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Impact of Cannabis Legalization on Substance Use Disorders in the United States

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2021

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An abstract of

A thesis submitted to the Faculty of the

Rollins School of Public Health of Emory University

in partial fulfillment of the requirements for the degree of

Master of Public Health

in Applied Epidemiology

2024

Abstract

Impact of Cannabis Legalization on Substance Use Disorder in the United States

By Hailey Whitmire

Background: Substance use disorders (SUDs) are a growing public health issue in the United States, affecting millions annually. The recent legalization of cannabis in various states raises concerns about its impact on SUD prevalence. This study investigates the relationship between the legal status of recreational cannabis and the prevalence of various SUDs.

Methods: A cross-sectional design analyzed data from the 2022 National Survey on Drug Use and Health (NSDUH). The study assessed the presence of SUDs, including any SUD, multiple SUDs (defined as two or more), alcohol use disorder, cannabis use disorder, methamphetamine use disorder, stimulant use disorder, and opioid use disorder, based on DSM-5 criteria. The primary independent variable was the legal status of recreational cannabis in participants' states. Data analysis used univariate and multivariate approaches, controlling for demographic and behavioral variables, such as age, sex, race/ethnicity, marital status, education level, family income, binge alcohol use, major depressive episode, and medical marijuana legality. Logistic regression assessed associations between cannabis legalization and SUDs, with odds ratios and 95% confidence intervals reported.

Results: The study included 48,612 participants; adolescents made up 18.46%, and adults 81.54%. SUDs were identified in 18.38% of participants, with 3.87% having multiple SUDs, 9.38% with cannabis use disorder, 11.38% with alcohol use disorder, 0.65% with methamphetamine use disorder, 0.39% with stimulant use disorder, and 0.96% with opioid use disorder. Recreational cannabis legalization was associated with higher odds of any SUD (adjusted odds ratio [aOR]: 1.147, 95% CI: 1.079-1.218) and cannabis use disorder (aOR: 1.313, 95% CI: 1.218-1.415). Conversely, legalization was linked to lower odds of methamphetamine use disorder (aOR: 0.557, 95% CI: 0.410-0.755). No significant associations were found between legalization and multiple SUDs, alcohol use disorder, stimulant use disorder, or opioid use disorder after adjustment.

Conclusion: This study found significant associations between recreational cannabis legalization and SUDs. States with legal recreational cannabis had higher odds of any SUD and cannabis use disorder, but lower odds of methamphetamine use disorder. These results highlight the need for targeted public health interventions in states with legal cannabis to address SUDs and mitigate potential adverse outcomes.

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CHAPTER 1: Introduction

Introduction and Rationale

Substance use disorders (SUDs) represent a significant public health crisis in the United States. In 2022, 48.7 million people (17.3%) aged 12 or older had a SUD within the past year.[1] This include 29.5 million who suffered from an alcohol use disorder (AUD), 27.2 million who suffered from a drug use disorder (DUD), and 8.0 million people who had both an AUD and DUD. This marks a significant increase from 2014 when only 8.1% of this demographic was reported to have SUDs.[2] The considerable increase in SUD prevalence highlights the urgent need for effective strategies to address this escalating crisis.

SUDs occur when recurrent use of alcohol or illicit drugs leads to considerable impairment, including health issues, disabilities, and the inability to fulfill major responsibilities at work, school, or home.[3] SUDs not only have a significant impact on individuals, families, and communities alike, but also contribute heavily to the burden of disease in the United States (US). They incur high costs due to lost productivity, healthcare expenses, and crime.[4,5] Despite being preventable and treatable, many individuals do not receive the necessary treatment.[6] As a result, understanding the individual-level and policy-level factors that influence substance use patterns within the US is vital for policy makers and service providers to effectively address the growing SUD crisis.

Legalization of cannabis, both for medical and recreational use, is a significant policy shift in the US, with 38 states legalizing medical cannabis and 24 states allowing recreational cannabis use as of June 2023.[7] This trend brings about critical public health implications, particularly concerning its potential impact on the prevalence and severity of SUDs. With the increased accessibility of cannabis, it is imperative to understand how this influences substance use behaviors. This knowledge is essential for public health officials to mitigate potential adverse effects and to inform the creation of policies that promote public health.

Problem Statement

The rise in the legalization of cannabis raises concerns about its potential to exacerbate SUDs, given the increase in cannabis use and heightened risk of cannabis use disorder in states where cannabis is legalized for recreational use.[8-13] Despite the potential therapeutic benefits of medical cannabis, there is a paucity of comprehensive research that delineates its impact on the broader spectrum of substance use disorders, including AUDs and DUDs. This gap in knowledge necessitates a thorough investigation into how the legal status of cannabis influences SUD prevalence.

Theoretical Framework

This study is grounded in the Social Ecological Model of health, which provides a comprehensive framework for understanding the multifaceted and interactive effects of personal and environmental factors that determine behaviors. This model emphasizes the interplay between individual, interpersonal, organizational, community, and policy levels in shaping health outcomes.[14] At the policy level, the model examines how laws and regulations impact substance use behaviors. Because the legalization of cannabis represents a significant policy shift, there are potential implications for SUDs. Policies at the state and federal levels can shape access to substances, influence public perceptions, and affect the prevalence of substance use. By utilizing the Social Ecological Model of health, this study aims to provide a nuanced understanding of how the legalization of cannabis affects substance use behaviors and the prevalence of SUDs.

Purpose Statement

The purpose of this study is to investigate the impact of the legalization of cannabis on the prevalence of substance use disorders (SUDs) among individuals aged 12 or older in the United States.

Research Question

Does the legalization of recreational cannabis correlate with a change in the odds of substance use disorders in states with legal cannabis use? Is there a difference in the odds of any substance use disorder, multiple substance use disorders, alcohol use disorder, cannabis use disorder, methamphetamine use disorder, stimulant use disorder, or opioid use disorder among states where recreational cannabis use is legal compared to states where it is not?

- Null hypothesis: There is no difference in the odds of any substance use disorder, multiple substance use disorders, alcohol use disorder, cannabis use disorder, methamphetamine use disorder, stimulant use disorder, or opioid use disorder among states where recreational cannabis use is legal compared to states where it is not.

Significance

This research holds significant implications for public health policy and practice. Understanding the relationship between cannabis legalization and SUDs can guide policymakers in crafting regulations that minimize adverse outcomes while maximizing public health benefits. It also provides insights for healthcare providers and service organizations in developing targeted interventions to address SUDs in the context of evolving cannabis policies.

CHAPTER 2: Review of Literature

Introduction

Substance use disorders (SUDs) represent a significant public health challenge in the United States and globally, with millions affected by conditions ranging from alcohol and drug use disorders to complex patterns of polydrug use.[1,2] The legalization of cannabis, now spanning 38 states for medical use

and 24 for recreational use as of June 2023, has profound implications for public health, including potential shifts in the prevalence and severity of SUDs.[7] Understanding these dynamics is crucial for policymakers, healthcare providers, and researchers seeking effective strategies to mitigate adverse outcomes and promote overall public health.

This literature review aims to synthesize findings from prior studies utilizing data sources such as National Survey on Drug Use and Health (NSDUH), focusing on cannabis use trends post-legalization, shifts in alcohol consumption patterns, and the relationship between cannabis policy changes and opioid use. Furthermore, the literature explores the implications of cannabis legalization on stimulant use patterns, another critical area of concern in substance use research. By consolidating current knowledge, this review aims to provide a comprehensive overview of the current research, highlighting the need for ongoing studies to fully understand the public health implications of recreational cannabis legalization.

Review of Literature

National Survey on Drug Use and Health

The National Survey on Drug Use and Health (NSDUH) is a comprehensive survey conducted at both national and state levels, targeting a representative sample of the civilian, non-institutionalized U.S. population aged 12 and older.[15] The survey includes residents of households and noninstitutional group quarters (e.g., shelters, dormitories, halfway houses) and civilians living on military bases, but excludes homeless individuals not using shelters, active duty military personnel, and residents of institutional group quarters (e.g., prisons, nursing homes). Data are collected annually through face-to-face household interviews using computer-assisted personal interviewing methods. NSDUH gathers data on the use of illicit drugs, alcohol, and tobacco; initiation and frequency of substance use; substance dependence and abuse; and perceptions of substance-related risks and other behavioral health indicators.

Several studies have used NSDUH data to investigate substance use in relation to the legal status of marijuana. In a 2012 study by Cerda et al., authors examined the impact of medical marijuana laws on marijuana use and dependence.[16] They found that residents of states with medical marijuana laws had higher odd of marijuana use (OR: 1.92; 95% CI: 1.49-2.47) and dependence (OR: 1.81; 95% CI: 1.22-2.67) compared to states without such laws. Wen et al. (2015) explored the effect of medical marijuana laws on marijuana, alcohol, and hard drug use.[17] Similarly, authors found that medical marijuana laws were associated with increased marijuana use among adults, however there was not a significant impact on the use of alcohol or hard drugs. In another study focused on the relationship between medical marijuana laws, perceived marijuana availability, and the prevalence of past-month marijuana use, it was found that past-month marijuana use increased from 5.87% to 7.15% after medical marijuana law passage (AOR: 1.24 [1.16–1.31]), with a corresponding rise in perceived availability among adults. This change was not observed among adolescents (12-17) or young adults (18-25).[18] An investigation into trends in marijuana use disorders among U.S. citizens aged 18 and older from 2002 to 2014 examined prevalence rates, initiation patterns, daily use frequencies, perceptions of harm, and annual use days.[19] Results show a rise in marijuana use from 10.4% to 13.3% over the studied period, alongside a decline in the perception of great harm from weekly marijuana use (50.4% to 33.3). Despite these trends, marijuana use disorders remained stable at approximately 1.5% among adults throughout the study period. Choo et al. (2014) studied the impact of state medical marijuana legislation on adolescent marijuana use, specifically.[20] They found no significant increase in adolescent marijuana use following the enactment of medical marijuana laws. In general, while NSDUH data has been employed in numerous studies exploring the effects of marijuana legalization, the emphasis has largely centered on the legal status of medical marijuana. Furthermore, existing research indicates an overall pattern where legalizing medical marijuana correlates with reduced perceived risk and increased marijuana use.

However, there remains a notable gap in understanding the broader implications of marijuana legalization on other substance use disorders.

Cannabis

Cannabis use among adolescents (ages 12-17) following recreational cannabis legalization (RCL) revealed inconsistent changes in usage rates. Gunadi et al. found that RCL was associated with a more pronounced transition from non-use to use compared to states without legalization and those with only medical cannabis legalization ($p<.001$), but not when compared to states with medical legalization alone.[21] Another study noted that adolescents who never used cannabis but used e-cigarettes were more likely to initiate cannabis use in RCL states than in non-RCL states (aOR = 18.39, 95% CI: 4.25-79.68 vs aOR = 5.09, 95% CI: 2.86-9.07, respectively).[22] Among adolescents co-using alcohol and cannabis, one study observed a significant increase in the frequency of cannabis use following RCL ($p<.001$).[23] In Canada, a study showed that adolescents had increased odds of ever using cannabis in the year following RCL in cross-sectional data (P = .009), but no significant differences in longitudinal data.[24] Additionally, there are multiple studies from Washington and Oregon that have found higher rates of cannabis use among adolescents during periods of recreational cannabis legalization (RCL) compared to non-legal periods, though not all differences were statistically significant (Mason, et al. (2006)).[25-27] Rusby et al. found that RCL did not affect initiation but led to significantly higher rates of use among current users (RR = 1.26, 95% CI = 1.10, 1.45).[26] Another study noted an increase in cannabis use post-RCL, though usage patterns (frequency and daily vs weekly use) remained similar.[27] Finally, two studies observed no significant increase in the either the frequency or prevalence of cannabis use following RCL.[28,29] Overall, while some evidence suggests RCL is associated with increased adolescent cannabis use, findings are inconsistent, indicating a mixed overall relationship between RCL and adolescent cannabis use.

Among studies investigating cannabis use among adults, four studies specifically focused on young adults aged 18-25 years.[30-33] Kerr et al. (2017) found a significant rise in cannabis use among Oregon college students from before to after RCL (P = .0002).[30] While Barker et al. (2020) found that the rate of students ever using cannabis did not change, the proportion of those using in the past 28 days rose faster post-RCL in Washington compared to Wisconsin, where recreational use is illegal (P ≤ .001).[31] A study on young adults who had never vaped cannabis revealed no difference in past-year cannabis use between states with or without RCL, but a larger increase in cannabis vaping rates in RCL states.[32] Additionally, RCL was linked to a higher likelihood of past-year cannabis use among youth in Oregon and Washington (P = .001).[33] Unlike adolescent studies, those on young adults consistently indicate an association between RCL and increased cannabis use.

Five studies examined changes in cannabis use among general adults related to RCL. Four studies suggested increased cannabis use in adults post-RCL compared to non-legal states.[21,29,34,35] In California, past 30-day cannabis use significantly increased one month post-RCL and remained elevated six months later.[34] Another study found a transition from non-users to cannabis users and weekly users in RCL states compared to those without legalization or only medical cannabis legalization (p<.001).[21] In Canada, a significant rise in cannabis use prevalence was noted post-RCL.[29] Additionally, Turna, et al. (2021) found increased use frequency, quantity, and misuse severity among new users, but decreased use among prior users in Canada.[35] However, one U.S. study found no link between RCL and cannabis use frequency.[36] These findings generally support the conclusion that there is an increase in adult cannabis use following RCL.

Alcohol

Several studies have examined changes in alcohol use before and after RCL. One study conducted in the state of Washington found a decrease in alcohol consumption among adolescents

following RCL.[25] However, the study population was limited to 238 students, and the results were not statistically significant. Meanwhile, another Washington study of 281 adolescents indicated that RCL predicted a higher likelihood of alcohol use among youth (AOR 3.38, p=0.034).[33] A Canadian study found no significant effect of RCL on rates of alcohol among youth.[37] Finally, in a study by Kerr et al. (2023) there were no changes in the frequency of alcohol use or binge drinking from before to after RCL among young, college age adults.[38] There appear to be inconsistent results regarding the impact of RCL on alcohol use, however studies are limited to younger adult and adolescent populations.

Opioids

In a study by Shah et al. (2019) that included 4,840,562 individuals over 15,705,562 person years, medical marijuana legalization was associated with slightly lower odds of any opioid use (OR = 0.95; CI 0.94-0.96), chronic opioid use (OR = 0.93; CI 0.91-0.95), and high-risk opioid use (OR = 0.96; CI 0.94-0.98).[39] The study concludes that medical marijuana legalization may modestly reduce opioid and high-risk opioid prescribing, suggesting policymakers consider it as a potential tool, though further research is needed to evaluate its risks and benefits and compare it directly with opioids for pain management. Another study examined the impact of recreational marijuana legalization on prescription opioid distribution in Colorado, comparing it with Utah and Maryland, which did not legalize recreational marijuana. Analysis of the interval pre (2007–2012) versus post (2013–2017) marijuana legalization revealed statistically significant decreases for Colorado ($P < 0.05$) and Maryland ($P < 0.01$), but not Utah, for pain medications.[40] There was a larger reduction from 2012 to 2017 in Colorado (–31.5%) than the other states (–14.2% to –23.5%), and Colorado had notably greater decreases in codeine and oxymorphone. The study suggests that further research across more states is needed to assess whether cannabis policy contributes to reductions in opioids prescribed for chronic pain. When Shi et al. (2019) compared eight states and DC, recreational marijuana legalization was not linked to changes in Schedule II opioid outcomes but was associated with a 32% reduction in prescriptions, a 30% reduction

in total doses, and a 31% reduction in spending on Schedule III opioids ($p = 0.003$, $p = 0.027$, and $p = 0.031$, respectively).[41] When comparing states with recreational and medical marijuana legalization, no significant associations with opioid outcomes were found.

Two studies examined the impact of RCLs on opioid-related mortalities. The first study used a difference-in-difference approach to examine the impact of medical and recreational marijuana on opioid overdose fatalities in the United States over the past two decades.[42] The findings indicate that marijuana access was associated with significant reductions in opioid mortality rates, with RCLs reducing annual opioid deaths by 20%–35%, especially for synthetic opioids. Nguyen et al. (2024) focused on the period between 2006 and 2020, when 13 states legalized recreational cannabis and 23 states legalized medical cannabis.[43] The study found no statistically significant association between these cannabis laws and opioid prescriptions or overall opioid overdose mortality over the 15-year period. However, there was a reduction in synthetic opioid deaths associated with recreational cannabis laws, with 4.9 fewer deaths per 100,000 population ($p = .04$). Overall, some evidence suggests that recreational and medical cannabis legalization is associated with reduced opioid prescribing and opioid-related mortality. However, more research is needed to confirm these findings due to the variability in results and study designs.

Other

In a study by Mennis et al. (2021), authors examined whether RCL in Colorado and Washington led to increased SUD treatment admissions for cocaine, opioids, and methamphetamines among adolescents and emerging adults.[44] Using SAMHSA's Treatment Episodes Data Set: Admissions data from 2008 to 2017, difference-in-differences models found no significant differences in pre- versus post-legalization trajectories between Colorado and Washington compared to states without RCL. This suggests that RCL enactment in these states did not correlate with higher SUD treatment admissions for

these substances among adolescents (12-17), early emerging adults (18-20), or late emerging adults (21-24). Another study using SAMHSA's NSDUH data (2016-2018) examined the impact of medical marijuana legalization on prescription drug misuse, illicit drug use, and combined substance use behaviors among U.S. adults aged 18 and older (n = 127,438).[45] Multinomial logistic regression showed that medical marijuana legalization was associated with increased illicit drug use (RRR = 1.33, 95% CI = [1.17, 1.51]; $p < .01$) and both prescription drug misuse and illicit drug use (RRR = 1.14, 95% CI = [1.05, 1.25]; $p < .01$) among adults. While Sabia et al. (2024) did not find statistically significant evidence, the results from their analysis across 24 states and the District of Columbia from 2000 to 2019 supported the general trend that RCL was associated with slight increases in the use of illicit substances and admissions to substance use treatment facilities among adults.[46] Overall, there is limited evidence that is nationally representative and inclusive of recreational marijuana laws at the present time. The reviewed studies indicate varied impacts of marijuana legalization on substance use behaviors across different age groups and states, highlighting the complexity and ongoing need for further research in understanding the public health implications of these policies.

Conclusion

While the prevalence and impact of substance use disorders (SUDs) continue to escalate in the United States, further research remains imperative. The legalization of recreational and medical cannabis has introduced new dimensions to the SUD landscape, necessitating ongoing investigation into its effects on patterns of substance use and disorder. Research into the impact of cannabis policy changes on substance use behaviors has yielded diverse and at times contradictory findings. The literature on cannabis use following recreational cannabis legalization reveals a nuanced landscape. While there is a general trend towards increased use among young adults and the general population, adolescent responses are more varied. Studies examining alcohol consumption following recreational cannabis legalization (RCL) have reported mixed results, highlighting variations across different age groups and

geographic regions. Similarly, investigations into opioid use have suggested complex relationships, with some studies indicating reductions in opioid prescriptions and mortality rates associated with cannabis access, while others find no significant correlation over extended periods. Additional research is needed to gain a comprehensive understanding of the impacts that the legal status of marijuana has on substance use disorders in the US. Additional research is crucial for informing effective policy interventions and enhancing treatment strategies to mitigate the growing SUD crisis in the country.

The current problem lies in the insufficient understanding of how cannabis legalization impacts the broader spectrum of substance use disorders). Despite the growing body of research, there remains a gap in comprehensive studies that consider various demographic factors and state-specific policies. Without this knowledge, policymakers and public health officials lack the necessary information to craft effective interventions and policies to mitigate the adverse effects of cannabis legalization on SUDs. This study aims to address this critical gap by providing an updated examination of the impact of cannabis legalization on substance use disorders across different demographic groups and substances in 2022.

CHAPTER 3: Methods

Population and Sample

NSDUH is a comprehensive survey conducted annually at both national and state levels, targeting a representative sample of the civilian, non-institutionalized U.S. population aged 12 and older. It includes residents of households, noninstitutional group quarters (e.g., shelters, dormitories, halfway houses), and civilians living on military bases, but excludes homeless individuals not using shelters, active duty military personnel, and residents of institutional group quarters (e.g., prisons, nursing homes). Data are collected through face-to-face household interviews using computer-assisted personal interviewing methods.

Research Design

This was a cross-sectional study of 2022 NSDUH survey participants. The primary outcome of interest was the presence of the following substance use disorders: any SUD, multiple SUDs (defined as any two or more co-occurring SUDs), alcohol use disorder, cannabis use disorder, methamphetamine use disorder, stimulant use disorder, or opioid use disorder. The presence of absence of SUDs were determined by the NSDUH using the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5), criteria for SUD. The primary independent variable was the legal status of recreational cannabis in the state of residence, defined as either legal or illegal.

Data Source

Data were obtained from the 2022 NSDUH. Patient demographic data were collected, including: age, sex, race/ethnicity, marital status, education level, and family income. Additional variables collected for this analysis included history of binge alcohol drinking in the past 30 days, major depressive episode in the past year, and the legal status of medical cannabis in the participant's state of residence. All 2022 Survey participants aged 12 and older were included in this research. Participants with missing data regarding the legal status of marijuana in their state were excluded from the study (n=10457), as each participant's state of residence was not a publicly available variable. Data were extracted from a publicly accessible dataset, and therefore the Emory University Institutional Review Board (IRB) determined use of the survey did not constitute human subjects research.

Data Analysis

We conducted a study to investigate the association between the legal status of recreational cannabis and various substance use disorders, including any SUD, multiple SUDs, alcohol use disorder, cannabis use disorder, methamphetamine use disorder, stimulant use disorder, and opioid use disorder. Both univariate and multivariate analyses were performed, controlling for variables such as age, sex,

race, marital status, education level, family income, binge alcohol use in the past 30 days, major depressive episode in the past year, and the legal status of medical marijuana. We utilized logistic regression to analyze both crude and adjusted associations between the legal status of recreational cannabis and the various substance use disorders, reporting odds ratios and 95% confidence intervals. Stepwise regression was used to determine the final models for each substance use disorder. To ensure the robustness of our multivariable models, we assessed multicollinearity among variables using variance decomposition proportion (VDP) analysis. Variables with VDPs greater than 30 would indicate a collinearity problem and be excluded from our model. However, no VDPs greater than 30 were observed, indicating no multicollinearity issues. All analyses were conducted using SAS® version 9.4 (SAS Institute Inc., Cary, NC).

CHAPTER 4: Results

Forty-eight thousand, six hundred and twelve patients were included in the study. The mean age of participants was 33.02 years (IQR: 19.0-42.0). Adolescents (age < 18 years) accounted for 18.46% of the total sample, while adults (age ≥ 18 years) constituted 81.54% of the sample. Males made up 46.41% of the sample. The majority of participants were Non-Hispanic White (58.59%). Other racial/ethnic groups included Non-Hispanic Black/African American (12.12%), Non-Hispanic Native American/Alaskan Native (1.46%), Non-Hispanic Native Hawaiian/Other Pacific Islander (0.41%), Non-Hispanic Asian (5.08%), Non-Hispanic more than one race (4.15%), and Hispanic (18.20%). Marital status varied among participants, with 33.47% being married, 2.05% widowed, 7.97% divorced/separated, and 47.78% never married. Regarding education, 7.87% of adults had less than a high school education, while high school graduates made up 20.56% of the sample, some college/associate's degree holders accounted for 24.13%, and college graduates comprised 28.98%. Family income levels showed that a significant portion of the sample had a family income of $75,000 or more (42.49%). Other income brackets included less

than $10,000 (7.40%), $10,000 - $19,999 (9.47%), $20,000 - $29,999 (8.49%), $30,000 - $39,999 (8.47%), $40,000 - $49,999 (9.33%), and $50,000 - $74,999 (14.36%). Behavioral and health characteristics revealed that 22.31% of participants reported binge alcohol use in the past 30 days. Major depressive episodes in the past year were reported by 9.35% of participants. SUDs were identified in 18.38% of participants, with 3.87% reporting two or more SUDs. In the past year, 11.38% of participants experienced alcohol use disorder, and 9.38% had a cannabis use disorder. Methamphetamine use disorder was reported by 0.65% of participants, while stimulant use disorder affected 0.39%. Opioid use disorder was present in 0.96% of participants over the past year. Table 1 presents the demographic distribution of the patient population, comparing overall data with those from states where recreational cannabis is legal and states where it is illegal.

Significant associations were observed between the legal status of cannabis in the state and SUDs occurring in the past year (Tables 2-8). In the univariate analysis, the odds ratio for having any SUD within states where recreational cannabis is legal compared to states where it is not was 1.175 (95% CI: 1.115, 1.231), while the odds ratio was 1.073 (95% CI: 0.966, 1.192) for having SUDs, 1.117 (95% CI: 1.048, 1.190) for alcohol use disorder, 1.218 (95% CI: 1.138, 1.304) for cannabis use disorder, and 0.625 (95% CI: 0.466, 0.839) for methamphetamine use disorder. There was not a significant association between the legal status of cannabis in the state and stimulant use disorder [OR 0.869 (95% CI: 0.616, 1.225)], or OUD [OR 0.940 (95% CI: 0.758, 1.165)] in the univariate analysis.

Tables 2-8 show the adjusted odds ratios (aOR) from multivariable analyses of the various substance use disorders when controlling for age, sex, race/ethnicity, marital status, education level, family income, history of binge alcohol use in the past 30 days, history of a major depressive episode in the past 1 year, and the legal status of medical marijuana use in the state or residence. The adjusted odds ratios when controlling for these variables included. In the adjusted model, the odds of having any SUD and cannabis use disorder were significantly higher in states where recreational cannabis is legal

compared to states where it is illegal (aOR: 1.147, 95% CI: 1.079-1.218; aOR: 1.313, 95% CI: 1.218, 1.415, respectively). However, legal recreational cannabis was significantly associated with a lower odds of methamphetamine use disorder (aOR: 0.557, 95% CI: 0.410, 0.755). There was no significant association between the legal status of cannabis and multiple substance use disorders, alcohol use disorder, stimulant use disorder, and opioid use disorder when controlling for age, sex, race/ethnicity, marital status, education level, family income, history of binge alcohol use in the past 30 days, history of major depressive episode in the past 1 year, and the legal status of medical marijuana. Additionally, each of these variables was significantly associated with the outcome of any substance use disorder, multiple substance use disorders, and cannabis use disorders in both the univariate and multivariate analyses. The legal status of medical marijuana was not significantly associated with alcohol use disorder in the univariable analyses, but was found to be significant in the multivariate analyses, while education level was not a significant predictor in the multivariate analyses. For methamphetamine use disorder, sex was not significantly associated in the univariate analyses, but was significant in the multivariate analysis, alcohol use in the past 30 days was not significant in the multivariate analysis, and the legal status of medical marijuana was not significantly associated with the outcome in either analysis. Sex, education level, and the legal status of medical marijuana was not significantly associated with stimulant use disorder in either the univariable or multivariable analysis, while age and income were not associated with this outcome in the multivariable analysis. Neither sex nor the legal status of medical marijuana was significantly associated with opioid use disorder in either analysis. The results of the stepwise selection process for identifying predictors of each outcome included in this study are summarized in tables 9-15, which show the strongest predictors of each outcome, as well as other significant predictors included in the final model for each respective disorder.

CHAPTER 5: Discussion

Key Results:

The goal of this study was to determine the association between the legalization of recreational cannabis and the prevalence of substance use disorders among individuals aged 12 and older in the US. We found a significant association between the legal status of recreational cannabis and higher odds of having any substance use disorder, and specifically, a cannabis use disorder. Our results show that individuals in states where recreational cannabis is legal have 14.7% higher odds of having any substance use disorder compared to those in states where it is illegal. Additionally, individuals in states where recreational cannabis is legal have 31.3% higher odds of having a cannabis use disorder compared to those in states where it is illegal. These findings are consistent with the results of prior studies which have shown increases in cannabis use post-legalization among adolescents, college-aged individuals, and adults. [21, 23-27, 29-33,34,35]

We observed no significant differences in the prevalence of multiple substances use disorders, alcohol use disorder, stimulant use disorder, or opioid use disorder, and a decrease in the prevalence of methamphetamine use disorder within states that have legalized recreational cannabis use, when controlling for potential confounders. These results are consistent with findings from a 2014 study using similar data from the NSDUH, where authors found that the legalization of medical marijuana was associated with increase cannabis use, but observed no significant changes in the use of hard drugs.[17] Authors of this study found an increase in alcohol consumption among adults, and although our findings did not support a statistically significant increase in alcohol use disorder, we did observe a general trend of increased alcohol use disorder among states where recreational cannabis use is legal.

The relationship between cannabis legalization and opioid use has also been explored. While existing evidence suggests the legalization of recreational cannabis may be associated with reduced opioid prescribing and opioid-related mortality, we did not observe a significant change in opioid use

disorder in this study.[39-43] More research is needed to confirm these results due to variability in study designs and outcomes, however.

Limitations and Strengths

This study has several limitations. First, the cross-sectional design limits the ability to infer causality between the legal status of cannabis and SUDs and prevents the ability to longitudinally assess whether these associations change with increasing years since the policy changes were implemented. Second, self-reported data on substance use and mental health may be subject to recall bias and social desirability bias. Third, the exclusion of subjects with missing data pertaining to the legal status of recreational cannabis has the potential to introduce selection bias, as we are unable to ascertain why these data were missing for some subjects. Fourth, the generalizability of the findings may be limited due to the specific population studied. Because this survey excluded homeless individuals not using shelters and residents of institutional group quarters (military, nursing homes, and prisons), there may be an underrepresentation of these groups in the results, potentially skewing the overall findings. Additionally, the exclusion of these populations may overlook unique patterns of substance use and mental health issues that are more prevalent or specific to these environments. Lastly, the reliance on survey data may not capture the full extent of substance use and mental health disorders, as some individuals may underreport or fail to recognize their conditions.

Despite these limitations, the study has several strengths. The large sample size enhances the statistical power to detect associations, allowing for more precise and reliable results. Additionally, the inclusion of multiple covariates in the multivariate models helps control for potential confounders, ensuring that the observed associations are not merely due to other underlying factors. Finally, the survey is conducted in such a way that questions about substance use are collected based on patterns of behavior, allowing for the diagnosis of substance use disorders after the fact by those conducting the

survey. This approach is a strength because it enables the capture of data on individuals who may not recognize or acknowledge their disorder or problem. By focusing on behavioral patterns rather than relying solely on self-diagnosis, the study can identify substance use disorders more accurately and comprehensively. This method reduces the risk of underreporting or misreporting and ensures that even those who are unaware of or unwilling to admit to their issues are included in the analysis. This enhances the overall validity and depth of the findings, providing a more complete picture of substance use disorders within the population studied.

Implications

The findings of this study have important implications for public health policy and practice. The association between the legal status of recreational cannabis and higher odds of substance use disorders suggests the need for targeted interventions in states with legal cannabis to mitigate potential negative outcomes. Public health programs should focus on prevention and treatment strategies for substance use disorders, particularly in populations at higher risk due to legal cannabis availability. Additionally, the observed association between legal cannabis and reduced methamphetamine use disorder highlights the potential for cannabis legalization to influence the use of other substances, which could inform harm reduction strategies.

Recommendations

Future research should explore the causal relationships between cannabis legalization and substance use disorders through longitudinal studies. Investigating the mechanisms underlying the associations observed in this study could provide valuable insights for developing targeted interventions. Additionally, examining the impact of different regulatory frameworks for cannabis on substance use behaviors could inform policy decisions. Public health programs should consider incorporating education

and prevention efforts addressing the risks associated with substance use in states with legal recreational cannabis.

Conclusion

This study identified significant associations between the legal status of recreational cannabis and various substance use disorders. States with legal recreational cannabis had higher odds of any substance use disorder and cannabis use disorder, while methamphetamine use disorder was less prevalent. These findings underscore the need for targeted public health interventions in states with legal cannabis to address substance use disorders and mitigate potential adverse outcomes. Further research is warranted to elucidate the mechanisms driving these associations and inform evidence-based policy and practice in the context of cannabis legalization.

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Appendix

Table 1. Baseline Patient Characteristics

	Total (n=48612)		Marijuana Legal State (n=12025)		Marijuana Illegal State (n=36587)	
	N	%	n	%	n	%
Age (years)						
Mean	33.02	-	36.90	-	31.75	-
IQR	19.0-42.0	-	22.0-42.0	-	19.0-42.0	-
Adolescent (Age < 18 years)	8973	18.46	1255	10.44	7718	21.09
Adult (Age ≥ 18 years)	39639	81.54	10770	89.56	28869	78.91
Gender						
Male	22563	46.41	5734	47.68	16829	46.00
Female	26049	53.59	6291	52.32	19758	54.00
Race/Ethnicity						
NonHisp White	28483	58.59	7429	61.78	21054	57.55
NonHisp Black/Afr Am	5894	12.12	1201	9.99	4693	12.83
NonHisp Native Am/AK Native	708	1.46	166	1.38	542	1.48
NonHisp Native HI/Other Pac	197	0.41	41	0.34	156	0.43
NonHisp Asian	2468	5.08	644	5.36	1824	4.99
NonHisp more than one race	2017	4.15	509	4.23	1508	4.12
Hispanic	8845	18.20	2035	16.92	6810	18.61
Marital Status						
Married	16269	33.47	4731	39.34	11538	31.54
Widowed	998	2.05	303	2.52	695	1.90
Divorced/Separated	3873	7.97	1089	9.06	2784	7.61
Never Married	23225	47.78	5317	44.22	17908	48.95
Age <14	4247	8.74	585	4.86	3662	10.01
Education Level						
Adult Less than High School	3825	7.87	854	7.10	2971	8.12
Adult High School Graduate	9995	20.56	2283	18.99	7712	21.08
Adult Some College/ Associate's Degree	11732	24.13	3001	24.96	8731	23.86
Adult College Graduate	14087	28.98	4632	38.52	9455	25.84
School Aged (12-17 years)	8973	18.46	1255	10.44	7718	21.09
Total Family Income						
Less than $10,000 (Including Loss)	3598	7.40	861	7.16	2737	7.48
$10,000 - $19,999	4605	9.47	1030	8.57	3575	9.77
$20,000 - $29,999	4125	8.49	899	7.48	3226	8.82
$30,000 - $39,999	4118	8.47	887	7.38	3231	8.83
$40,000 - $49,999	4534	9.33	1038	8.63	3496	9.56
$50,000 - $74,999	6979	14.36	1693	14.08	5286	14.45
$75,000 or More	20653	42.49	5617	46.71	15036	41.10
Binge Alcohol Use in Past 30 Days						
No	37571	77.29	9081	75.52	28490	77.87

Yes	10847	22.31	2889	24.02	7958	21.75
Missing	194	0.40	55	0.46	139	0.38
Major Depressive Episode in Past 1 Year						
No	44068	90.65	10816	89.95	33252	90.88
Yes	4544	9.35	1209	10.05	3335	9.12
Medical Marijuana Legal at Time of Interview						
No	11717	24.10	851	7.08	10866	29.70
Yes	36895	75.90	11174	92.92	25721	70.30
Any Substance Use Disorder in Past Year						
No	39678	81.62	9591	79.76	30087	82.23
Yes	8934	18.38	2434	20.24	6500	17.77
Two or More Substance Use Disorders in Past Year						
No	46733	96.13	11536	95.93	35197	96.20
Yes	1879	3.87	489	4.07	1390	3.80
Alcohol Use Disorder in Past Year						
No	43081	88.62	10554	87.77	32527	88.90
Yes	5531	11.38	1471	12.23	4060	11.10
Marijuana Use Disorder in Past Year						
No	44054	90.62	10740	89.31	33314	91.05
Yes	4558	9.38	1285	10.69	3273	8.95
Methamphetamine Use Disorder Severity in Past Year						
No	48296	99.35	11971	99.55	36325	99.28
Yes	316	0.65	54	0.45	262	0.72
Stimulant Use Disorder Severity in Past Year						
No	48423	99.61	11983	99.65	36440	99.60
Yes	189	0.39	42	0.35	147	0.40
Opioid Disorder in Past Year						
No	48146	99.04	11915	99.09	36231	99.03
Yes	466	0.96	110	0.91	356	0.97

Table 2. Univariate and Multivariate Analyses: Odds of having Any Substance Use Disorder

Variable	**Univariate Analysis**			**Multivariate Analysis**		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Legal Status of Marijuana						
Illegal	---			---		
Legal	1.175	(1.115,1.231)	<.0001	1.147	(1.079,1.218)	<.0001
Age (years)						
12-17	---			---		
18-25 (vs 12-17)	3.813	(3.504,4.149)	<.0001	1.400	(1.231,1.592)	<.0001
26-34 (vs 12-17)	3.501	(3.201,3.829)	<.0001	1.631	(1.421,1.872)	<.0001
35-49 (vs 12-17)	2.652	(2.428,2.896)	<.0001	1.506	(1.309,1.733)	<.0001
50-64 (vs 12-17)	1.672	(1.491,1.874)	<.0001	1.039	(0.883,1.223)	0.6419
65 or Older (vs 12-17)	0.699	(0.603,0.812)	<.0001	0.575	(0.473,0.699)	<.0001

Sex						
Male	---			---		
Female	0.766	(0.732,0.802)	<.0001	0.686	(0.651,0.723)	<.0001
Race/Ethnicity						
NonHisp White	---			---		
NonHisp Black/Afr Am	0.956	(0.889,1.028)	0.2265	0.916	(0.843,0.996)	0.0401
NonHisp Native Am/AK Native	1.667	(1.410,1.971)	<.0001	1.508	(1.242,1.831)	<.0001
NonHisp Native HI/Other Pac	0.941	(0.652,1.357)	0.7446	0.866	(0.579,1.294)	0.4820
NonHisp Asian	0.463	(0.403,0.531)	<.0001	0.588	(0.507,0.682)	<.0001
NonHisp more than one race	1.236	(1.108,1.379)	0.0001	1.157	(1.022,1.309)	0.0213
Hispanic	0.991	(0.932,1.054)	0.7795	0.874	(0.814,0.938)	0.0002
Marital Status						
Married	---			---		
Widowed	0.626	(0.502,0.782)	<.0001	1.148	(0.896,1.471)	0.2758
Divorced/Separated	1.810	(1.657,1.977)	<.0001	1.619	(1.464,1.791)	<.0001
Never Married	2.049	(1.941,2.163)	<.0001	1.660	(1.539,1.790)	<.0001
Age <14	0.247	(0.210,0.292)	<.0001	0.504	(0.413,0.614)	<.0001
Education Level						
Adult Less than High School	---			---		
Adult High School Graduate	0.961	(0.880,1.049)	0.3741	0.887	(0.804,0.978)	0.0167
Adult Some College/ Associate's Degree	0.931	(0.854,1.015)	0.1064	0.829	(0.752,0.915)	0.0002
Adult College Graduate	0.648	(0.594,0.707)	<.0001	0.693	(0.625,0.769)	<.0001
School Aged (12-17 years)	0.299	(0.270,0.333)	<.0001	1.807	(1.530,2.134)	<.0001
Total Family Income						
Less than $10,000 (Including Loss)	---			---		
$10,000 - $19,999	0.967	(0.873,1.072)	0.5270	1.044	(0.930,1.172)	0.4636
$20,000 - $29,999	0.831	(0.746,0.925)	0.0007	0.932	(0.825,1.051)	0.2506
$30,000 - $39,999	0.845	(0.759,0.941)	0.0021	0.931	(0.825,1.051)	0.2464
$40,000 - $49,999	0.740	(0.665,0.823)	<.0001	0.841	(0.745,0.948)	0.0048
$50,000 - $74,999	0.690	(0.626,0.761)	<.0001	0.819	(0.732,0.916)	0.0005
$75,000 or More	0.583	(0.535,0.634)	<.0001	0.717	(0.648,0.794)	<.0001
Binge Alcohol Use in Past 30 Days						
No	---			---		
Yes	7.010	(6.667,7.371)	<.0001	7.235	(6.560,7.981)	<.0001
Missing	4.902	(3.654,6.577)	<.0001	5.499	(3.323,9.099)	<.0001
Major Depressive Episode in Past 1 Year <.0001						
No	---					
Yes	3.508	(3.289,3.742)	<.0001	2.975	(2.761,3.207)	<.0001
Medical Marijuana Legal at Time of Interview <.0001						
Illegal	---			---		
Legal	1.131	(1.071,1.195)	<.0001	1.176	(1.104,1.253)	<.0001

Table 3. Univariable and Multivariable Analyses: Odds of Multiple Substance Use Disorder

Variable	Univariate Analysis			Multivariate Analysis		
	OR	95% CI	p-value	OR	95% CI	p-value
Legal Status of Marijuana						
Illegal	---			---		
Legal	1.073	(0.966,1.192)	<.0001	1.093	(0.974,1.227)	0.1297
Age (years)						
12-17	---			---		
18-25 (vs 12-17)	3.568	(3.018,4.218)	<.0001	1.213	(0.961,1.530)	0.1035
26-34 (vs 12-17)	2.897	(2.422,3.465)	<.0001	1.436	(1.122,1.839)	0.0041
35-49 (vs 12-17)	1.955	(1.630,2.346)	<.0001	1.278	(0.990,1.649)	0.0596
50-64 (vs 12-17)	0.775	(0.581,1.033)	0.0825	0.576	(0.407,0.816)	0.0019
65 or Older (vs 12-17)	0.193	(0.113,0.327)	<.0001	0.234	(0.132,0.415)	<.0001
Sex						
Male	---			---		
Female	0.728	(0.664,0.799)	<.0001	0.655	(0.593,0.724)	<.0001
Race/Ethnicity						
NonHisp White	---			---		
NonHisp Black/Afr Am	1.132	(0.982,1.303)	0.0866	1.014	(0.869,1.182)	0.8633
NonHisp Native Am/AK Native	2.265	(1.716,2.990)	<.0001	1.592	(1.173,2.161)	0.0028
NonHisp Native HI/Other Pac	1.678	(0.933,3.018)	0.0839	1.579	(0.844,2.955)	0.1533
NonHisp Asian	0.361	(0.256,0.510)	<.0001	0.532	(0.374,0.758)	0.0005
NonHisp more than one race	1.579	(1.296,1.923)	<.0001	1.301	(1.052,1.607)	0.0150
Hispanic	1.075	(0.951,1.216)	0.2462	0.866	(0.759,0.988)	0.0322
Marital Status						
Married	---			---		
Widowed	0.505	(0.249,1.025)	0.0584	1.120	(0.535,2.344)	0.7641
Divorced/Separated	3.316	(2.743,4.009)	<.0001	2.607	(2.128,3.193)	<.0001
Never Married	4.000	(3.496,4.578)	<.0001	2.434	(2.072,2.859)	<.0001
Age <14	0.355	(0.234,0.541)	<.0001	0.523	(0.329,0.832)	0.0062
Education Level						
Adult Less than High School	---			---		
Adult High School Graduate	0.835	(0.714,0.976)	0.0234	0.755	(0.639,0.892)	0.0010
Adult Some College/ Associate's Degree	0.760	(0.652,0.887)	0.0005	0.652	(0.551,0.771)	<.0001
Adult College Graduate	0.372	(0.314,0.440)	<.0001	0.443	(0.367,0.535)	<.0001
School Aged (12-17 years)	0.285	(0.234,0.348)	<.0001	4.275	(2.409,7.588)	<.0001
Total Family Income						
Less than $10,000 (Including Loss)	---			---		
$10,000 - $19,999	0.991	(0.828,1.186)	0.9188	1.085	(0.896,1.313)	0.4057
$20,000 - $29,999	0.697	(0.571,0.851)	0.0004	0.783	(0.633,0.968)	0.0240
$30,000 - $39,999	0.754	(0.620,0.917)	0.0047	0.857	(0.695,1.056)	0.1466
$40,000 - $49,999	0.646	(0.530,0.788)	<.0001	0.801	(0.648,0.990)	0.0400

$50,000 - $74,999	0.531	(0.441,0.640)	<.0001	0.714	(0.585,0.872)	0.0010
$75,000 or More	0.406	(0.347,0.476)	<.0001	0.652	(0.546,0.779)	<.0001
Binge Alcohol Use in Past 30 Days						
No	---			---		
Yes	7.235	(6.560,7.981)	<.0001	6.427	(5.782,7.143)	<.0001
Missing	5.499	(3.323,9.099)	<.0001	5.669	(3.357,9.574)	<.0001
Major Depressive Episode in Past 1 Year						
No	---			---		
Yes	4.429	(3.989,4.917)	<.0001	3.405	(3.027,3.830)	<.0001
Medical Marijuana Legal at Time of Interview						
Illegal	---			---		
Legal	1.155	(1.033,1.291)	0.0116	1.206	(1.068,1.361)	0.0025

Table 4. Univariable and Multivariable Analyses: Odds of Alcohol Use Disorder

Variable	**Univariate Analysis**			**Multivariate Analysis**		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Legal Status of Marijuana						
Illegal	---			---		
Legal	1.117	(1.048,1.190)	0.0007	1.003	(0.931,1.081)	0.9331
Age (years)						
12-17	---			---		
18-25 (vs 12-17)	4.815	(4.262,5.439)	<.0001	1.180	(0.986,1.413)	0.0708
26-34 (vs 12-17)	4.952	(4.364,5.620)	<.0001	1.327	(1.099,1.601)	0.0032
35-49 (vs 12-17)	4.218	(3.724,4.778)	<.0001	1.355	(1.119,1.640)	0.0018
50-64 (vs 12-17)	2.949	(2.540,3.424)	<.0001	1.153	(0.932,1.428)	0.1903
65 or Older (vs 12-17)	1.429	(1.193,1.711)	0.0001	0.834	(0.654,1.064)	0.1449
Sex						
Male	---			---		
Female	0.765	(0.723,0.809)	<.0001	0.701	(0.657,0.748)	<.0001
Race/Ethnicity						
NonHisp White	---			---		
NonHisp Black/Afr Am	0.832	(0.759,0.912)	<.0001	0.960	(0.863,1.068)	0.4494
NonHisp Native Am/AK Native	1.435	(1.173,1.757)	0.0005	1.547	(1.217,1.968)	0.0004
NonHisp Native HI/Other Pac	0.828	(0.521,1.316)	0.4244	0.934	(0.556,1.568)	0.7957
NonHisp Asian	0.552	(0.471,0.647)	<.0001	0.825	(0.692,0.983)	0.0311
NonHisp more than one race	0.924	(0.801,1.066)	0.2811	0.963	(0.819,1.134)	0.6528
Hispanic	0.907	(0.841,0.978)	0.0109	0.945	(0.865,1.031)	0.2042
Marital Status						

Married	---			---		
Widowed	0.601	(0.462,0.781)	0.0001	1.175	(0.874,1.580)	0.2853
Divorced/Separated	1.523	(1.373,1.689)	<.0001	1.492	(1.324,1.682)	<.0001
Never Married	1.472	(1.381,1.568)	<.0001	1.435	(1.309,1.572)	<.0001
Age <14	0.115	(0.087,0.151)	<.0001	0.420	(0.306,0.575)	<.0001
Education Level						
Adult Less than High School	---			---		
Adult High School Graduate	1.025	(0.916,1.147)	0.6628	0.916	(0.807,1.041)	0.1781
Adult Some College/ Associate's Degree	1.139	(1.021,1.270)	0.0195	0.952	(0.839,1.079)	0.4407
Adult College Graduate	1.043	(0.936,1.161)	0.4474	0.992	(0.871,1.129)	0.8999
School Aged (12-17 years)	0.260	(0.224,0.301)	<.0001	1.199	(0.940,1.529)	0.1449
Total Family Income						
Less than $10,000 (Including Loss)	---			---		
$10,000 - $19,999	0.919	(0.806,1.047)	0.2047	0.942	(0.811,1.093)	0.4282
$20,000 - $29,999	0.759	(0.660,0.872)	0.0001	0.793	(0.676,0.929)	0.0041
$30,000 - $39,999	0.886	(0.774,1.015)	0.0802	0.906	(0.776,1.058)	0.2133
$40,000 - $49,999	0.825	(0.721,0.943)	0.0048	0.884	(0.758,1.031)	0.1150
$50,000 - $74,999	0.861	(0.763,0.972)	0.0159	0.946	(0.821,1.089)	0.4379
$75,000 or More	0.823	(0.740,0.915)	0.0003	0.880	(0.774,1.001)	0.0525
Binge Alcohol Use in Past 30 Days						
No	---			---		
Yes	14.541	(13.623,15.521)	<.0001	12.644	(11.804,13.545)	<.0001
Missing	9.787	(7.131,13.431)	<.0001	9.051	(6.554,12.501)	<.0001
Major Depressive Episode in Past 1 Year						
No	---			---		
Yes	2.699	(2.503,2.910)	<.0001	2.337	(2.134,2.559)	<.0001
Medical Marijuana Legal at Time of Interview						
Illegal	---			---		
Legal	1.064	(0.996,1.137)	0.0656	1.104	(1.022,1.193)	0.0121

Table 5. Univariable and Multivariable Analyses: Odds of Cannabis Use Disorder

Variable	**Univariate Analysis**			**Multivariate Analysis**		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Legal Status of Marijuana						
Illegal	---			---		
Legal	1.218	(1.138,1.304)	<.0001	1.313	(1.218,1.415)	<.0001
Age (years)						

12-17	---			---		
18-25 (vs 12-17)	3.046	(2.759,3.362)	<.0001	1.481	(1.281,1.713)	<.0001
26-34 (vs 12-17)	2.154	(1.933,2.401)	<.0001	1.483	(1.265,1.737)	<.0001
35-49 (vs 12-17)	1.217	(1.087,1.363)	0.0007	1.041	(0.882,1.229)	0.6330
50-64 (vs 12-17)	0.570	(0.475,0.683)	<.0001	0.512	(0.409,0.641)	<.0001
65 or Older (vs 12-17)	0.143	(0.102,0.200)	<.0001	0.164	(0.114,0.237)	<.0001
Sex						
Male	---			---		
Female	0.748	(0.704,0.795)	<.0001	0.689	(0.645,0.736)	<.0001
Race/Ethnicity						
NonHisp White	---			---		
NonHisp Black/Afr Am	1.285	(1.173,1.408)	<.0001	1.070	(0.969,1.182)	0.1787
NonHisp Native Am/AK Native	2.195	(1.799,2.678)	<.0001	1.610	(1.298,1.998)	<.0001
NonHisp Native HI/Other Pac	1.246	(0.791,1.962)	0.3435	1.003	(0.624,1.611)	0.9901
NonHisp Asian	0.382	(0.307,0.475)	<.0001	0.440	(0.352,0.550)	<.0001
NonHisp more than one race	1.774	(1.557,2.021)	<.0001	1.389	(1.208,1.598)	<.0001
Hispanic	1.180	(1.089,1.278)	<.0001	0.878	(0.805,0.957)	0.0032
Marital Status						
Married	---			---		
Widowed	0.449	(0.287,0.703)	0.0005	0.944	(0.589,1.512)	0.8092
Divorced/Separated	2.180	(1.908,2.491)	<.0001	1.764	(1.531,2.034)	<.0001
Never Married	3.738	(3.438,4.064)	<.0001	1.915	(1.730,2.121)	<.0001
Age <14	0.524	(0.423,0.648)	<.0001	0.453	(0.355,0.579)	<.0001
Education Level						
Adult Less than High School	---			---		
Adult High School Graduate	0.929	(0.835,1.035)	0.1814	0.877	(0.783,0.983)	0.0237
Adult Some College/ Associate's Degree	0.777	(0.698,0.865)	<.0001	0.755	(0.673,0.847)	<.0001
Adult College Graduate	0.357	(0.318,0.400)	<.0001	0.490	(0.431,0.558)	<.0001
School Aged (12-17 years)	0.390	(0.344,0.442)	<.0001	6.086	(4.217,8.783)	<.0001
Total Family Income						
Less than $10,000 (Including Loss)	---			---		
$10,000 - $19,999	1.091	(0.962,1.238)	0.1759	1.246	(1.090,1.423)	0.0012
$20,000 - $29,999	0.953	(0.835,1.088)	0.4767	1.135	(0.987,1.306)	0.0766
$30,000 - $39,999	0.885	(0.774,1.012)	0.0751	1.081	(0.938,1.246)	0.2819
$40,000 - $49,999	0.746	(0.651,0.854)	<.0001	0.957	(0.829,1.104)	0.5446
$50,000 - $74,999	0.636	(0.560,0.722)	<.0001	0.904	(0.790,1.035)	0.1441
$75,000 or More	0.431	(0.386,0.482)	<.0001	0.706	(0.625,0.799)	<.0001
Binge Alcohol Use in Past 30 Days						

No	---			---		
Yes	2.872	(2.695,3.059)	<.0001	2.469	(2.304,2.646)	<.0001
Missing	2.448	(1.656,3.621)	<.0001	2.428	(1.604,3.673)	<.0001
Major Depressive Episode in Past 1 Year						
No	---			---		
Yes	3.802	(3.524,4.103)	<.0001	2.889	(2.656,3.143)	<.0001
Medical Marijuana Legal at Time of Interview						
Illegal	---			---		
Legal	1.246	(1.156,1.343)	<.0001	1.273	(1.174,1.381)	<.0001

Table 6. Univariable and Multivariable Analyses: Odds of Methamphetamine Use Disorder

Variable	**Univariate Analysis**			**Multivariate Analysis**		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Legal Status of Marijuana						
Illegal	---			---		
Legal	0.625	(0.466,0.839)	0.0017	0.557	(0.410,0.755)	0.0002
Age (years)						
12-17	---			---		
18-25 (vs 12-17)	10.997	(3.417,35.397)	<.0001	5.761	(1.740,19.070)	0.0041
26-34 (vs 12-17)	32.797	(10.378,103.649)	<.0001	33.451	(10.242,109.252)	<.0001
35-49 (vs 12-17)	40.959	(13.052,128.537)	<.0001	49.676	(15.262,161.689)	<.0001
50-64 (vs 12-17)	21.990	(6.730,71.850)	<.0001	24.416	(7.156,83.310)	<.0001
65 or Older (vs 12-17)	1.486	(0.248,8.899)	0.6642	2.013	(0.322,12.599)	0.4545
Sex						
Male	---			---		
Female	0.812	(0.651,1.013)	0.0651	0.629	(0.498,0.794)	<.0001
Race/Ethnicity						
NonHisp White	---			---		
NonHisp Black/Afr Am	0.257	(0.140,0.471)	<.0001	0.138	(0.075,0.256)	<.0001
NonHisp Native Am/AK Native	1.767	(0.903,3.460)	0.0965	0.764	(0.381,1.530)	0.4474
NonHisp Native HI/Other Pac	4.316	(1.894,9.837)	0.0005	2.360	(0.986,5.650)	0.0539
NonHisp Asian	0.223	(0.083,0.600)	0.0030	0.443	(0.163,1.207)	0.1115
NonHisp more than one race	1.236	(0.762,2.005)	0.3907	0.934	(0.567,1.539)	0.7890
Hispanic	0.969	(0.729,1.288)	0.8284	0.727	(0.539,0.980)	0.0363

Marital Status						
Married	---			---		
Widowed	2.181	(0.928,5.124)	0.0737	(1.076,6.419)	(1.076,6.419)	0.0340
Divorced/ Separated	8.285	(5.771,11.894)	<.0001	(2.684,5.771)	(2.684,5.771)	<.0001
Never Married	2.785	(2.007,3.864)	<.0001	(2.005,4.132)	(2.005,4.132)	<.0001
Age <14	<0.001	(<0.001,>999.999)	0.9671	(<0.001,>999.999)	(<0.001,>999.999)	0.9690
Education Level						
Adult Less than High School	---			---		
Adult High School Graduate	0.562	(0.418,0.754)	0.0001	0.618	(0.454,0.841)	0.0022
Adult Some College/ Associate's Degree	0.447	(0.332,0.603)	<.0001	0.522	(0.379,0.719)	<.0001
Adult College Graduate	0.082	(0.051,0.131)	<.0001	0.143	(0.086,0.237)	<.0001
School Aged (12-17 years)	0.017	(0.005,0.053)	<.0001	0.497	(0.079,3.108)	0.4545
Total Family Income						
Less than $10,000 (Including Loss)	---			---		
$10,000 - $19,999	0.658	(0.474,0.913)	0.0124	0.630	(0.449,0.886)	0.0079
$20,000 - $29,999	0.458	(0.314,0.668)	<.0001	0.476	(0.322,0.703)	0.0002
$30,000 - $39,999	0.426	(0.289,0.627)	<.0001	0.442	(0.296,0.660)	<.0001
$40,000 - $49,999	0.297	(0.194,0.453)	<.0001	0.344	(0.222,0.532)	<.0001
$50,000 - $74,999	0.102	(0.060,0.175)	<.0001	0.130	(0.075,0.226)	<.0001
$75,000 or More	0.093	(0.064,0.135)	<.0001	0.177	(0.117,0.268)	<.0001
Binge Alcohol Use in Past 30 Days						
No	---			---		
Yes	1.493	(1.173,1.901)	0.0011	1.124	(0.875,1.443)	0.3604
Missing	<0.001	(<0.001,>999.999)	0.9736	<0.001	(<0.001,>999.999)	0.9878
Major Depressive Episode in Past 1 Year						
No	---			---		
Yes	4.367	(3.432,5.558)	<.0001	3.152	(2.436,4.078)	<.0001
Medical Marijuana Legal at Time of Interview						
Illegal	---			---		
Legal	0.952	(0.738,1.230)	0.7084	1.089	(0.834,1.422)	0.5322

Table 7. Univariable and Multivariable Analyses: Odds of Stimulant Use Disorder

Variable	Univariate Analysis			Multivariate Analysis		
	OR	95% CI	p-value	OR	95% CI	p-value
Legal Status of Marijuana						
Illegal	---			---		
Legal	0.869	(0.616,1.225)	0.4226	0.896	(0.625,1.286)	0.5515
Age (years)						
12-17	---			---		
18-25 (vs 12-17)	1.831	(1.161,2.888)	0.0093	0.640	(0.316,1.299)	1.5265
26-34 (vs 12-17)	2.003	(1.242,3.231)	0.0044	1.142	(0.545,2.391)	0.1235
35-49 (vs 12-17)	1.362	(0.834,2.222)	0.2168	1.115	(0.521,2.384)	0.0783
50-64 (vs 12-17)	0.472	(0.194,1.147)	0.0974	0.492	(0.168,1.440)	1.6760
65 or Older (vs 12-17)	0.171	(0.041,0.721)	0.0162	0.278	(0.057,1.340)	2.5456
Sex						
Male	---			---		
Female	0.857	(0.644,1.140)	0.2881	0.791	(0.589,1.061)	0.1175
Race/Ethnicity						
NonHisp White	---			---		
NonHisp Black/Afr Am	0.241	(0.113,0.515)	0.0002	0.213	(0.099,0.461)	<.0001
NonHisp Native Am/AK Native	0.286	(0.040,2.050)	0.2131	0.213	(0.030,1.537)	0.1251
NonHisp Native HI/Other Pac	1.033	(0.144,7.421)	0.9743	1.011	(0.138,7.403)	0.9915
NonHisp Asian	0.411	(0.168,1.004)	0.0510	0.568	(0.231,1.400)	0.2192
NonHisp more than one race	0.705	(0.330,1.508)	0.3677	0.554	(0.257,1.192)	0.1308
Hispanic	0.643	(0.428,0.965)	0.0332	0.549	(0.362,0.832)	0.0047
Marital Status						
Married	---			---		
Widowed	<0.001	(<0.001,>999.999)	0.9711	<0.001	(<0.001,>999.999)	0.9774
Divorced/Separated	2.105	(1.131,3.915)	0.0188	1.681	(0.886,3.191)	0.1122
Never Married	3.236	(2.179,4.804)	<.0001	2.750	(1.723,4.388)	<.0001
Age <14	0.766	(0.319,1.841)	0.5511	1.014	(0.363,2.832)	0.9794
Education Level						
Adult Less than High School	---			---		
Adult High School Graduate	0.900	(0.510,1.589)	0.7167	0.782	(0.440,1.390)	0.4028
Adult Some College/ Associate's Degree	1.248	(0.731,2.131)	0.4172	0.955	(0.552,1.652)	0.8701
Adult College Graduate	0.654	(0.371,1.152)	0.1416	0.611	(0.335,1.114)	0.1076

School Aged (12-17 years)	0.651	(0.353,1.201)	0.1695	3.602	(0.746,17.392)	0.1106
Total Family Income						
Less than $10,000 (Including Loss)	---			---		
$10,000 - $19,999	1.028	(0.565,1.870)	0.9274	1.022	(0.559,1.868)	0.9436
$20,000 - $29,999	0.687	(0.349,1.355)	0.2790	0.700	(0.353,1.389)	0.3072
$30,000 - $39,999	0.735	(0.377,1.431)	0.3647	0.742	(0.378,1.456)	0.3853
$40,000 - $49,999	0.877	(0.471,1.633)	0.6780	0.931	(0.495,1.751)	0.8254
$50,000 - $74,999	0.759	(0.423,1.361)	0.3542	0.820	(0.451,1.493)	0.5171
$75,000 or More	0.595	(0.356,0.993)	0.0468	0.719	(0.417,1.239)	0.2346
Binge Alcohol Use in Past 30 Days						
No	---			---		
Yes	3.676	(2.761,4.893)	<.0001	3.030	(2.234,4.110)	<.0001
Missing	<0.001	(<0.001,>999.999)	0.9802	<0.001	(<0.001,>999.999)	0.9885
Major Depressive Episode in Past 1 Year						
No	---			---		
Yes	5.391	(3.995,7.274)	<.0001	4.093	(2.949,5.682)	<.0001
Medical Marijuana Legal at Time of Interview						
Illegal	---			---		
Legal	0.859	(0.622,1.185)	0.3539	0.907	(0.648,1.269)	0.5680

Table 8. Univariable and Multivariable Analyses: Odds of Opioid Use Disorder

Variable	Univariate Analysis			Multivariate Analysis		
	OR	95% CI	p-value	OR	95% CI	p-value
Legal Status of Marijuana						
Illegal	---			---		
Legal	0.940	(0.758,1.165)	0.5695	0.955	(0.764,1.195)	0.6888
Age (years)						
12-17	---			---		
18-25 (vs 12-17)	1.114	(0.814,1.525)	0.5011	1.074	(0.692,1.665)	0.7502
26-34 (vs 12-17)	1.453	(1.052,2.006)	0.0234	2.489	(1.580,3.920)	<.0001
35-49 (vs 12-17)	2.023	(1.512,2.706)	<.0001	4.408	(2.841,6.838)	<.0001
50-64 (vs 12-17)	1.358	(0.922,1.999)	0.1213	2.981	(1.771,5.020)	<.0001
65 or Older (vs 12-17)	0.582	(0.341,0.993)	0.0471	1.665	(0.857,3.235)	0.1322
Sex						
Male	---			---		
Female	1.047	(0.872,1.258)	0.6214	0.961	(0.796,1.162)	0.6830
Race/Ethnicity						
NonHisp White	---			---		
NonHisp Black/Afr Am	0.998	(0.749,1.329)	0.9891	0.663	(0.491,0.894)	0.0071
NonHisp Native Am/AK	1.316	(0.675,2.567)	0.4207	0.727	(0.369,1.434)	0.3576

Native						
NonHisp Native HI/Other Pac	1.580	(0.502,4.974)	0.4340	1.025	(0.319,3.293)	0.9667
NonHisp Asian	0.166	(0.062,0.446)	0.0004	0.258	(0.096,0.695)	0.0074
NonHisp more than one race	1.700	(1.181,2.446)	0.0043	1.294	(0.892,1.876)	0.1747
Hispanic	0.980	(0.767,1.252)	0.8711	0.732	(0.567,0.946)	0.0169
Marital Status						
Married	---			---		
Widowed	1.819	(0.911,3.632)	0.0901	1.414	(0.681,2.937)	0.3531
Divorced/Separated	3.893	(2.835,5.346)	<.0001	2.057	(1.475,2.869)	<.0001
Never Married	2.395	(1.868,3.071)	<.0001	2.235	(1.668,2.995)	<.0001
Age <14	1.279	(0.826,1.979)	0.2701	1.773	(0.996,3.156)	0.0515
Education Level						
Adult Less than High School	---			---		
Adult High School Graduate	0.585	(0.448,0.765)	<.0001	0.609	(0.463,0.802)	0.0004
Adult Some College/ Associate's Degree	0.458	(0.349,0.601)	<.0001	0.452	(0.340,0.601)	<.0001
Adult College Graduate	0.130	(0.091,0.187)	<.0001	0.163	(0.111,0.241)	<.0001
School Aged (12-17 years)	0.303	(0.220,0.418)	<.0001	0.600	(0.309,1.166)	0.1322
Total Family Income						
Less than $10,000 (Including Loss)	---			---		
$10,000 - $19,999	0.891	(0.654,1.213)	0.4635	0.900	(0.657,1.233)	0.5133
$20,000 - $29,999	0.607	(0.427,0.861)	0.0052	0.671	(0.469,0.959)	0.0287
$30,000 - $39,999	0.562	(0.393,0.805)	0.0016	0.641	(0.444,0.925)	0.0175
$40,000 - $49,999	0.458	(0.316,0.664)	<.0001	0.567	(0.388,0.828)	0.0033
$50,000 - $74,999	0.270	(0.185,0.396)	<.0001	0.371	(0.250,0.550)	<.0001
$75,000 or More	0.247	(0.184,0.331)	<.0001	0.432	(0.313,0.597)	<.0001
Binge Alcohol Use in Past 30 Days						
No	---			---		
Yes	1.587	(1.303,1.934)	<.0001	1.466	(1.191,1.804)	0.0003
Missing	1.840	(0.585,5.787)	0.2969	2.054	(0.643,6.567)	0.2246
Major Depressive Episode in Past 1 Year						
No	---			---		
Yes	3.833	(3.123,4.704)	<.0001	3.565	(2.850,4.461)	<.0001
Medical Marijuana Legal at Time of Interview						
Illegal	---			---		
Legal	1.093	(0.878,1.359)	0.4258	1.151	(0.918,1.443)	0.2218

Table 9. Summary of Stepwise Selection, Any Substance Use Disorder

Step	Entered	Removed	DF	Number In	Score ChiSq	Wald ChiSq	Pr > ChiSq
1	Binge Alcohol Use in Past 30 Days		2	1	6793.5751		<.0001
2	Major Depressive Episode in Past Year		1	2	1255.2024		<.0001
3	Marital Status		4	3	820.0617		<.0001
4	Sex		1	4	187.1985		<.0001
5	Age Category		5	5	216.5840		<.0001
6	Family Income		6	6	142.5101		<.0001
7	Race/ Ethnicity		6	7	100.3829		<.0001
8	Highest Level of Education Completed		3	8	55.8759		<.0001
9	Legal Status of Medical Cannabis		1	9	38.8496		<.0001
10	Legal Status of Recreational Cannabis		1	10	19.6596		<.0001

Table 10. Summary of Stepwise Selection, Multiple Substance Use Disorders

Step	Entered	Removed	DF	Number In	Score ChiSq	Wald ChiSq	Pr > ChiSq
1	Binge Alcohol Use in Past 30 Days		2	1	2058.1145		<.0001
2	Major Depressive Episode in Past Year		1	2	651.1528		<.0001
3	Marital Status		4	3	428.2836		<.0001
4	Highest Level of Education Completed		4	4	142.4132		<.0001
5	Age Category		4	5	82.3070		<.0001
6	Sex		1	6	58.2422		<.0001
7	Family Income		6	7	48.9692		<.0001
8	Race/ Ethnicity		6	8	38.5080		<.0001
9	Legal Status of Medical Cannabis		1	9	11.9127		0.0006

Table 11. Summary of Stepwise Selection, Alcohol Use Disorder

Step	Entered	Removed	DF	Number In	Score ChiSq	Wald ChiSq	Pr > ChiSq
1	Binge Alcohol Use in Past 30 Days		2	1	9222.2390		<.0001
2	Major Depressive Episode in Past Year		1	2	417.3828		<.0001

3	Marital Status		4	3	187.6719		<.0001
4	Sex		1	4	110.8893		<.0001
5	Age Category		5	5	47.4937		<.0001
6	Race/ Ethnicity		6	6	20.5117		0.0022
7	Legal Status of Medical Cannabis		1	7	6.6836		0.0097
8	Family Income		6	8	10.7934		0.0950
9		Family Income	6	7		10.7829	0.0953

Table 12. Summary of Stepwise Selection, Cannabis Use Disorder

Step	Entered	Removed	DF	Number In	Score ChiSq	Wald ChiSq	Pr > ChiSq
1	Marital Status		4	1	1527.1698		<.0001
2	Binge Alcohol Use in Past 30 Days		2	2	894.1775		<.0001
3	Major Depressive Episode in Past Year		1	3	761.5407		<.0001
4	Highest Level of Education Completed		4	4	324.9969		<.0001
5	Age Category		4	5	279.3198		<.0001
6	Sex		1	6	101.3691		<.0001
7	Family Income		6	7	133.5161		<.0001
8	Race/ Ethnicity		6	8	115.4191		<.0001
9	Legal Status of Recreational Cannabis		1	9	75.4706		<.0001
10	Legal Status of Medical Cannabis		1	10	34.3113		<.0001

Table 13. Summary of Stepwise Selection, Methamphetamine Use Disorder

Step	Entered	Removed	DF	Number In	Score ChiSq	Wald ChiSq	Pr > ChiSq
1	Family Income		6	1	275.1450		<.0001
2	Age Category		5	2	260.3107		<.0001
3	Major Depressive Episode in Past Year		1	3	104.8706		<.0001
4	Highest Level of Education Completed		3	4	71.7455		<.0001
5	Marital Status		4	5	56.5519		<.0001
6	Race/ Ethnicity		6	6	62.0371		<.0001
7	Sex		1	7	14.4415		0.0001
8	Legal Status of Recreational Cannabis		1	8	14.2425		0.0002

Table 14. Summary of Stepwise Selection, Stimulant Use Disorder

Step	Entered	Removed	DF	Number In	Score ChiSq	Wald ChiSq	Pr > ChiSq
1	Major Depressive Episode in Past Year		1	1	152.5579		<.0001
2	Binge Alcohol Use in Past 30 Days		2	2	72.2635		<.0001
3	Marital Status		4	3	30.5065		<.0001
4	Race/ Ethnicity		6	4	23.9297		0.0005
5	Age Category		5	5	15.6578		0.0079
6	Highest Level of Education Completed		3	6	7.4670		0.0584
7		Highest Level of Education Completed	3	5		7.3498	0.0615

Table 15. Summary of Stepwise Selection, Opioid Use Disorder

Step	Entered	Removed	DF	Number In	Score ChiSq	Wald ChiSq	Pr > ChiSq
1	Major Depressive Episode in Past Year		1	1	191.0554		<.0001
2	Highest Level of Education Completed		4	2	155.8298		<.0001
3	Age Category		4	3	88.8107		<.0001
4	Family Income		6	4	64.2336		<.0001
5	Marital Status		4	5	36.1034		<.0001
6	Binge Alcohol Use in Past 30 Days		2	6	14.7296		0.0006
7	Race/ Ethnicity		6	7	22.6406		0.0009