Post reform cannabis use and mental health: A naturalistic investigation

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Abstract

Since cannabis reform, the use of marijuana has surged exponentially, yet safe intake interval has not been investigated for long term mental health consequences. This study presents a comprehensive analysis of the severity of cannabis use and mental health outcomes, sociodemographic correlates of cannabis use utilizing National Survey on Drug Use and Health (NSDUH) data collected in 2021. The study involved a nationally representative sample of 47,291 adult residents of U.S. Descriptive and inferential statistical tests were conducted to analyze the prevalence and associations. The study reveals a significant prevalence of marijuana use among the participants, with 51% reporting having used marijuana at some point in their lives. Higher marijuana use was observed with young adults and females. Increased likelihood of lifetime and past year depression episodes, depression with severe role impairment were observed among cannabis users compared to non-users. However mild cannabis use seems to exhibit a level of mental health impact that is next to that of severe consumption. Around 80% of adults considered both heavy and mild marijuana consumption as not posing a great risk for recreational use. These findings highlight the importance of considering the potential risks of marijuana consumption, particularly in relation to mental health outcomes. This research contributes valuable insights that can inform targeted interventions and policies aimed at promoting mental health and well-being.

Keywords:

Introduction

Marijuana is one of the most abused substances globally (Pintori et al., 2023). Historically in the U.S., the drug had long been used as analgesic until the invention of aspirin and opioid. However, its extensive consumption and associated side effects prompted its prohibition in 1937 (Aggarwal et al., 2018). Cannabis use has brought about considerable controversy in recent years since it is thought to be less harmful than other substances like alcohol or tobacco (Antunes et al., 2023; Artiles et al., 2019; Van Amsterdam et al., 2015). The growing interest in the potential benefits of medical marijuana has led to resurgence of legal medical applications, followed by the enactment of recreational marijuana use.

Cannabinoids have been utilized for medicinal purposes, showing potential benefits in managing various conditions such as chronic pain, muscle spasticity, cachexia, anorexia, opioid addiction, anxiety or depression, fibromyalgia multiple sclerosis, neurodegenerative disorders, epilepsy, schizophrenia, cardiovascular disorders, dermatological problem like pruritus, psoriasis, and cancer (Avila et al., 2020; Kogan & Mechoulam, 2007; Malhotra et al., 2021; Sagy et al., 2019; Sanchez-Ramos, 2015; Vučković et al., 2018). While the drug has exhibited various therapeutic properties, a collective scholarly perspective strongly indicates potential harm to the extent that the risks appear to outweigh the benefits. Chronic consumption of the drug presents negative effects on brain function, increased risk of mental health problems like anxiety, cognitive decline, depression, psychosis, schizophrenia, addictions, cannabis use disorder, self-harm, suicidal intent, ideation, attempts, and death, and also physical health problems like oral cancer, cardiorespiratory problems, increased risks of accidents, mental health issues, and adverse perinatal outcomes (Cohen et al., 2019; Crocker et al., 2021; Dhadwal & Kirchhof, 2017; Nawa et al., 2020; Pacher et al., 2017; Paul et al., 2019; Singh et al., 2017; Sorkhou et al., 2021). Even short-term intake may result in unfavorable outcomes such as dizziness, cognitive effects, and dry mouth (MacCallum et al., 2021).

Depression is one of the most pronounced side effects of cannabis consumption, and the nature of the relationship, whether it is a direct or bidirectional association, remains unclear. According to Dierker et al. (2018), depression is a major problem associated with marijuana consumption across all frequency levels. Cannabis use has been linked to increased suicidal ideation, planning, and attempts among young adults, independent of existing depression (Han et al., 2021). Evidence suggests a bidirectional nature in this relationship, with mental health conditions such as depression, mood disorders, or substance use like cigarette smoking contributing to a higher likelihood of marijuana usage, including earlier initiation and lifelong use (Crane et al., 2015; Dierker et al., 2018; Hines et al., 2020). Cannabis use may exacerbate the symptoms of mood disorders, hindering the proper treatment of individuals already suffering from depression or bipolar disorder (Fontanella et al., 2021). In contrast, medical marijuana is believed to have therapeutic effects on negative affect symptoms, including stress, anxiety, and depression. However, existing literature presents mixed findings on this issue. While acute usage of medicinal cannabis promptly decreases negative symptoms, repeated usage does not lead to sustained long-term relief; instead, baseline depression levels may increase (Cuttler et al., 2018).

Despite widespread concerns voiced by the researchers on the harmful effects of cannabis, medical cannabis has been legalized in 38 states, three territories, and the District of Columbia by April 24, 2023. Additionally, regulations for recreational marijuana have been enacted in 24 states, two territories, and the District of Columbia since November 8, 2023. The recreational marijuana reform, following cannabis reform, decriminalized possession for recreational use among adults aged 21 and older in the U.S. (*State Medical Cannabis Laws*, 2023). Overall, the introduction of medical and recreational marijuana reform has led to a significant increase in marijuana use, reflecting a notable shift in risk perception, an elevated risk threshold, and higher availability (Martins et al., 2016; Ryan & Ammerman, 2017, Wen et al.,

2015). Between 2014 and 2021, cannabis use in the adult age group experienced substantial rise. Among young adults (18 to 25 years old), cannabis use increased by 73.53%, adding 5 million new users (from 6.8 million in 2014 to 11.8 million in 2021). The surge was even more pronounced for adults 26 years and older, with a staggering increase of 180.74%, totaling almost 24.4 million adults (from 13.5 million in 2014 to 37.9 million in 2021) (Center for Behavioral Health Statistics and Quality, 2015; Substance Abuse and Mental Health Services Administration, 2022). This underscores the urgency and importance of investigating the mental health impact of marijuana use frequency in the adult population.

In the context of post-legalization, the perceived safety of mild marijuana consumption has undergone a significant shift. Among young adults aged 18 to 25 in 2021, 1.1 million people-initiated marijuana use in the past year. Additionally, 620,000 adults aged 26 or older initiated marijuana use in the past year, constituting almost 25 percent of those who initiated use in 2021. Among individuals aged 12 or older in 2021, 16.3 million people reported past-year marijuana use disorder. Most (57.6 percent) had a mild disorder, compared to only 16.1 percent with a severe disorder (Substance Abuse and Mental Health Services Administration, 2022). However, whether mild consumption has mental health effects extrapolating beyond conventional safety assumptions (Chang et al., 2019; Englund et al., 2017) has not been studied adequately. Additionally, we found a noticeable scarcity of discussion on sociodemographic correlates of marijuana use. Some studies have researched into trends primarily among different age group or gender groups of American adults in general. Salas-Wright et al. (2017) studied participants of latter adulthood and reported an upward trend in marijuana consumption. Weidberg et al. (2023) found that female young adults who used cannabis in the past month had higher levels of depression, anxiety, and stress compared to male users. However, we feel the need to explore the sociodemographic trends in marijuana use and correlates encompassing not only age and gender

but also other important factors like race, income, employment, marital status etc. Neither of our literature search provide an in-depth assessment of the most recent trend data as of 2021, nor systematically examine the national estimate of key correlates of marijuana use in a broad range of sociodemographic factors.

Based on this justification, we seek to advance the current research landscape by understanding the mental health safety in adults in relation to mild marijuana consumption. Additionally, our focus includes exploring the trends in perception, prevalence of usage, and identifying the sociodemographic distribution by cannabis use frequency. The contributions of this work are many. First, the study contributes to the existing pool of literature in the relationship between marijuana use frequency and depression. Second, the study results can provide latest conservative national estimates of marijuana consumptions correlates and trends of use and perception. Third, we estimate predictive prevalence depression at different level of use of cannabis and compare our findings to inform future work. The remainder of the paper is organized as follows. The next section describes the study in terms of materials, measurements, methods, analysis, findings, and discussion. We propose several launching points for research based on the study findings and implications.

Method

Sample Participants:

The National Survey of Drug Use and Health (NSDUH) survey conducted in2021 has 47,291 adult participants. Data were compiled in four quarters throughout the year. Participant's responses were collected through web and in-person due to the challenges posed by the COVID-19 pandemic. This dataset represents data from across the United States. To achieve national representativeness, state based multistage area sampling techniques were adopted. The inclusion criteria were adults aged 18 and above, excluding youth aged 12 to 17 due to differences in

depression measurement for this age group, residents of the US, and completion of the survey for all independent and dependent variables of interest.

Measurement:

The primary outcome measures were lifetime major depressive episodes (MDE), Past year MDE, MDE with severe role impairment. All of these are binary dichotomous variables with the answer "Yes" or "No". The National Survey on Drug Use and Health (NSDUH) assessed lifetime Major Depressive Episode (MDE) with criteria adopted from Diagnostic and Statistical Manual of Mental Disorders-5 (American Psychiatric Association, 2013) which defines lifetime MDE requiring at least five of nine depression symptoms in a 2-week period, including a depressed mood or loss of interest. Respondents with a lifetime MDE were further classified as having past-year MDE if they experienced a 2-week or longer period of depression in the past 12 months with other MDE symptoms present. Past year cannabis use was categorized into 4 categories based on the number of days the participant used cannabis in the past year named non-user (no use of cannabis in the past year), mild user (1-11 days in the past year), moderate user (12-49 days in the past year), heavy user ($\geq$50 days in the past year) (Gukasyan & Strain, 2020). The NSDUH 2021 further adopted Sheehan Disability Scale (Leon et al., 1997) and measured four role domains (home management, ability to work, close relationships, and social life), evaluating the impact of the disorder on adults. A 10-point scale measured role functioning, with scores $\geq$7 in any domain indicating MDE with severe role impairment.

Statistical Analysis:

Descriptive analysis was conducted to describe the demographics of participants, and to measure the prevalence of cannabis use in lifetime and in the preceding year and the perception of the participants about the risk associated with the frequency of the cannabis use. Chi square

cross tab analyses were conducted to assess the participants demographic distribution in relation to cannabis use. Binary logistic regression analyses were conducted to assess the to assess the predictive probabilities of experiencing Lifetime Major Depressive Episode (MDE), Past Year MDE, and Past Year MDE with Severe Role Impairment based on various sociodemographic factor and cannabis use frequency. The magnitude of the observed association was highlighted with calculated odds ratios (OR) with 95% confidence intervals (CI). All statistical analyses were performed using SPSS version 26.0 (SPSS, Chicago, IL, USA) and p-value cutoff for statistical significance was 0.05 with 95% confidence.

Result

Supplementary Table 1 and Table 2 in the appendix displays the socio-demographic distribution, prevalence of cannabis use, cannabis consumption behavior, perception of cannabis use of total adult sample participants (N= 47291). Results are reported with unweighted number of participants (N) and weighted percentages across the categories of sociodemographic variables. Within the nationally representative adult sample, 29.6% were aged 18-25 years and 11.5% aged 65 or older. The majority were female (55.8%), white (62.1%), never married (44.9%), and college graduates (36.7%). Employment status varied, with 48.5% employed full time. Total family income showed diversity, with 39.7% earning $75,000 or more. Approximately 51% acknowledged having used marijuana at some point in their lives, with 6.3% using it for 300-365 days in the past year (near daily use). Past year's consumption patterns revealed infrequent or abstinent behavior among 75.8% of participants while varying frequencies were reported among users (24.2%). Among users, 6.5% and 13.9% of respondents were mild and heavy users respectively. 78.5% of participants perceive heavy marijuana use (1-2 times per week) as posing a minimal risk.

Table 1: Sociodemographic Correlates of Marijuana Use

Variable	Marijuana ever used N (%)	p	Past year cannabis uses N (%)			p
			Mild	Moderate	Severe	
Age		<0.001				<0.001
18-25 Years	6872(28.5)		1192(39)	772(42.6)	2783(42.4)	
26-34 Years	5429(22.5)		756(24.7)	425(23.4)	1632(24.9)	
35-49 Years	6715(27.8)		747(24.5)	405(22.3)	1508(23)	
50-64 Years	3003(12.4)		231(7.6)	130(7.2)	445(6.8)	
65 or Older	2110(8.7)		129(4.2)	82(4.5)	197(3.0)	
Gender		<0.001				<0.001
Male	11015(45.7)		1253(41)	820(45.2)	3420(52.1)	
Female	13114(54.3)		1802(59)	994(54.8)	3145(47.9)	
Race		<0.001				<0.001
White	16198(67.1)		2073(67.9)	1137(62.7)	3945(60.1)	
African American	2465(10.2)		241(7.9)	210(11.6)	946(14.4	
Hispanic	3226(13.4)		428(14)	283(15.6)	986(15)	
Other	2240(9.3)		313(10.2)	184(10.1)	688(10.5)	
Marital Status		<0.001				<0.001
Married	9173(38)		963(31.5)	472(26)	1451(22.1)	
Widowed	478(2)		32(1)	22(1.2)	67(1)	
Divorced or separated	3016(12.5)		298(9.8)	178(9.8)	744(11.3)	
Never Been Married	11462(47.5)		1762(57.7)	1142(63)	4303(65.5)	
Education		<0.001				<0.001
Less high school	1955(8.1)		148(4.8)	162(8.9)	794(12.1)	
High school grad	5482(22.7)		553(18.1)	401(22.1)	1930(29.4)	
Some college	7826(32.4)		994(32.5)	579(31.9)	2362(36)	
College graduate/above	8866(36.7)		1360(44.5)	672(37)	1479(22.5)	
Employment status		<0.001				<0.001
Employed full time	12597(52.2)		1675(54.8)	928(51.2)	3007(45.8)	
Employed part time	3569(14.8)		557(18.2)	321(17.7)	1086(16.5)	
Unemployed	1643(6.8)		193(6.3)	142(7.8)	702(10.7)	
Other	6320(26.2)		630(20.6)	423(23.3)	1770(27)	
Total family Income		0.01				<0.001

Less than $20,000	4416(18.3)	577(18.9)	397(21.9)	1702(25.9)
$20,000 - $49,999	6498(26.9)	729(23.9)	522(28.8)	2161(32.9)
$50,000 - $74,999	3664(15.2)	450(14.7)	233(12.8)	956(14.6)
$75,000 or More	9551(39.6)	1299(42.5)	662(36.8)	1746(36.6)

Note. N= 47,291, chi square test is conducted to observe the association, p value is significant at <0.05

The sociodemographic correlates of marijuana use are explored with crosstab chi-square analyses in Table 1, revealing significant associations with age, gender, race, marital status, education, employment status, and total family income. A clear trend emerges for age association, with the prevalence of marijuana use decreasing as age increases. The highest prevalence is observed among those aged 18-25 years, accounting for 28.5% reported ever using marijuana, while those aged 65 or older had the lowest prevalence (8.7%). A similar pattern was observed in the past-year use of cannabis, with the highest prevalence in the youngest age group and a progressive decline with increasing age. The chi-square test indicates a highly significant association between age and marijuana use ($p < 0.001$). Gender differences are also evident, with females showing a higher prevalence of marijuana use compared to males (54.3% vs. 45.7%), and this difference is statistically significant ($p < 0.001$). However past year heavy use of marijuana seems to be higher in males (52.1%) than females (47.9%).

The data highlights that race exhibited a significant association with marijuana use ($p < 0.001$). Individuals identifying themselves as White have a higher prevalence of marijuana use compared to other racial groups (67.1%). Similarly, marital status, education, employment status, and total family income demonstrated significant associations with both lifetime and past-year marijuana use ($p < 0.05$). Never-married individuals have a higher prevalence (47.5%) of lifetime marijuana consumption compared to those who are married, widowed, or

divorced/separated (p < 0.001). Education and employment status also play a role, with higher education and full-time employment associated with increased marijuana use (p < 0.001) income disparities influence marijuana use, with higher prevalence among individuals with family incomes more than 75,000(39.6%) followed by below $20,000 (18.3%). This income-related disparity is statistically significant (p = 0.01) and similar trends were observed among past year cannabis user in three different categories.

Table 2. Binary logistic regression analyses; MDE and respective predictive margins of sociodemographic variables and severity of cannabis use

Variable	Lifetime MDE (Major Depressive Episode)		Past Year MDE		Past Year MDE with Severe Role Impairment	
	Odds ratio	p	Odds ratio	p	Odds ratio	p
Age						
18-25 Years	3.615(3.23-4)	**<0.001**	7.048(5.99-8.29)	**<0.001**	9.018(7.28-11.17)	**<0.001**
26-34 Years	2.907(2.62-3.23)	**<0.001**	4.555(3.85-5.38)	**<0.001**	5.691(4.56-7.09)	**<0.001**
35-49 Years	2.383(2.15-2.65)	**<0.001**	3.393(2.87-4)	**<0.001**	4.096(3.29-5.11)	**<0.001**
50-64 Years	1.767(1.57-1.99)	**<0.001**	2.34(1.94-2.82)	**<0.001**	2.964(2.33-3.77)	**<0.001**
65 or Older	Reference					
Gender						
Male	0.576(0.55-0.6)	<0.001	0.56(0.53-0.59)	<0.001	0.55(0.51-0.59)	<0.001
Female	Reference					
Race						
White	1.175(1.09-1.27)	**<0.001**	1.056(0.96-1.16)	0.25	1.007(0.91-1.12)	0.89
African American	0.623(0.56-0.69)	**<0.001**	0.694(0.61-0.79)	**<0.001**	0.663(0.57-0.77)	**<0.001**
Hispanic	0.973(0.89-1.07)	0.548	1.027(0.92-1.15)	0.64	0.956(0.84-1.09)	0.49
Other	Reference					
Marital Status						
Married	0.525(0.5-0.55)	**<0.001**	0.376(0.35-0.40)	**<0.001**	0.342(0.32-0.37)	**<0.001**
Widowed	0.495(0.42-0.58)	**<0.001**	0.37(0.29-0.46)	**<0.001**	0.363(0.28-0.47)	**<0.001**
Divorced or separated	0.93(0.86-1)	0.055	0.765(0.69-0.84)	**<0.001**	0.762(0.69-0.85)	**<0.001**

Never Married	Reference					
Education						
High school grad	1.254(1.14-1.38)	**<0.001**	1.154(1.03-1.29)	**<0.05**	1.150(1-1.31)	**<0.05**
Some college	1.838(1.68-2.02)	**<0.001**	1.59(1.43-1.77)	**<0.001**	1.606(1.42-1.82)	**<0.001**
≥ College grad	1.453(1.33-1.59)	**<0.001**	0.961(0.86-1.07)	0.485	0.856(0.75-0.98)	**<0.05**
Less high school	Reference					
Employment						
Part time	1.462(1.37-1.56)	**<0.001**	1.62(1.5-1.75)	**<0.001**	1.66(1.52-1.82)	**<0.001**
Unemployed	1.218(1.11-1.34)	**<0.001**	1.689(1.52-1.88)	**<0.001**	1.898(1.68-2.15)	**<0.001**
Other	0.895(0.89-0.85)	**<0.001**	1.091(1.02-1.17)	**<0.05**	1.189(1.1-1.29)	**<0.001**
Full time	Reference					
Family Income						
Less than $20,000	1.371(1.29-1.46)	**<0.001**	1.883(1.74-2.04)	**<0.001**	2.194(2-2.4)	**<0.001**
$20,000 - $49,999	1.286(1.22-1.36)	**<0.001**	1.58(1.47-1.69)	**<0.001**	1.707(1.57-1.86)	**<0.001**
$50,000 - $74,999	1.171(1.09-1.26)	**<0.001**	1.277(1.17-1.39)	**<0.001**	1.367(1.23-1.52)	**<0.001**
$75,000 or More	Reference					
Severity of cannabis use						
Mild user	2.326(2.14-2.52)	**<0.001**	2.44(2.21-2.69)	**<0.001**	2.332(2.08-2.61)	**<0.001**
Moderate user	2.119(1.91-2.35)	**<0.001**	2.211(1.95-2.51)	**<0.001**	2.136(1.84-2.48)	**<0.001**
Severe user	2.294(2.16-2.43)	**<0.001**	2.68(2.5-2.87)	**<0.001**	2.967(2.74-3.21)	**<0.001**
No user	Reference					

Note: Odds ratios (OR), 95% confidence intervals (CI), and p-values (significant at <0.05) are presented for sociodemographic variables and cannabis use frequency in relation to major depressive episodes.

The table 2 provides a comprehensive overview of the odds ratios (OR) at 95% confidence intervals (CI) for lifetime and past year major depressive episodes (MDE), and MDE with severe role impairment across various socio- demographic and cannabis usage variables. The sociodemographic and cannabis use variables of interest are age, gender, race, marital status, education, employment, family income, and severity of cannabis use. The odds ratios indicate the

likelihood of experiencing lifetime and past year major depressive episode, and MDE with severe role impairment in different groups compared to reference categories, with statistical significance denoted by p-values.

Individuals aged 18-25 years exhibit significantly higher odds of lifetime MDE (OR=3.615, p<0.001), past-year MDE (OR=7.048, p<0.001), and past-year MDE with severe role impairment (OR=9.018, p<0.001) compared to those aged 65 or older, who serve as the reference group. This trend continues across age groups, with decreasing odds as age increases. Males demonstrate lower odds of lifetime MDE (OR=0.576, p<0.001), past-year MDE (OR=0.560, p<0.001), and past-year MDE with severe role impairment (OR=0.550, p<0.001) compared to females. In other words, in comparison to males, females have approximately 1.736 times higher odds of lifetime MDE, 1.786 times higher odds of past-year MDE, and 1.818 times higher odds of past-year MDE with severe role impairment.

Being married (OR=0.525, p<0.001) is associated with lower odds of MDE compared to never married individuals. Similarly, higher education levels and family income are generally associated with lower odds of MDE, while Part-time employment (OR=1.462, p<0.001) and unemployment (OR=1.218, p<0.001) are linked with higher odds of MDE compared to full-time employment.
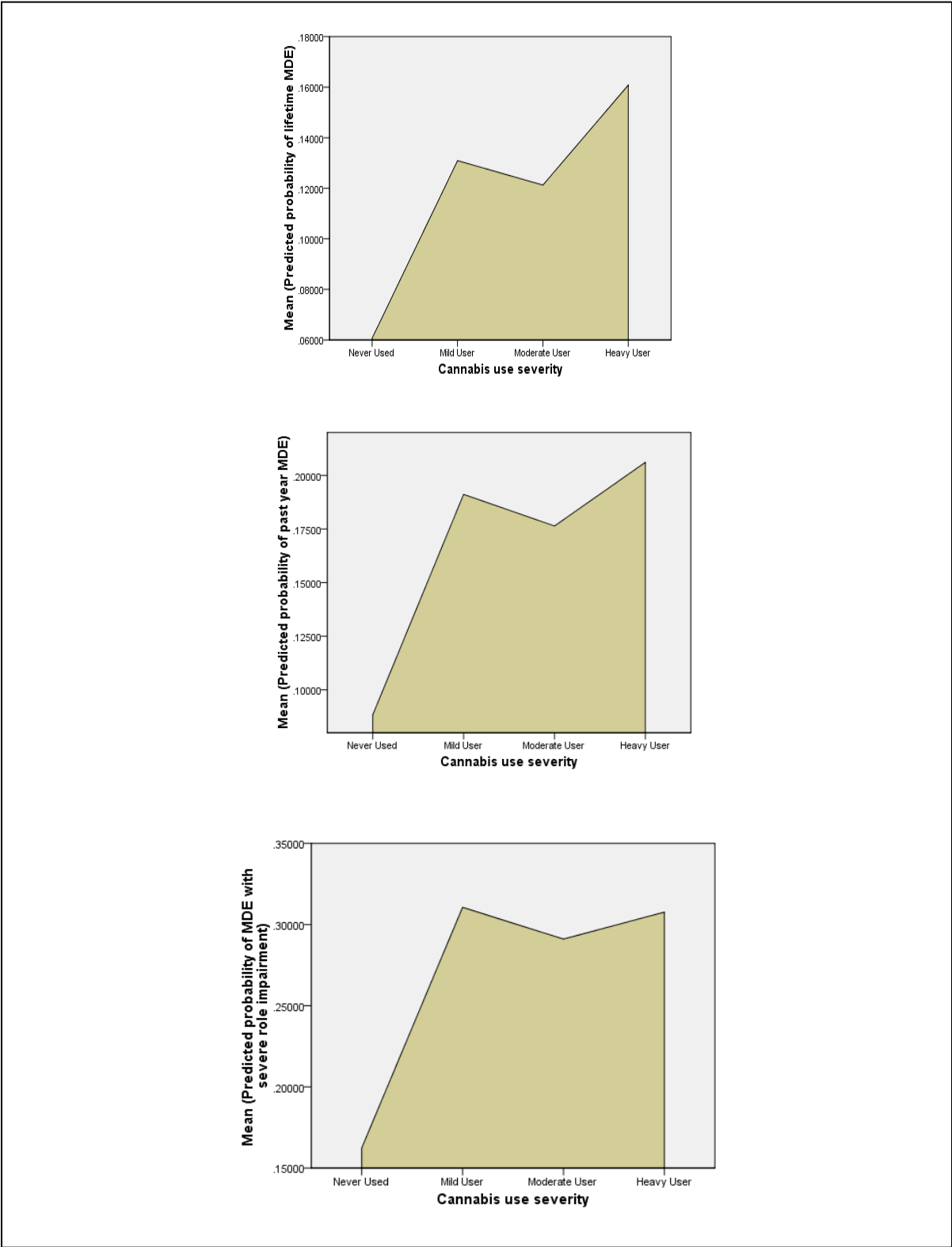
Fig 1: Predictive probability of lifetime MDE, past year MDE, MDE with severe role impairment

Individuals with mild, moderate, or severe cannabis use exhibit progressively higher odds of MDE compared to non-users, emphasizing a potential association between past year cannabis use severity and depressive episodes. Compared to non-users, mild cannabis users have 2.326 times higher odds of a lifetime MDE, 2.44 times higher odds of a past-year MDE, and 2.332 times higher odds of a past-year MDE with severe role impairment. Similarly, moderate and severe users exhibit progressively higher odds ratios. The narrow confidence intervals reflect a high degree of precision in the estimations. Figure 1 demonstrates predictive probability of lifetime major depressive episodes (MDE), past year MDE, MDE with severe role impairment for past year cannabis use severity categories (no use, mild use, moderate use, heavy use).

Discussion

The findings shed light on the complex interplay between sociodemographic factors, cannabis use perceptions and patterns, and the prevalence of major depressive episodes (MDE) in lifetime or the preceding year and with morbidity like severe role impairment among a diverse nationally representative sample of 47,291 participants from the U.S. We observed age-related variation in marijuana use, with the highest prevalence observed among individuals aged 18-25 years and a gradual decline in usage with increasing age. This partly aligns with existing literature highlighting a sharp rise in post-legalization susceptibility to cannabis use during early adulthood (De Faria et al., 2021). Females exhibit a higher prevalence of marijuana use and higher odds of major depressive disorder (MDE) than males. While males show lower prevalence of mild and moderate use of marijuana, they demonstrate a higher incidence of heavy consumption compared to females. Females show overall higher likelihood of lifetime MDE, past year MDE, and MDE with severe role impairment. In contrast, existing literature has mixed findings on gender association of cannabis use and subsequent relationship to MDE. Some studies reported cannabis use in different gender to have no significant association to MDE

(Halladay et al., 2018) or poorer mental health predominantly in male counterpart (Prowse et al., 2021), while some studies reported otherwise (Weidberg et al., 2023).

Approximately one-fourth of the adult population in the U.S. reported past-year marijuana use in 2021, with the highest rates observed among young adults, females, white individuals followed by Hispanic, never married individuals, and individuals with annual incomes below $20,000 or above $75,000. Other studies, including Salas-Wright et al. (2017), have reported a parallel increase in cannabis use trends from 2002 to 2014, while Mitchell et al. (2020) noted a significant rise in consumption, especially among low-income and younger age cohorts, spanning from 2005 to 2018. As indicated by Parekh et al. (2020), frequent marijuana users were predominantly young adults, non-Hispanic, either white or black, with some college education while our findings suggest college grads and above has the highest consumption followed by some college cohort.
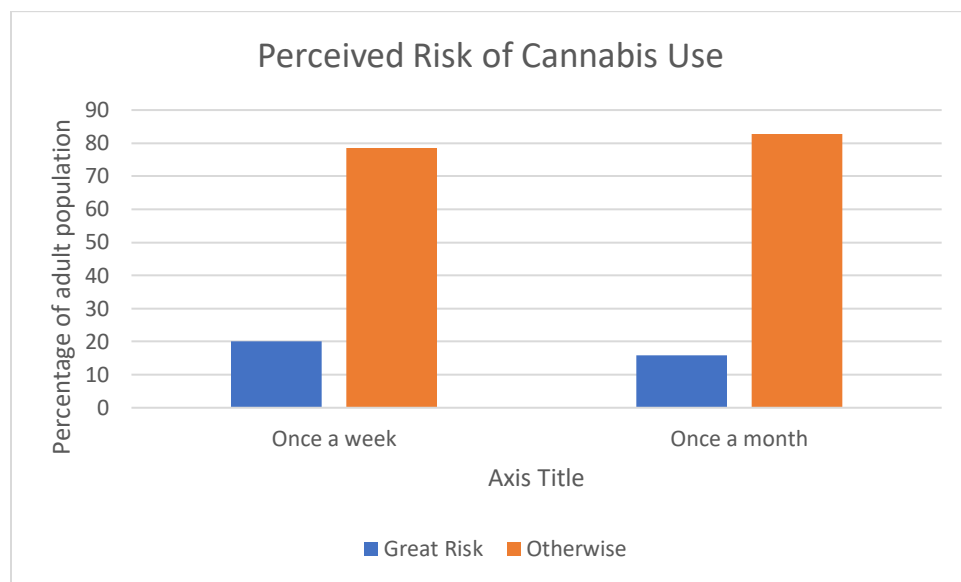

Figure 2. Adult perception of risk of Marijuana use

Moving beyond the sociodemographic associations, we investigated the relationship between cannabis use severity and MDE outcomes (lifetime MDE, past year MDE, MDE with

severe role impairment). The odds ratios reveal a significant association between increasing cannabis use severity and higher predictive prevalence of lifetime and past-year MDE, as well as MDE with severe role impairment. The findings reveal that the impact of mild cannabis use on Major Depressive Episode (MDE) outcomes is closely aligned with that of severe use surpassing moderate use. This is an interesting novel finding, which adds a layer of complexity to the understanding of cannabis use impact on mental health landscape. It prompts a reconsideration of conventional assumptions about the relative safety of mild cannabis consumption, suggesting that even as little as one to 11 days of use per year may bear significant consequences for mental well-being. Studies have shown that recreational cannabis legalization increases the perceived safety threshold of cannabis use (Amroussia et al., 2020). Furthermore, our study found that about 80% of the adult population perceived heavy marijuana consumption (>50 days a year) and mild marijuana consumption (1-11 days per year) as posing a low risk for intake (Figure 2). Policymakers, healthcare professionals, and the public alike should consider these findings when formulating guidelines, interventions, and educational initiatives related to cannabis use.

Our study uniquely contributes to the field by utilizing the most recent NSDUH data available, collected in 2021. To the best of our knowledge, such extensive analysis of sociodemographic variables, cannabis use patterns and perceptions, and mental health outcomes in conjunction with the nationally representative data have not been previously undertaken. In our exploration of the existing literature, we identified a study that bears resemblance to ours, focusing on adolescent participants and utilizing NSDUH data from 2012-2017. Interestingly, in contrast to our study, this research found that heavy cannabis use among adolescents was associated with a lower likelihood of adverse mental health effects, such as depression and suicidal attempts, compared to mild and moderate use. Some limitations of our study, such as the reliance on self-reported data and the cross-sectional nature of the analysis, are acknowledged.

This observation overall raises important questions about the relative safety of mild cannabis consumption, potential bidirectional relationship between cannabis uses and mental health outcomes.

Conclusion

The outcomes of our study present important insights into the dynamics of marijuana use, sociodemographic factors, and mental health outcomes. The observed sociodemographic variations underscore the susceptibility to cannabis use among young adults and females, aligning with post-legalization trends. The study challenges conventional assumptions about the safety of mild cannabis consumption. About four in five adults perceived risky consumption of marijuana as non-risky intake suggesting a need for educational intervention in a large scale. Our findings indicate that any level of cannabis use is associated with higher likelihood of depression with or without severe role impairment. Even mild cannabis use may have significant consequences for mental well-being, urging policymakers and healthcare professionals to consider these insights. Future research can explore the causation as well as consider co use of other substances or other overlapping factors for the detrimental mental health effect at different level of cannabis consumption.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used language model chat GPT in a very few instances to concise the writing and improve the readability. After using this tool/service, the

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Appendix

Supplementary Table 1. Demographic characteristics of the participants

Variable	Frequency	Percentage
Age		
18-25 Years Old	13,979	29.6
26-34 Years Old	9,588	20.3
35-49 Years Old	1,561	26.6
50-64 Years Old	5.725	12.1
65 or Older	5,438	11.5
Gender		
Male	20,901	44.2
Female	26,390	55.8
Race		
White	29,349	62.1
African American	5,244	11.1
Hispanic	7,451	15.8
Other	5,247	11.1
Marital Status		
Married	19,778	41.8
Widowed	1,416	3.0

Variable	Frequency	Percentage
Divorced or separated	4,875	10.3
Never Been Married	21,222	44.9
Education		
Less high school	4,473	9.5
High school grad	11,189	23.7
Some coll/Assoc Dg	14,251	30.1
College graduate	17,378	36.7
Employment status		
Employed full time	22,947	48.5
Employed part time	7,001	14.8
Unemployed	2,896	6.1
Other	14,447	30.5
Total family Income		
Less than $20,000	8,412	17.8
$20,000 - $49,999	12,907	27.3
$50,000 - $74,999	7,180	15.2
$75,000 or More	18,792	39.7

Note. Total participants, N= 47,291

Supplementary Table 2. Cannabis consumption behavior and perception among participants

Variable	Frequency	Percentage
Marijuana use- ever		
No	23,162	49.0
Yes	24,129	51.0
Days of marijuana use in the past year		
1-11 Days	3,055	6.5
12-49 Days	1,814	3.8
50-99 Days	948	2.0
100-299 Days	2,654	5.6
300-365 Days	2,963	6.3
Non-User/No Past Year Use	35,857	75.8
Cannabis user type		
Never Used	35,857	75.8
Mild User	3,055	6.5
Moderate User	1,814	3.8
Heavy User	6,565	13.9
Marijuana use 1-2 times per week		
Otherwise	37,100	78.5

Great Risk	9,476	20.0

Note. Total number of participants, N= 47,291