syndromes (Machado Rocha, Stéfano, De Cássia Haiek, Rosa Oliveira, & Da Silveira, 2008; Volkow et al., 2014). Recreational marijuana users report reasons for use

including the subjective effects of relaxation, stress reduction, reflection and introspection, euphoria, socialization, aphrodisiac properties, and general enjoyment of life and activities (Osborne & Fogel, 2008).

However, not all users have favorable outcomes from marijuana use. Some find use of the substance to help alleviate anxiety, but approximately 20-30% of users experiences increased anxiety, fear, or panic (Sachs et al., 1994). Other negative acute effects include impaired memory and judgement, impaired coordination, increased likelihood of engaging in risky behaviors, and increased risk of accidents while driving (Volkow et al., 2014). Additionally, approximately 9% of individuals who try marijuana will form a dependency on the drug. Long-term marijuana use has been linked to several negative consequences. Smoking marijuana has a deleterious impact on the user's airways and lungs (Volkow et al., 2014). There is also a correlational between heavy marijuana use and anxiety and mood disorders, though no causal pathway has been established. Those who become dependent upon marijuana may experience withdrawal symptoms that can last from days to weeks, including irritability, depression, craving, appetite changes, and difficulty sleeping when abstinent (Budney, Roffman, Stephens, & Walker, 2007).

The risks and harms of dependency are accentuated in adolescents (Volkow et al., 2014). Regular marijuana use in adolescents has been linked to cognitive impairments and brain development deficiencies, which may influence IQ declines. Frequent adolescent marijuana use is also correlated with lower grades, increased school drop-out rates, delinquency, and lower educational and vocational goals (Budney et al., 2007; Volkow et al., 2014). Approximately half of individuals that seek treatment for marijuana use disorder are 25 or younger. With the stakes even higher for adolescents who use, the implications of marijuana legalization are particularly important for this age group.

Approximately 35% of incoming college freshman have used marijuana (Pinchevsky et al., 2013; Suerken et al., 2015). Almost 74% of non-users will be offered marijuana while in college, with 25% of non-users initiating use during this time (Pinchevsky et al., 2013). By the end of college, around 47% of students have tried marijuana. The decision to try marijuana was influenced by marijuana-using peers, prior drug use, and low parental monitoring. Protective factors included religiosity, low spending money, continuous off-campus residence, and parental monitoring (Pinchevsky et al., 2013; Suerken et al., 2015).

Marijuana's History in Colorado

In 2000, Colorado passed legislation permitting marijuana use for individuals with certain medical conditions (Schuermeyer et al., 2014). Between 2001 and 2009, less than 5000 people registered for medical marijuana use cards. In 2009, several changes occurred that sparked growth in the use of medicinal marijuana. First, the federal government, which still bans all forms of marijuana, stated it would end federal enforcement of its prohibition on state-legal medical use. The United States Justice Department reinforced that position by barring federal resources from use in prosecuting medical marijuana dispensaries and patients that were abiding by state laws. Finally, rulings in a Denver District Court expanded the definition of “caregiver” to anyone that provides medical marijuana to a patient, not only those that provide additional care such as doctors. This change made it easier for dispensaries to provide marijuana to patients, in turn, allowing more dispensaries to open. By the end of 2010, over 116,000 Coloradans had obtained medical marijuana cards (Colorado Department of Public Health & Environment, 2010). This increase is indicative of and reflected in a general cultural attitude of acceptance toward medical marijuana use, and likely marijuana use as a whole, in Colorado. Though not all

Coloradans were in support of marijuana, cities, like Fort Collins, that attempted to ban medical marijuana quickly repealed these policies at voter's behest (Contrain, 2015).

Changes in marijuana use perceptions occurring between the year periods of 2007-2008 to 2010-2011 showed a significant decrease in perceived risk of use in both adolescents 12 to 17 and adults over 26 years old (Schuermeyer et al., 2014). There was also a significant increase in perceived availability for those 26 and older. Likely related to these changes, researchers also noted a significantly higher marijuana dependence rate of around 9% in those 18 to 25 years old, compared to the national average of approximately 5%.

Nationally, marijuana use in 18 to 25 year olds remained relatively stable from 2011 to 2013 at approximately 31% of these young adults having used in the past year, and approximately 19% in the past month (Substance Abuse and Mental Health Services Administration, 2014). In Colorado, from 2011 to 2012, approximately 39% of that same age group had used marijuana in the past year, and approximately 27% in the past month. From 2012 to 2013, that had increased to roughly 42% and 29%, respectively. This higher-than-average use is also suggestive of a culture in Colorado that is more accepting of both recreational and medicinal marijuana use.

Marijuana Legalization Implications

Support for marijuana legalization culminated in creating legislation, passed in 2012 and enacted in 2014, permitting recreational use of marijuana by adults 21 years of age and older (Colorado Const. art XVIII § 16., 2012). Since this was the first instance of legalization of recreational marijuana in the United States, the implications of such a policy are generally unknown, however it is likely that legal recreational use may increase availability of marijuana

to those of legal purchasing age, and likely those under legal purchasing age as well (Hopfer, 2014).

One way to predict the impact of legalizing recreational use of marijuana is to examine the outcomes of implementing medical marijuana. Typically, states with medical marijuana laws tend to report higher rates of marijuana use than those without similar legislation (Cerdá, Wall, Keyes, Galea, & Hasin, 2012). Despite higher overall rates of use, Cerdá et al (2012) found prevalence of marijuana use disorders in those 12 years and older was equal across states with and without legal medical marijuana. Additionally, prior to and after enacting medical marijuana legislation, there were no differences found in prevalence or frequency of adolescent use (Lynne-Landsman, Livingston, & Wagenaar, 2013). This study also replicated the finding that states permitting medical marijuana use had higher overall use both before and after enacting laws than those without medical marijuana. Even though there is a higher prevalence of dependence in Coloradan adolescents, previous findings suggest that rate will remain constant even with new legislation.

Another way to predict consequences of recreational legalization is to look at self-reported intentions of use. When surveying high school seniors in Washington and Colorado prior to legalization, Palamar, Ompad, & Petkova (2014) found that the vast majority of marijuana users stated they would continue to use the same amount, and about 10% of non-users stated they would try marijuana once if the drug became legal. A minority (18%) of users reported an intention to increase use, which was correlated with more recent marijuana use. Other risk factors for increased use consisted of being white, male, or cigarette smokers, while protective factors included peer group disapproval of marijuana use. These risk factors are similar to reasons found for current college student initiation of marijuana use: being male,

white, and having other marijuana using peers (Pinchevsky et al., 2013). It was unclear, however, if this survey stated that marijuana use would be legal for their age group, or only adults, such as the current laws in Colorado. These survey results highlight a potential risk associated with legalization, increased use among adolescents for whom marijuana use would remain illegal, and also target groups for interventions.

Hopfer (2014) predicted several other potential changes due to legalization. Along with potential increases in use due to increased availability and social acceptance, a legal market may increase competition and subsequently decrease prices. High alcohol prices have negatively correlated with alcohol use and related adverse consequences, particularly in adolescents (Chaloupka, Grossman, & Saffer, 2002). Surveys of Colorado recreational dispensaries have found decreasing prices from fall 2014 to spring 2015 (Chin, 2015). These marijuana price declines could make the drug more accessible, especially to adolescents, and therefore increase use. Additionally, new marijuana products and forms, such as novel edible forms and portable vaporizers, may increase interest in use (Hopfer, 2014). All of these influences may impact adolescent marijuana use post-legalization.

Another potential trend that may impact prevalence of marijuana use is changes in the Colorado population. From 2010 to 2014, Colorado saw an increase in number of residents (United States Census Bureau, 2015). Additionally, since the beginning of 2014, a higher number of people have been visiting Colorado (Surry, 2014). This influx may be related to the medical and recreational marijuana legislation, though its exact cause is unknown. Newspapers have anecdotal reports of families moving to Colorado in order to provide medical marijuana to ailing family members (e.g., Flener, 2015). If people moving to Colorado are doing so for legal marijuana, this may result in an increased prevalence of marijuana users.

State colleges, such as Colorado State University and University of Colorado Boulder, have received a relatively constant number of applications from Colorado residents, however have been receiving increasing numbers of non-resident applications (P. Lehene-Singh, personal communication, May 12, 2015; Institutional Research & Analysis, 2014). From 2010 to 2014, Colorado State University in-state applications fluctuated between 8,419 and 9,289. However, out-of-state applications increased from 6,385 to 9,021 from 2010 to 2013, then dropped to 8,248 in 2014. Similarly, from 2010 to 2011, Boulder's in-state applications dropped from 8,117 to 7,191, then increased to 7,923 by 2014. More strikingly, Boulder non-resident applications steadily increased from 13,012 to 20,929 during that same time period. Colorado State University and University of Colorado Boulder have also admitted increasing numbers of non-resident students over the past several years (Institutional Research, 2014; Institutional Research & Analysis, 2014). Though the cause of this shift is also unknown, it may be influenced by additional interest in Colorado schools by out-of-state marijuana users. This may be especially pertinent for those in states with more restrictive marijuana laws and limited access. If this is the case, there may be a rise in marijuana use among college students due to a change in the student body, not because of changes in attitudes among Colorado residents.

Based on the findings of the aforementioned studies and projections, there may be several different implications of legalizing recreational marijuana. The pattern of increasing use will likely continue as marijuana becomes more easily accessible, socially acceptable, less costly and perceived as less harmful. More adolescents report intentions to try marijuana if recreationally legal (Palamar et al., 2014), while those in states who have legalized medical marijuana do not seem to follow this trend. Though price decreases might increase accessibility to young adults, it may be mitigated by the 28% tax placed on recreational marijuana (Colorado Department of

Revenue, 2015). Additionally, novel forms of use may tempt adolescents to try, continue using, or increase use of marijuana products. Finally, an influx of marijuana users, especially to universities, may result in an increase in use, both as a whole, and due to more marijuana using peers. However, increased use outcomes may be diminished by preemptive intervention programs, especially those targeted at high risk groups. As increases in adolescent use are a common concern (Pew Research Center, 2014), intervention programs are a likely preventative measure. With so many influencing factors, the exact outcome of legalization on adolescent marijuana use is difficult to predict.

Individual Factors

One factor that may increase the prevalence of marijuana use is the personality trait of sensation seeking. Sensation seeking has been linked to engagement in many health risk behaviors, including drug use (Zuckerman, 2007). Those high in sensation seeking were the most likely to move from legal to illegal drug use, particularly marijuana, as well as engaging in other illegal activity. Additionally, having peers high in sensation seeking is related to increased marijuana use, possibly due to seeking out peers with similar levels of sensation seeking (Donohew, Clayton, Skinner, & Colon, 1999).

Sensation seeking can be broken down into two subcomponents: experience seeking and risk seeking (Conner & Henson, 2011). Experience seeking is the desire for novel sensations and experiences. Risk seeking is the desire to engage in dangerous, illegal, or potentially harmful activities. Individuals may have similar or differing ratings on each of these subsets. Both of these components of sensation seeking can moderate marijuana use. However, legalization of marijuana may influence each of these constructs differently. Now that recreational marijuana use is a more readily available experience for those over 21, as the risk of engaging in use has

diminished and accessibility has increased, those high in experience seeking may choose to initiate marijuana use. For those under 21, there will likely be no change in the predictive nature of experience seeking since the accessibility of the experience has not changed. Conversely, risk seeking will likely remain a significant predictor of underage marijuana use since this remains a prohibited activity for those individuals. However, for those of legal age, risk seeking will likely no longer be a significant predictor of marijuana use as this behavior has become less risky for those individuals.

Another personal factor that influences marijuana use is sexual orientation. Sexual orientation can be measured categorically (heterosexual, bisexual, or homosexual) (e.g., Ford & Jasinski, 2006) or on a continuum, from exclusively heterosexual to exclusively homosexual (e.g., McCabe, Hughes, Bostwick, & Boyd, 2005; Trocki, Drabble, & Midanik, 2009). Measuring sexual orientation on a continuum is more sensitive to differences than categorical measures, so is often preferred (Korchmaros, Powell, & Stevens, 2013). Research has found that sexual orientation has a moderating effect on marijuana use. People that identify as bisexuals, or toward the center of the continuum, are more likely to use marijuana than those who identify as heterosexual or homosexual (Ford & Jasinski, 2006). Some findings also show gay men reporting higher in marijuana use than heterosexual men (Trocki et al., 2009). Other research has found that any non-heterosexual individual, especially bisexual females, report higher marijuana use (Corliss et al., 2010; Eisenberg & Wechsler, 2003). Though findings have been inconsistent, there has been a consistent quadratic relation between sexual orientation and marijuana use, with potentially higher use on the homosexual end of the spectrum than on the heterosexual end, but a pronouncedly higher amount of use at the bisexual center of the continuum. This may be because bisexual and homosexual individuals may be more open to experiences, as evidenced by more

sexual exploration and experimentation (Eisenberg & Wechsler, 2003). It may also be influenced by difficulty coping with emotions related to confusion, non-acceptance, not fitting in, social discrimination, homophobia, and the associated depression and anxiety, which is related to an increased risk of substance use. (Eisenberg & Wechsler, 2003). This may be exceptionally pronounced for bisexuals as they may face biphobia from both heterosexual and homosexual counterparts (Mulick & Wright, 2011). Though these individual and social factors may be present with or without marijuana legalization, changing social values toward marijuana use may alter the nature of the relation between sexual orientation and use. For example, heterosexual individuals may be more likely to use marijuana for coping, experimentation or otherwise, as acceptability perceptions have increased. This could equalize the relation between homosexual and heterosexual marijuana use.

Hypotheses

Based on past research, several hypotheses were made. First, marijuana legalization would be related to an overall increase in marijuana use in college students. When broken down by age, I hypothesized that underage students would show no statistically significant change in overall use. Conversely, over-age students would show an increase in use. On the facets of sensation seeking, experience seeking and risk seeking would moderate the relation between marijuana use and age. After legalization, experience seeking would be related to an increase in marijuana initiation among those 21 and over, but would not be a significant predictor of use in those under 21. Conversely, risk seeking would be a significant predictor of marijuana use in underage students both before and after legalization, however, risk seeking would only be a significant predictor of use for those of age prior to legalization. Next, sexual orientation would have a moderating effect on marijuana use. It would maintain a quadratic relation overall,

however, prior to legalization there would be significant differences between heterosexuals and homosexuals in marijuana use, but after legalization, there would be no significant differences between use in these two groups. Finally, the relation between the influence of marijuana legislation on out-of-state student's decision to attend a Colorado university and their marijuana use was examined.

METHODS

Participants and Procedures

Undergraduate college students ($N = 5241$) completed a survey as part of a study on personality and health behaviors. Participants were between the ages 18 to 58. They received research credits in exchange for participating in the survey. Demographic and descriptive information are presented in Table 1. Participants were recruited from introductory and research methods psychology courses. However, the majority were from the former which has students from various majors. The survey was completed either online or in a computer lab on a personal computer where privacy was ensured in order to help participants feel comfortable responding honestly. Data was collected from the beginning of 2013 to the end of 2015.

Measures

Marijuana use was assessed by self-report as a part of the Risky Behavior Inventory (RBI; Conner & Henson, 2013). The RBI asked participants about engagement in a variety of health-risk behaviors. Marijuana use was measured by asking participants if they had ever used it (46.3%), and, if so, age of initiation ($M = 16.13$, $SD = 1.92$), past 30 day use ($M = 10.14$, $SD = 18.85$), and lifetime use ($M = 523.02$, $SD = 1783.95$). Participants were also asked if they were an out-of-state student (not a resident of Colorado prior to attending college here, 27.9%). If they were, they were asked how much the marijuana laws influenced their decision to attend school in Colorado. This item was a 5-point Likert scale, ranging from “not at all” to “it’s the reason I came” ($M = 1.38$, $SD = 0.77$). This item was included starting in fall 2014 and therefore has limited responses ($n = 609$).

Sexual orientation was measured using a 7-point Likert scale, ranging from 1, gay/lesbian, to 7, heterosexual ($M = 6.60$, $SD = 1.12$). This scale was based on Kinsey's scale, ranging from 0-6, which is more sensitive than categorical or dichotomous measures of sexual orientation and preferred by participants (Kinsey, Pomeroy, & Martin, 1948; Drucker, 2012; Korchmaros, Powell, & Stevens, 2013). Participants were also asked to report their sexual orientation in a text entry field. This was to both allow participants to self-identify, as well as provide a comparison for their numerical response.

Sensation seeking was measured using the Sensation Seeking Personality Type (SSPT) scale (Conner & Henson, 2011). The inventory included 14 items measuring two different aspects of sensation seeking: risk seeking (9 items, Cronbach's alpha = .85, $M = 25.45$, $SD = 6.14$) and experience seeking (5 items, Cronbach's alpha = .77, $M = 19.06$, $SD = 3.22$). Participants were asked to rate on a 5-point Likert-style scale, ranging from "strongly disagree" to "strongly agree", items that are a latent trait assessment of these constructs (e.g., "I do things other people think are dangerous").

Analysis

Participant data that failed to include a completed SSPT and relevant RBI sections were removed ($n = 92$). Additionally, participants identified as duplicates, responding randomly, or under 18 years old were removed ($n = 335$). Final participant sample size was $N = 5421$. Little's Missing Completely at Random (MCAR) test was run to determine if any statistically significant differences exist between the responses missing data and those fully completed. Participant marijuana use responses that were significant outliers (e.g., 1,000,000) were transformed to the highest "reasonable value". This value was determined by examining natural cutoffs in responses and concluding what a realistic maximum value may be. For past 30-day use, 23 responses were

transformed down to 100 times. For lifetime use, 38 responses were transformed down to 10,000 times. Marijuana use frequency responses unable to be quantified (e.g., “a lot”, “many times”) were removed ($n = 74$). Additionally, since sexual orientation was assessed using both a self-report and scale measure, responses were analyzed for discrepancies. As the open text field likely caused less confusion than the numerical scale, these responses were relied on when verifying numerical responses. Participants indicating opposing scores ($n = 265$) had their numerical score reversed (e.g., reporting “straight” and 1 was changed to 7, 2 to a 6, etc.).

A Pearson’s χ^2 test was used to examine potential differences in reported marijuana use between those who took the survey in lab versus those who took it online. Comparisons were made on “having ever used marijuana” and “pre/post legalization status”. Using this analysis helped determine if differences exist in likelihood of reporting marijuana use based on testing setting, assessing potential validity concerns. This test was appropriate due to the non-parametric data and its ability to compare populations.

Another χ^2 test was used to explore the relation of underage and of-age marijuana use in college students prior to and after legalization. This test is appropriate for non-parametric data analysis and determines if the populations before and after are equivalent. An analysis of variance (ANOVA) was conducted testing the effects of age (divided into under 21 and at least 21) and pre- and post-legalization use on past 30-day use, as well as the interaction between age group and time period.

The moderating effect of sensation seeking was tested using negative binomial regression, estimating confidence intervals using bootstrapping. Negative binomial regression is appropriate for count data, such as past 30 day marijuana use, when the variance is greater than the mean, as found here. Since there was a significant amount of nonusers, there were an excess

of “0” responses. While a zero-inflated model is sometimes recommended to correct for the additional zeros (e.g. Atkins & Gallop, 2007), that the zero-inflated model does not statistically increase model fit unless “0” responses are the overwhelming majority (Allison, 2012). Each facet of sensation seeking, risking seeking and experience seeking, was tested separately. This was further broken down into pre- and post-legalization and age, divided again into below or above legal age of use. Each of these separate groups was then regressed on past 30 day use to determine relations among the variables.

The moderating effects of sexual orientation was also tested using a negative binomial regression. The continuous numerical sexual orientation score was regressed on past 30 day use to examine the relation. Since it was hypothesized that sexual orientation would have a quadratic relation with past 30 day and lifetime marijuana use, a quadratic sexual orientation term was also created by squaring the sexual orientation numerical score. The squared sexual orientation term was regressed on past 30 day use to assess for the quadratic relation.

Finally, two polyserial correlations were calculated. The first one was between scores from non-resident student’s decision to attend schools in Colorado due to the marijuana laws and past 30 day use. The second was calculated between the non-resident scores and lifetime marijuana use. A polyserial correlation was appropriate for this analysis as it can calculate the relation between count and continuous data.

G*Power 3.1 (Faul, Erdfelder, Buchner & Lang, 2009), a power analysis program, was used a priori to estimate the number of participants needed for each analysis. All power analyses were based on a medium effect size (Cohen, 1969), two-tailed with an alpha level of .05, and a power level of .95. Additional specifications are noted with each analysis. The power analysis conducted for the Chi-square indicated that 145 participants were needed for that analysis, based

on 1 degree of freedom. The negative binomial regressions were required to have 89 participants, based on 10 predictors. Finally, the polyserial correlation was estimated using a bivariate correlation model, resulting in 138 needed participants. Alpha was set to 0.05 for all analyses.

RESULTS

MCAR analysis of SSPT items, sex, sexual orientation, and having ever used marijuana showed no significant differences between responses and missing data ($p = .655$).

χ^2 indicated a significant difference between the number of people reporting marijuana use in a lab setting versus online ($\chi^2 = 20.87, df = 1, p < .001$). Overall, 52.5% of people in lab and 46.0% of people online reported having ever used marijuana. When broken down by pre- and post-legalization, this pattern held, with a greater proportion of people in lab reporting marijuana use ($\chi^2 = 20.17, df = 1, p < .001$; $\chi^2 = 10.53, df = 1, p < .001$).

χ^2 analysis comparing the percent of participants reporting having tried marijuana pre- and post-legalization, by those over and under 21 years of age, found significant differences in use by age group. Overall, prior to legalization 43.5% of participants reported having tried marijuana, however after legalization, 53.6% reported having tried marijuana ($\chi^2 = 50.64, df = 1, p < .001$). For those under 21 years, 43.7% reported having tried marijuana pre-legalization, and 52.6% post-legalization ($\chi^2 = 35.63, df = 1, p < .001$). The 40.0% of participants over 21 reported having tried marijuana before legalization increased to 60.9% after legalization ($\chi^2 = 15.45, df = 1, p < .001$). These results support the hypothesis that marijuana initiation would increase after legalization. However, they are contrary to the hypothesis that use would only increase for those 21 and older.

The ANOVA found mixed results in differences in past 30 day use by age and legal status. There was a significant effect on 30 day use by age, wherein individuals of legal age ($M = 13.51, SD = 23.70$) reported significantly higher 30 day use compared to those underage ($M = 9.71, SD = 18.91$), $F(1,2399) = 5.867, MSE = 354.05, p < .05$. However, there was no difference

pre- or post-legalization (pre- $M = 12.00$, $SD = 44.47$; post- $M = 11.21$, $SD = 26.91$) in past 30-day use $F(1,2399) = .254$, $MSE = 354.05$, $p = .615$. Additionally, the interaction between pre/post status and legal age was nonsignificant, $F(1,2399) = .417$, $MSE = 354.05$, $p = .519$.

The negative binomial regression testing the relations between sensation seeking, age, legal status, and past 30 day use was significant ($\chi^2 = 337.77$, $df = 8$, $p < .001$). There were significant direct effects as well as interactions (see Table 2). Being underage was a significant predictor of decreased past 30 days marijuana use compared to those overage. Experience seeking significantly negatively predicted marijuana use overall. The hypothesis that experience seeking predicts use in those over 21 after legalization was not upheld, as the interaction was not significant. There was a significant interaction between being underage and risk seeking, wherein being both underage and high on risk seeking predicted increased past 30 day use. This supports the hypothesis that risk seeking would most strongly predict use in those under 21 after legalization.

The negative binomial regression examining sexual orientation (SO), past 30 day use, and pre/post status, including a quadratic sexual orientation (SO^2) term was significant ($\chi^2 = 30.128$, $df = 5$, $p < .001$). The results indicated significant direct effects of both sexual orientation and the quadratic term (see Table 3). However, pre/post status ($p = .597$) and the related interaction terms (SO interaction $p = .545$; SO^2 interaction $p = .561$) were not significant. This was contrary to the hypothesis that use would change after legalization. The direct effect of the SO^2 term indicates a curvilinear relation between sexual orientation and past 30 day marijuana use, as hypothesized (Figure 1). Graphed results indicated that exclusively homosexual and exclusively heterosexual individuals are predicted to use less marijuana than bisexual individuals. Past 30 day use was greatest among bisexual individuals, however use only mildly decreased when

moving to either end of the continuum. The nature of the relation does support the hypothesis that bisexual individuals would report the most use.

Lastly, polyserial correlations examining the influence of marijuana laws on out-of-state student's ($n = 609$) decision to attend a Colorado university and their marijuana use revealed a significant relation between the two variables. Reported influence of marijuana laws was significantly positively correlated with past 30 day use ($\rho = 0.29, p < .001$) and with lifetime use ($\rho = 0.17, p < .001$).

DISCUSSION

The present study examined the influence of marijuana legalization, age, sensation seeking, and sexual orientation on marijuana use. It is one of the first to study the effect of marijuana legalization on marijuana use, and the first to explore these relations in the context of these individual differences. Results indicated a significant increase in the number of people having tried marijuana after it became legal, as hypothesized. However, the hypothesis that initiation would only increase for those of legal age was not supported. While there was an increase in marijuana initiation among those over 21, as predicted, initiation also increased for those under 21, though by a lesser amount. This is not consistent with the findings from studies examining the impact of legalizing medical marijuana on marijuana use (e.g. Cerdá et al, 2012). This likely indicates different patterns of initiation associated with legalization of recreational use compared to legalization of medical use.

Another important factor to consider is frequency of marijuana use. Those 21 and older reported significantly higher frequency of past month use on average compared to those underage. However, when comparing pre/post legalization past month use, there was no difference in frequency of use before and after legalization. Additionally, neither over nor underage individuals, when examined independently, showed an increase in past month frequency of use from pre- to post-legalization. These findings indicate that even though more people have been trying marijuana since legalization, the frequency of use has not been increasing. Though this study did not assess for dependence, constant frequency of use post-legalization supports the hypothesis that dependence rates may also be unchanged.

Experience seeking and risk seeking were both associated marijuana use, though not as predicted. As experience seeking increased, past 30 day marijuana use decreased. This finding does not support past research linking sensation seeking to marijuana use (Zuckerman, 2007). Since experience seeking is the desire for novelty, it may not predict past 30 day use as continued use is no longer novel. Experience seeking also did not differentially predict marijuana use by legal status or age group, as hypothesized. Risk seeking was not a predictor of use prior to legalization, in contrast to what was hypothesized. As hypothesized, risk seeking was a significant predictor of underage marijuana use. This is best explained by the fact that marijuana still illegal and thus riskier for underage users.

A curvilinear relation between sexual orientation and marijuana was identified, supporting the study hypothesis and consistent with past research (e.g. Ford & Jasinski, 2006; Eisenberg & Wechsler, 2003). The resulting model indicated that marijuana use was marginally lower among exclusively homosexual individuals than among exclusively heterosexual individuals. However, use was highest among bisexual individuals. This finding supported the hypothesis that use would be highest at the center of the sexual orientation spectrum and lower on either end. Additionally, it was consistent with past studies that found use was highest among bisexual individuals. The increased use may be reflective of biphobia and related stress. Using marijuana to cope with social rejection, while possible among homosexuals, seems more likely among bisexuals as they may face rejection from hetero- and homosexuals. Though a difference in use exists across the spectrum, it is smaller than past findings (e.g. Ford & Jasinski, 2006). This may be reflective of the culture in Colorado where use is more acceptable and permitted. Therefore, individuals of all orientations may experience less pressure to abstain from use. Moreover, bisexual individuals are not the most common orientation, and thus an “out-group”.

Having this status may make those individuals less likely to succumb to any remaining social pressure as they may already feel stigmatized. Since disapproval of use is stronger in states where use is illegal, this may account for the increased use in previous studies. In contradiction to the hypothesis, there was no significant difference in the quadratic relation by pre and post legalization. This showed that legalization did not have an impact on the nature of this relation. Therefore, other factors beyond legality and related changes in perceptions seem to be more strongly impacting marijuana use by sexual orientation.

Impact of the marijuana laws on a student's decision to attend a Colorado university was associated with both past 30 day use and lifetime use. A medium effect was found for past 30 day use for out-of-state students, while a small effect was found for lifetime use. These findings might indicate that there are out-of-state students interested in attending college in Colorado because marijuana is legal, and that those students are more likely to use. While the relation with lifetime use was smaller, some current users may have previously refrained from use due to marijuana illegality in their home state. Once in Colorado, these users may have initiated or increased use due to decreased repercussions for using marijuana (i.e. legal for adults, decriminalized for underage). Therefore, the stronger association with recent use may be reflective of interest in marijuana when legal. It cannot be determined if there have been more users coming to Colorado, thus changing the population makeup. However, these results support that out-of-state students are influenced to move by the marijuana laws. Since this phenomenon is unique to states with legalized marijuana, it is likely that users, especially heavier ones, are more interested in moving to one of these states. Consequently, student body composition has likely shifted toward more users in these states compared to states without legal marijuana.

Several limitations should be noted when interpreting this data. First, a difference was found in reporting marijuana use between the lab setting and the online survey. While the cause of this difference is unknown, it may indicate differences in response patterns by setting. Influences of social desirability or fear of consequences may have impacted honest responding. Though anonymity and privacy were ensured, dishonest reporting may still have occurred. Next, the pre-legalization group extended to 2013, which was after legislation was passed legalizing marijuana, but before the policy was implemented. By 2013, users may have already been attracted to Colorado due to impending changes. Moreover, decreasing perceived risk of use during this time may have influenced increased initiation. Data extending further back would help illuminate trends of use more clearly. Similarly, outcomes have only been examined through the first two years of implementation. Thus, findings may not be indicative of the long-term trends. The influence of marijuana laws on attending a Colorado school did not have a comparison group for prior to legalization. Therefore, it is unknown if marijuana users were previously attracted to Colorado due to its marijuana culture. Moreover, this study is not an experimental design. Consequently, a causal relation between the influence of laws on attending a Colorado college and marijuana use could not be established based on this data. Finally, the sex, race, and ethnicity demographics of the sample did not reflect the adolescent and young adult population in the United States (United States Census Bureau, 2014). The overrepresentation of European-American participants, reflective of Colorado's population, may be different than areas with larger diversity. Subsequently, caution should be taken when generalizing these findings. Additionally, the larger proportion of women may also alter the findings.

There are several implications of this study. First, legalizing marijuana may increase the number of people who try marijuana, especially among those of legal age. However, it will not necessarily increase frequency of use. As more people try marijuana, informing them of safe use practices will be necessary to minimize adverse outcomes.

Next, individual differences in personality predict different patterns of marijuana use. Experience seeking negatively predicted marijuana use in general and risk seeking positively predicted marijuana use among those under the age of 21. Harm reduction interventions may be beneficial for individuals high in risk sensation seeking in order to reduce adverse outcomes related to marijuana use. Given that risk is higher for younger users (Volkow et al, 2014), targeting underage risk seekers for interventions may decrease rates of dependence and other harms experienced by this population.

The quadratic relation between sexual orientation and marijuana use provides insight into use behavior by orientation. Use varies across the continuum of sexual orientations, with unique concerns and needs existing at different points on the spectrum. Understanding behavior in this context gives a better background for designing and implementing interventions. For example, individuals identifying near the bisexual center of the spectrum may feel pressured to use when facing rejection from both heterosexual and homosexual peers. This pressure may result in marijuana use as a coping mechanism. Moreover, lower use among homosexuals than bisexuals highlights the importance of not grouping all non-heterosexual individuals. Given these potentials, research and interventions can be more sensitive to individual differences by sexual orientation.

The relation between influence of marijuana laws on the decision to attend college in Colorado and past month and lifetime use, exposes another area of potential risk. Having

marijuana as a highly influencing factor in moving is likely predictive of heavier or problematic use. Increased availability in Colorado provides more access to these users, who are more likely to face adverse outcomes. For others moving here, perceptions of decreased risk, increased availability, and increased acceptability may motivate initiation or continued use. To combat potential harms, colleges could implement education and harm reduction interventions targeted at out-of-state students. Similarly, government and health facilities could provide marijuana information to reduce risks for both non-residents and residents. For example, new Colorado residents often visit the department of motor vehicles shortly after moving. This could be a potential place to target incoming residents with harm reduction interventions and pamphlets.

While it is useful to see what initial changes arise, the long term effects are yet to be seen. As legislation changes in response to unanticipated issues, and cultural familiarization increases, there may be unforeseen changes in use. Longitudinal studies spanning the next several years will be valuable for determining the long term outcomes of legalization. Additionally, this study has identified several groups at risk for adverse outcomes, but other high risk groups exist and should be identified. With adolescents at higher risk for negative outcomes and shifts in cultural views toward decreased risk and increased acceptance, interventions aimed at abstinence and harm reduction will prove indispensable. Future research is needed to design effective interventions that take into account the changing perceptions and cultural factors around marijuana. Though marijuana dependency has existed for years, changing perceptions toward the drug and its use may exhibit unique challenges when treating dependent and abusing individuals.

As an increasing number of states begin considering legalizing recreational marijuana for adults, the potential ramifications of doing so should be considered. The consequences, good and bad, need to be evaluated in both the short and long term. If recreational use laws are enacted

across the United States, then understanding their implications will be vital to safely implementing these policies.

TABLES

Table 1
Demographic Statistics

Sex %	Age	Race %	Ethnicity %
<u>Lab (N = 2231)</u>			
Female = 60.6	<i>M</i> = 19.51	American Indian = 1.5	Hispanic/Latino = 13.1
Male = 39.4	<i>SD</i> = 2.43	Asian/Asian American = 4.5	Non-Hispanic/Latino = 81.2
		Black/African American = 3.4	DNR = 5.7
		Native Hawaiian/Pacific Islander = 0.7	
		White/European American = 84.6	
		Multiracial = 1.4	
		DNR = 3.9	
<u>Online (N = 3010)</u>			
Female = 67.9	<i>M</i> = 19.72	American Indian = 0.5	Hispanic/Latino = 12.4
Male = 32.1	<i>SD</i> = 2.43	Asian/Asian American = 3.7	Non-Hispanic/Latino = 82.1
		Black/African American = 3.0	DNR = 5.6
		Native Hawaiian/Pacific Islander = 0.3	
		White/European American = 84.0	
		Multiracial = 4.6	
		DNR = 3.9	
<u>Total (N = 5421)</u>			
Female = 64.8	<i>M</i> = 19.67	American Indian = 0.9	Hispanic/Latino = 12.7
Male = 35.2	<i>SD</i> = 2.43	Asian/Asian American = 4.0	Non-Hispanic/Latino = 81.7
		Black/African American = 3.2	DNR = 4.8
		Native Hawaiian/Pacific Islander = 0.5	
		White/European American = 84.2	
		Multiracial = 3.2	
		DNR = 3.9	

Note: Did not respond (DNR)

Table 2

Negative binomial regression: Sensation seeking, age, & legal status regressed on 30 day use

	β	SE	95% Wald CI	Wald χ^2	<i>p</i>
Direct Effects					
Age	-3.514	.950	-5.462, -1.634	45.022	<.01
Experience seeking	-.085	.033	-.163, -.026	18.494	<.05
Interactions					
Age * Risk seeking	.084	.040	.019 – .138	40.416	<.01

Note: Results estimated using bootstrapping

Table 3

Negative binomial regression: Sexual orientation & quadratic regressed on 30 day use

	β	SE	95% Wald CI	Wald χ^2	<i>p</i>
Direct Effects					
SO	.574	.209	.210, 1.023	19.001	<.01
SO ²	-.062	.022	-.109, -.024	21.079	<.01

Note: Results estimated using bootstrapping. Sexual orientation (SO) and sexual orientation squared (SO²).

FIGURES

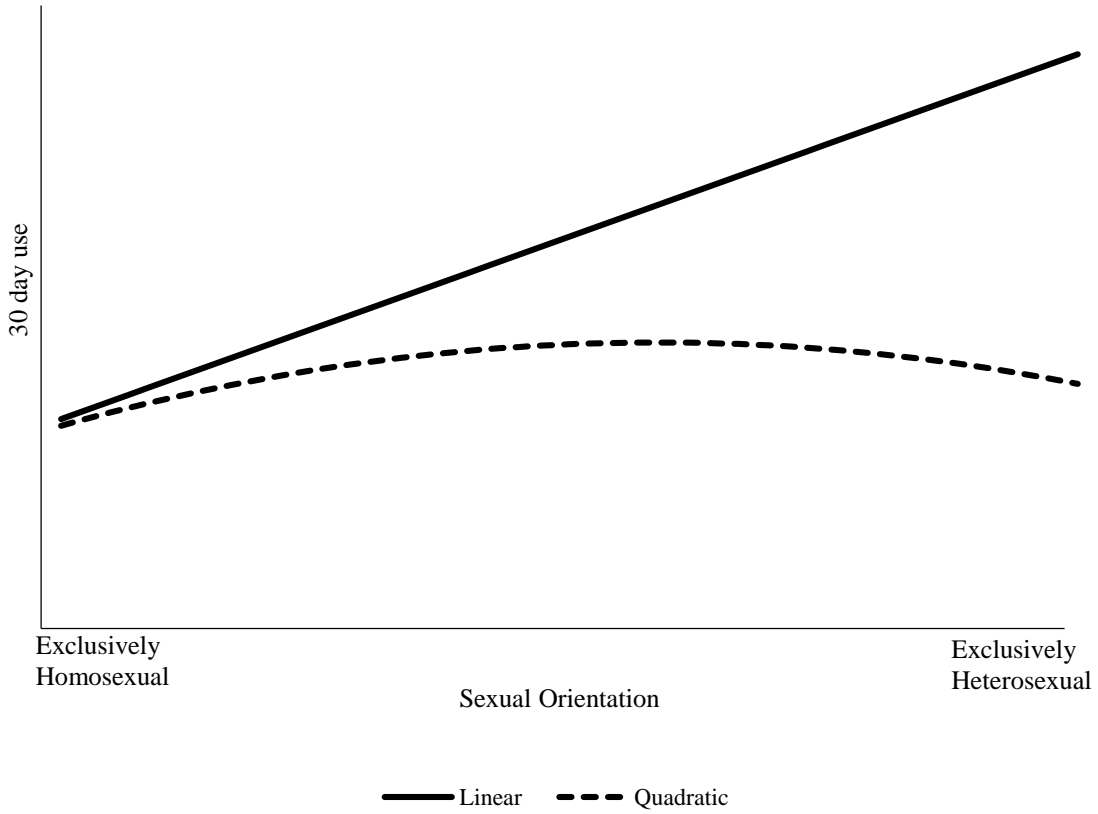


Figure 1. The direct effects of sexual orientation and the quadratic term on past 30 day use

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