





## Post-reform cannabis use and major depressive episode: A naturalistic investigation

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### ABSTRACT

Since cannabis reform, the use of marijuana has surged exponentially. Marijuana use is a widely known risk factor for depression, yet a safe cannabis intake interval has not been investigated in relation to depression. This study presents a comprehensive analysis of the depressive episodes at different levels of cannabis use, as well as socio-demographic correlates of cannabis use, utilizing national survey on drug use and health data collected in 2021. The study involved a nationally representative sample of 47,291 adult residents of the USA. 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 certain likelihood of depressive episodes 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 depression outcomes. This research contributes valuable insights that can inform targeted interventions and policies aimed at promoting mental health and well-being.

**Keywords:** marijuana, adult depression, mild cannabis use, major depressive episode with severe role impairment, cannabis consumption behavior and perception

## INTRODUCTION

Marijuana is one of the most abused substances globally [1]. Historically in the USA, 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 [2]. 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 [3-5]. 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 problems like pruritus, psoriasis, and cancer [6-11]. 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 [12-18]. Even short-term intake may result in unfavorable outcomes such as dizziness, cognitive effects, and dry mouth [19].

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. Depression is a major problem associated with marijuana consumption across all frequency levels [20]. Cannabis use has been linked to increased suicidal ideation, planning, and attempts among young adults, independent of existing depression [21]. 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 [20, 22]. Cannabis use may exacerbate the symptoms of mood disorders, hindering the proper treatment of individuals already suffering from depression or bipolar disorder [23]. 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 [24].

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 24 April 2023. Additionally, regulations for recreational marijuana have been enacted in 24 states, two territories, and the District of Columbia since 8 November 2023. The recreational marijuana reform, following cannabis reform, decriminalized possession for recreational use among adults aged 21 and older in the USA [25]. 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 [26-28]. 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) [29, 30]. This underscores the urgency and importance of investigating the mental health impact by 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 [30]. However, whether mild consumption has mental health effects extrapolating beyond conventional safety assumptions has not been studied adequately [31, 32]. Additionally, we found a noticeable scarcity of discussion on socio-demographic factors of marijuana use. Some studies have researched into trends primarily among different age group or sex groups of American adults in general. It was studied for participants of latter adulthood and reported an upward trend in marijuana consumption [33]. It was found that female young adults who used cannabis in the past month had higher levels of depression, anxiety, and stress compared to male users [34]. However, we feel the need to explore the socio-demographic trends and factors in marijuana use encompassing not only age and sex 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 in the prevalence of marijuana consumption and perceived marijuana safety data as of 2021, nor systematically examine the key factors of marijuana use in a broad range of socio-demographic factors with a nationally representative adult sample.

Based on this justification, we seek to advance the current research landscape by understanding the likelihood of major depressive episodes (MDE) in adults in relation to mild

marijuana consumption. Additionally, our focus includes exploring the trends in perception, prevalence of usage, and identifying the socio-demographic 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 national estimates of the socio-demographic factors influencing marijuana consumption and trends of use and perception. Third, we estimate the odds of 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 in 2021 has 47,291 adult participants. Data were compiled for 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 data set represents data from across the USA. 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 USA, and completion of the survey for all independent and dependent variables of interest.

### Measurement

The primary outcome measures were lifetime MDE, past-year MDE, MDE with severe role impairment. All of these are binary dichotomous variable with answer "yes" or "no". NSDUH assessed lifetime MDE with criteria adopted from diagnostic and statistical manual of mental disorders-5 by American Psychiatric Association in 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/yearly use), moderate user (12-49 days in the past-year/monthly use), heavy user ( $\geq 50$  days in the past-year/weekly to near daily use). Frequency of use was recoded from NSDUH question for "Days of use of marijuana in the past-year" with six categories, as follows: 1-11 days, 12-49 days, 50-99 days, 100-299 days, 300-365 days, non-user or no past-year use. This categorization is adopted from previous cannabis literature, some of which also utilized data from NSDUH of early years [35-37]. NSDUH 2021 further adopted Sheehan disability scale [38] 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

**Table 1.** Demographic characteristics of the participants

Variable	Frequency (n)	Percentage (%)
<b>Age</b>		
18-25 years old	13,979	29.6
26-34 years old	9,588	20.3
35-49 years old	12,561	26.6
50-64 years old	5,725	12.1
65 or older	5,438	11.5
<b>Sex</b>		
Male	20,901	44.2
Female	26,390	55.8
<b>Race</b>		
White	29,349	62.1
African American	5,244	11.1
Hispanic	7,451	15.8
Other	5,247	11.1
<b>Marital status</b>		
Married	19,778	41.8
Widowed	1,416	3.0
Divorced or separated	4,875	10.3
Never been married	21,222	44.9
<b>Education</b>		
Less high school	4,473	9.5
High school grad	11,189	23.7
Some coll/associate degree	14,251	30.1
College graduate	17,378	36.7
<b>Employment status</b>		
Employed full time	22,947	48.5
Employed part time	7,001	14.8
Unemployed	2,896	6.1
Other	14,447	30.5
<b>Total family income</b>		
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

indicating MDE with severe role impairment. Further details can be found in 2021 NSDUH public use file codebook [39].

### 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. Logistic regression analyses were conducted to assess the likelihood experiencing lifetime MDE, past-year MDE, and past-year MDE with severe role impairment based on various socio-demographic factor and cannabis use frequency. The magnitude of the observed association was highlighted with calculated odds ratios (OR) at 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.

## RESULTS

**Table 1** outlines the demographic characteristics of 47,291 participants. The age distribution shows a diverse range, with the majority falling between 18-49 years (76.5%). Sex distribution indicates a slight female majority (55.8%), and the

**Table 2.** Cannabis consumption behavior and perception among participants

Variable	Frequency (n)	Percentage (%)
<b>Marijuana use-ever</b>		
No	23,162	49.0
Yes	24,129	51.0
<b>Days of marijuana use in the past year</b>		
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 or no past-year use	35,857	75.8
<b>Cannabis user type</b>		
Never used	35,857	75.8
Mild user	3,055	6.5
Moderate user	1,814	3.8
Heavy user	6,565	13.9
<b>Marijuana use 1-2 times per week</b>		
Otherwise	37,100	78.5
Great risk	9,476	20.0

Note. Total participants: N = 47,291

racial composition is predominantly White (62.1%). Marital status reveals a mix, with a significant portion never been married (44.9%). Education levels vary, with a considerable proportion holding a college degree (36.7%). Employment status highlights a majority being employed full-time (48.5%). The total family income distribution demonstrates diversity, with 39.7% reporting an income of \$75,000 or more.

**Table 2** delves into the prevalence and perception of marijuana consumption among participants. A significant past usage among the respondents were observed. A considerable proportion of respondents (51%) acknowledged having used marijuana at some point in their lives. Analysis of the past-year's consumption patterns revealed infrequent or abstinent behavior that 75.8% of participants were non-users during this period while varying frequencies were reported among users (24.2%). User participants were categorized into four distinct types to explore usage pattern: past-year abstinence (0 days of cannabis consumption in the past-year), mild users (1-11 days in the past-year), moderate users (12-51 days in the past-year), and severe users (> 51 to up to 365 days in the past-year) [36]. 6.5%, 13.9% of respondents were classified as mild and heavy users, respectively. The study also explored the perception of risk associated with using marijuana 1-2 times per week (heavy consumption of marijuana). Findings demonstrate that 78.5% of participants perceive heavy use of marijuana (1-2 times a week) as posing a low risk.

The socio-demographic correlates of marijuana use are explored in **Table 3**, revealing significant associations with age, sex, 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. Chi-square test indicates a highly significant association between age and marijuana use ( $p < 0.001$ ). Sex differences are also evident, with females showing a higher prevalence of marijuana use compared to males (45.7% vs. 54.3%), and this

**Table 3.** Socio-demographic correlations 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	6,872 (28.5)		1,192 (39.0)	772 (42.6)	2,783 (42.4)	
26-34 years	5,429 (22.5)		756 (24.7)	425 (23.4)	1,632 (24.9)	
35-49 years	6,715 (27.8)		747 (24.5)	405 (22.3)	1,508 (23.0)	
50-64 years	3,003 (12.4)		231 (7.6)	130 (7.2)	445 (6.8)	
65 or older	2,110 (8.7)		129 (4.2)	82 (4.5)	197 (3.0)	
Sex		< 0.001				< 0.001
Male	11,015 (45.7)		1,253 (41.0)	820 (45.2)	3,420 (52.1)	
Female	13,114 (54.3)		1,802 (59.0)	994 (54.8)	3,145 (47.9)	
Race		< 0.001				< 0.001
White	16,198 (67.1)		2,073 (67.9)	1,137 (62.7)	3,945 (60.1)	
African American	2,465 (10.2)		241 (7.9)	210 (11.6)	946 (14.4)	
Hispanic	3,226 (13.4)		428 (14.0)	283 (15.6)	986 (15.0)	
Other	2,240 (9.3)		313 (10.2)	184 (10.1)	688 (10.5)	
Marital status		< 0.001				< 0.001
Married	9,173 (38.0)		963 (31.5)	472 (26.0)	1,451 (22.1)	
Widowed	478 (2.0)		32 (1.0)	22 (1.2)	67 (1.0)	
Divorced or separated	3,016 (12.5)		298 (9.8)	178 (9.8)	744 (11.3)	
Never been married	11,462 (47.5)		1,762 (57.7)	1,142 (63.0)	4,303 (65.5)	
Education		< 0.001				< 0.001
Less high school	1,955 (8.1)		148 (4.8)	162 (8.9)	794 (12.1)	
High school grad	5,482 (22.7)		553 (18.1)	401 (22.1)	1,930 (29.4)	
Some college	7,826 (32.4)		994 (32.5)	579 (31.9)	2,362 (36.0)	
College graduate/above	8,866 (36.7)		1,360 (44.5)	672 (37.0)	1,479 (22.5)	
Employment status		< 0.001				< 0.001
Employed full time	12,597 (52.2)		1675 (54.8)	928 (51.2)	3,007 (45.8)	
Employed part time	3,569 (14.8)		557 (18.2)	321 (17.7)	1,086 (16.5)	
Unemployed	1,643 (6.8)		193 (6.3)	142 (7.8)	702 (10.7)	
Other	6,320 (26.2)		630 (20.6)	423 (23.3)	1,770 (27.0)	
Total family income		0.010				< 0.001
Less than \$20,000	4,416 (18.3)		577 (18.9)	397 (21.9)	1,702 (25.9)	
\$20,000-\$49,999	6,498 (26.9)		729 (23.9)	522 (28.8)	2,161 (32.9)	
\$50,000-\$74,999	3,664 (15.2)		450 (14.7)	233 (12.8)	956 (14.6)	
\$75,000 or more	9,551 (39.6)		1,299 (42.5)	662 (36.8)	1,746 (36.6)	

Note. N = 47,291 & Chi-square test is conducted for categorical variables

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 4** provides a comprehensive overview of OR at 95% CI for lifetime and past-year MDE, and MDE with severe role impairment across various socio-demographic and cannabis usage variables. The socio-demographic and cannabis use

variables of interest are age, sex, race, marital status, education, employment, family income, and severity of cannabis use. OR indicate the likelihood of experiencing lifetime and past-year MDE, 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.

**Table 4.** Logistic regression analyses: Associations of MDE with socio-demographic variables and different levels of cannabis use

Variable	Lifetime MDE		Past-year MDE		Past-year MDE with SRI	
	OR	p	OR	p	OR	p
<b>Age</b>						
18-25 years	3.615 (3.23-4.00)	< 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 (2.87-4.00)	< 0.001	4.096 (3.29-5.11)	< 0.001
50-64 years	1.767 (1.57-1.99)	< 0.001	2.340 (1.94-2.82)	< 0.001	2.964 (2.33-3.77)	< 0.001
65 or older	Reference					
<b>Sex</b>						
Male	0.576 (0.55-0.60)	< 0.001	0.560 (0.53-0.59)	< 0.001	0.550 (0.51-0.59)	< 0.001
Female	Reference					
<b>Race</b>						
White	1.175 (1.09-1.27)	< 0.001	1.056 (0.96-1.16)	0.250	1.007 (0.91-1.12)	0.890
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)	0.640	0.956 (0.84-1.09)	0.490
Other	Reference					
<b>Marital status</b>						
Married	0.525 (0.50-0.55)	< 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	0.370 (0.29-0.46)	< 0.001	0.363 (0.28-0.47)	< 0.001
Divorced or separated	0.930 (0.86-1.00)	0.055	0.765 (0.69-0.84)	< 0.001	0.762 (0.69-0.85)	< 0.001
Never been married	Reference					
<b>Education</b>						
High school graduate	1.254 (1.14-1.38)	< 0.001	1.154 (1.03-1.29)	< 0.050	1.150 (1.00-1.31)	< 0.050
Some college	1.838 (1.68-2.02)	< 0.001	1.590 (1.43-1.77)	< 0.001	1.606 (1.42-1.82)	< 0.001
≥ college graduate	1.453 (1.33-1.59)	< 0.001	0.961 (0.86-1.07)	0.485	0.856 (0.75-0.98)	< 0.050
Less high school	Reference					
<b>Employment</b>						
Part time	1.462 (1.37-1.56)	< 0.001	1.620 (1.50-1.75)	< 0.001	1.660 (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)	< 0.050	1.189 (1.10-1.29)	< 0.001
Full time	Reference					
<b>Family Income</b>						
Less than \$20,000	1.371 (1.29-1.46)	< 0.001	1.883 (1.74-2.04)	< 0.001	2.194 (2.00-2.40)	< 0.001
\$20,000-\$49,999	1.286 (1.22-1.36)	< 0.001	1.580 (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					
<b>Severity of cannabis use</b>						
Mild user	2.326 (2.14-2.52)	< 0.001	2.440 (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	2.680 (2.50-2.87)	< 0.001	2.967 (2.74-3.21)	< 0.001
No user	Reference					

Note. p-values (significant at <0.05) are presented for socio-demographic variables and cannabis use frequency in relation to MDE & SRI: 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 OD. The narrow CI reflect a high degree of precision in the estimations.

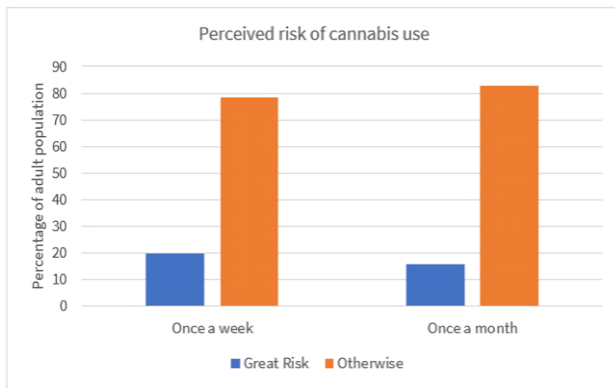
## DISCUSSION

The findings shed light on the complex interplay between socio-demographic factors, cannabis use perceptions and patterns, and the prevalence of 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 USA. 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 aligns with existing literature highlighting a sharp rise in post-legalization susceptibility to cannabis use during early adulthood [40]. Females exhibit a higher prevalence of marijuana use and higher odds of 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.

Approximately one-fourth of the adult population in the USA 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. The study in [33] has reported a parallel increase in cannabis use trends from 2002 to 2014, while the study in [41] noted a significant rise in consumption, especially among low-income and younger age cohorts, spanning from 2005 to 2018. As indicated in [42], frequent marijuana users were predominantly young adults, non-Hispanic, either white or





**Figure 1.** Adult perception of risk of marijuana use (Source: Authors' own elaboration)

black, with some college education while our findings suggest college grads and above has the highest consumption followed by some college cohort.

Moving beyond the socio-demographic associations, we investigated the relationship between cannabis use severity and MDE outcomes (lifetime MDE, past-year MDE, and MDE with severe role impairment). OR reveal a significant association between increasing cannabis use severity and lifetime MDE, past-year MDE, as well as MDE with severe role impairment. The findings reveal that the impact of mild cannabis use on 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 [43]. 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 1**). 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 socio-demographic 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 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. This observation overall raises important questions about the relative safety of mild cannabis consumption, potential bidirectional relationship between cannabis uses and mental health outcomes.

Some limitations of our study, such as the reliance on self-reported data and the cross-sectional nature of the analysis, are acknowledged. One limitation in this field of research is the lack of established severity categories for marijuana use frequency ranges. There are variations in defining different levels of cannabis consumption. Further research is needed to establish a guideline for the severity of marijuana exposure. Despite the legalization of recreational marijuana use, there is a general need to address the dose, duration, interval based on formulation and method of administration and integrate those factors into consumer regulation.

## CONCLUSION

The outcomes of our study present important insights into the dynamics of marijuana use, socio-demographic factors, and mental health outcomes. The observed socio-demographic 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.

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**Ethics declaration:** The authors stated that the study utilized publicly available data from the National Survey on Drug Use and Health (NSDUH) 2021, which is conducted in compliance with ethical guidelines and approved by relevant institutional review boards. No additional ethical approval was required as the dataset is anonymized and does not contain personally identifiable information. The authors further stated that informed consent was obtained by the original data-collecting organization. The authors declare no conflicts of interest related to this research.

**Declaration of interest:** No conflict of interest is declared by the authors.

**Data sharing statement:** Data supporting the findings and conclusions are available upon request from the corresponding author.

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