Cannabis Use Among US Adolescents

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abstract

BACKGROUND AND OBJECTIVES: Adolescence is a critical period for cognitive, social, and emotional development. Existing data on dose-dependent associations between cannabis use and adverse psychosocial development indicators in adolescence are limited, particularly for low-frequency users. We describe relationships between cannabis use frequency and psychosocial indicators.

METHODS: This cross-sectional study used a US nationally representative sample of 8th, 10th, and 12th grade students from the 2018-2022 Monitoring the Future surveys. Participants were categorized for nonuse and noncurrent, monthly, weekly, and near-daily cannabis use. We describe demographically adjusted odds of cannabis use frequency and cognitive, social, and emotional indicators.

RESULTS: Among 162 532 respondents (mean age, 16.0 years [SD, 1.7]; 45.8% male; racially and ethnically diverse), 42 601 (26.2%) were cannabis users: 7515 (4.6%) were near-daily, 5853 (3.6%) were weekly, 7802 (4.8%) were monthly, and 21 431 (13.2%) were noncurrent users. Compared with nonusers, noncurrent and monthly users had greater odds of poor academic performance (adjusted odds ratio [aOR], 1.30–2.20), poor impulsivity and self-regulation (aOR, 1.26–2.19), and adverse emotional states (aOR, 1.1–1.42). Adjusted odds of all adverse psychosocial categories, excluding low social engagement, showed a consistent dose-response trend. Effect sizes were small for poor academic performance ($d = 0.39$–0.44), small to medium for poor impulsivity and self-regulation ($d = 0.43$–0.55), small for adverse emotional state ($d = 0.33$–0.40), and none to small ($d = 0.03$–0.18) for low social engagement. Younger users (aged <16 years) showed greater susceptibility for academic and emotional indicators.

CONCLUSION: In this nationally representative sample, dose-dependent associations of frequency of cannabis use with adverse academic and emotional functioning were observed, even among monthly users, underscoring the importance of routinely inquiring about cannabis use in adolescents.

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Dr Sultan conceptualized and designed the study, supervised data analyses, interpreted analyses, and critically reviewed and revised the manuscript. Mr Zhang contributed to conceptualization, conducted data analyses, interpreted analyses, drafted parts of the initial manuscript, and critically reviewed and revised the manuscript. Dr Becker interpreted analyses, drafted parts of the initial manuscript, and critically reviewed and revised the manuscript. Ms Sethaputra contributed to conceptualization, data analyses, and literature review. Ms Huang contributed to revision/editing and visualization. Dr Levin contributed to conceptualization and revision/editing. Drs Simon, Levy, and Olfson interpreted analyses and critically reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

WHAT'S KNOWN ON THIS SUBJECT: Early and frequent cannabis use in adolescence is associated with subsequent risk for substance use disorders and academic/occupational, social, and emotional difficulties; however, correlates of infrequent use are underinvestigated. In an evolving cannabis context, many perceive cannabis as relatively harmless.

WHAT THIS STUDY ADDS: Among adolescents, cannabis use correlates with adverse academic and emotional markers even at low-frequency use. Compared with nonusers, monthly users (1–2 times per month) were more likely to report poor academic performance, emotional states, and impulsivity and self-regulation. Associations were stronger for younger users.

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INTRODUCTION

Since the 1990s, the policy landscape surrounding cannabis use in the United States has changed rapidly, with increasing medicalization, decriminalization, and legalization.[1] These changes have increased cannabis availability, changed norms, and reduced perceptions that cannabis can be harmful.[1] Other recent changes include promotion of cannabis vaping devices and new edible products that may attract new users and change use patterns, as well as a 3-fold increase in average delta-9-tetrahydrocannabinol potency.[1–4] In this context, the prevalence of cannabis use by adolescents has persisted at high levels, with 1 in 3 US high school students reporting lifetime cannabis use, 1 in 5 reporting current use, and near-record levels of frequent cannabis use,[5] despite otherwise historically low levels of use of other substances by this age group.[6]

Substantial evidence indicates that cannabis use in adolescence can adversely impact neurodevelopment and interfere with a successful transition to adulthood.[7–9] However, the risks of cannabis use in adolescence remain contested, particularly for low-frequency use. Marked discrepancies exist between widespread public perceptions (cannabis is relatively harmless),[10,11] and longitudinal epidemiologic studies, which have found cannabis use to be associated with adverse mental health, cognition, and social functioning.[12,13] Longitudinal studies have found frequent cannabis use in adolescence, particularly early initiation, strongly predictive of later disordered use of cannabis and other substances,[14–17] reduced educational and employment success,[14,16,17] self-control difficulties (eg, intimate partner violence, arrest, delinquency, and suicide attempts),[14,16,17] and increased risk of depression and psychotic disorders.[18,19]

Associations between cannabis use and poor psychosocial outcomes could reflect a combination of shared vulnerability factors that may not always be fully adjusted (eg, various forms of childhood adversity); reverse causality, such as use of cannabis to ameliorate emerging psychiatric symptoms (ie, "self-medication"); or negative impacts of cannabis itself on neurodevelopment. There is biological plausibility that exposure to cannabis in adolescence directly contributes to adverse developmental associations, underscoring the importance of addressing this modifiable risk factor. During adolescence, the brain undergoes significant reorganization and maturation processes that are highly susceptible to exogenous psychoactive substances.[20] The endocannabinoid system is involved in regulating neurodevelopmental processes.[21] Cannabis use has been associated with neurobiological changes in areas dense with cannabinoid CB1 receptors, including gray matter volume reduction in the medial temporal cortex, temporal pole, parahippocampal gyrus, insula, and orbitofrontal cortex.[22] These regions underlie motivational, emotional, and affective processing; thus, disruptions may contribute to adverse psychosocial outcomes linked to cannabis use. Further work is necessary to clarify how the frequency of cannabis use may affect the strength of associations with adverse consequences and whether these associations are present even for low-frequency cannabis users.

Despite clear evidence of negative psychosocial associations with heavy cannabis use, less is known about potential negative associations of less frequent use. Notably, low-frequency use is exceedingly common, with 80% of cannabis-using adolescents not meeting criteria for cannabis use disorder.[23] It remains a critical public health goal to clarify how cannabis exposure, particularly at initiation or relatively low levels of use, are associated with adverse consequences.[24] Our group's recent US nationally representative study found that subclinical cannabis use was associated with 2 to 4 times increased odds of adverse academic, social, and mental health events.[23] Existing knowledge about associations between frequency of adolescent cannabis use and psychosocial indicators are limited by older cohorts that may not reflect current cannabis use patterns, small cohorts that may not detect less common outcomes, lack of nationally representative samples, and less focus on healthy social engagement with peers, a core developmental task of adolescence.[17]

To address these knowledge gaps, we assessed associations between cannabis use frequency and academic, social, and emotional functioning among 8th, 10th, and 12th grade students, utilizing data from the nationally representative 2018–2022 Monitoring the Future surveys.[6] We hypothesized an association between cannabis use and adverse psychosocial functioning among those reporting "low-frequency" use and a consistent, dose-dependent relationship between cannabis use frequency and the likelihood of adverse psychosocial functioning.

METHODS

Study Population

We analyzed responses from 8th, 10th, and 12th grade students (N = 162 532) from the restricted-access 2018–2022 Monitoring the Future (MTF) surveys, with exemption from institutional review board approval. Conducted annually by the University of Michigan, the MTF is a cross-sectional and self-reported national survey of private and public high school students across the United States. The MTF uses a multistage random-sample design to ensure a nationally representative sample. Additional details regarding survey design and sampling can be found online.[6] From 2018 to 2022, response rates ranged from 69% to 87%, with absentee students constituting nearly all nonresponses.[6] Despite the 2020 sample being merely one-fifth the size of other years, it was equally representative.[25] We evaluated the following sociodemographic factors: age, grade level, sex,

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school and community type, race and ethnicity, parental education, and past-year alcohol use.

Measures

Frequency of Cannabis Use

Cannabis use was stratified into 5 groups. Respondents who reported no lifetime cannabis use were classified as nonuse. Noncurrent (0 occasions), monthly (1 or 2 occasions), weekly (3–9 occasions), and near-daily use (10 or more occasions), respectively, were defined as the numbers of cannabis use in the past 30 days (eTable 1). In this study, we considered "noncurrent" and "monthly" as "low-frequency use."

Adverse Academic, Social, and Emotional Functioning

We identified 13 indicators of adverse functioning across academic functioning (no college plans, truancy, low grade point average [GPA]), social engagement (lack of social outings, no extracurricular activities, no close friends), and emotional well-being (impulsivity and self-regulation: serious fighting, risk-seeking behavior, and preference for risk-seeking friends; emotional state: anhedonic, low self-esteem, anxious, and existential). Measures were based on youth self-answered survey questions, with descriptions in eTable 1. Prior research has generally supported associations between these constructs and adolescent cannabis use.[7–9,12,13,15,18,23,26–44]

Risk, Availability, and Perceptions of Use

To evaluate risk, availability, and perceptions of cannabis use among adolescents, we compared associations with these survey variables between cannabis use groups (eTable 1).

Statistical Analysis

The adolescent sample (N = 162 532) was first partitioned by frequency of cannabis use categories: nonuse (N = 119 931), noncurrent (N = 21 431), monthly (N = 7802), weekly (N = 5853), and near daily (N = 7515).

All adjusted odds ratios (aORs) were computed using logistic regression with all cannabis use groups with nonuse as the reference group for the independent variable of interest. We controlled for age, sex, community type, parental education, and alcohol and nicotine use, which are commonly adjusted for analyses and may confound the associations of interest.[6] Because of evidence that the prevalence of current cannabis use is higher among Black than Hispanic, white, or Asian US adolescents,[45] we included a variable for race and ethnicity as well. School type was excluded due to its lack of association with outcomes. aOR values were included to estimate associations between the frequency of cannabis use and adverse psychosocial indicators. Logistic regression models were created in R using the "svydesign" function from the "survey" package to generate aOR and 95% CIs. Unadjusted odds ratios (ORs) were obtained using the same methods and are included in the supplemental materials. To ensure representation of the US adolescent population, we incorporated individual respondent sampling weights provided by MTF. These weights were used to derive demographic prevalence values and in all subsequent analyses.

Cohen *d* effect sizes were calculated for frequency of cannabis use groups, with nonuse as control, on 4 domains of adverse psychosocial functioning: academics, social, impulsivity and self-regulation, and emotional state. To create a continuous variable for effect size analyses, we created scales for each adverse event category, which are reported in the supplemental materials (eTable 1). We relied on Cohen's recommendations (0.2 = small, 0.5 = medium, 0.8 = large) to interpret effect sizes.[46] To account for the possibilities of shared vulnerability, we conducted analyses using noncurrent and monthly use groups as alternative control groups. Similar patterns were observed (eFigure 3, eFigure 4, eTable 2, eTable 3).

To evaluate relationships between age and sex and adverse associations of cannabis use, we modified frequency of cannabis use by age (up to 16 and over 16 years old)[47] and sex (male and female; "other" and "missing" were excluded). We obtained aORs of the interactions between age and sex, individually, on frequency of cannabis use and adverse psychosocial indicators.

To provide a contextual background for the study period, the data were stratified into 2 time periods: prepandemic (2018–2019) and postpandemic (2020–2022).[48] Comparative results are detailed in the supplemental materials (eTable 4).

RESULTS

Sociodemographic Characteristics and Frequency of Cannabis Use Groups

The largest group (N = 119 931, 73.8%) reported no cannabis use, followed by those reporting noncurrent (N = 21 431, 13.2%), monthly (N = 7802, 4.8%), near-daily (N = 7515, 4.6%), and weekly (N = 5853, 3.6%) cannabis use (Table 1). Overall, frequent (eg, weekly or near-daily) cannabis users compared with nonusers tended to be older (16.7 vs 15.9 years), tended to be from households in which neither parent completed college, and were more likely to report past-year alcohol use.[49,50] Across frequency groups, there were minimal sociodemographic differences noted for sex, school type, community type, or race and ethnicity (Table 1). Contrary to a prior report indicating that the prevalence of cannabis use was higher among Black than other common racial and ethnic groups,[45] we observed little variation in cannabis use across ethnic and racial groups. The percentage of adolescents with no cannabis use who were Black and non-Hispanic (12.7%) closely resembled

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TABLE 1. Sociodemographic Characteristics of US 2018–2022 MTF Adolescent Respondents, by Frequency of Cannabis Use

Characteristic	Total (N = 162 532)	Frequency of Cannabis Use[a]				
		Nonuse (N = 119 931)	Noncurrent (N = 21 431)	Monthly (N = 7802)	Weekly (N = 5853)	Near Daily (N = 7515)
Age, mean (SD), y	16.0 (1.7)	15.9 (1.6)	16.5 (1.7)	16.4 (1.7)	16.5 (1.7)	16.7 (1.7)
Grade, n (%)						
8th (mean age, 14.1 y [SD, 0.5])	33.0	35.6	26.2	26.7	25.0	21.7
10th (mean age, 16.1 y [SD, 0.5])	35.9	38.6	29.0	29.6	28.8	24.6
12th (mean age, 18.1 y [SD, 0.6])	31.1	25.7	44.8	43.6	46.2	53.7
Sex, n (%)						
Male	45.8	45.9	44.6	41.6	44.7	52.3
Female	45.5	44.6	50.0	52.4	48.7	38.4
Other[b]	2.0	1.8	2.1	1.9	2.5	2.8
Missing data	6.7	7.7	3.3	4.1	4.1	6.5
School type, n (%)						
Public	88.7	89.1	87.9	87.2	87.1	88.6
Private	11.3	10.9	12.1	12.8	12.9	11.4
Community type, n (%)						
Metropolitan	75.1	73.8	78.8	80.1	79.5	75.8
Nonmetropolitan	19.9	20.1	19.6	17.9	18.3	20.9
Other or missing data	5.0	6.1	1.6	2.0	2.2	3.3
Race and ethnicity, n (%)						
African American, non-Hispanic	12.7	12.7	12.3	13.7	12.6	13.2
Asian/Native Hawaiian or Pacific Islander, non-Hispanic	5.9	6.0	5.5	5.7	5.5	5.5
Hispanic	25.2	25.0	26.6	24.9	25.6	24.5
White, non-Hispanic	48.1	47.7	49.0	49.2	49.5	49.5
Missing data	8.1	8.6	6.6	6.5	6.8	7.3
Parent education, n (%)						
Either graduated college	51.0	51.9	49.0	52.7	48.8	43.2
Neither graduated college	29.1	26.4	36.9	34.0	36.9	38.5
Missing data	19.9	21.7	14.1	13.3	14.3	18.3
Alcohol use, n (%)						
Past year	32.2	18.4	63.6	75.2	79.5	81.6
No past-year use	59.9	72.4	32.6	20.5	15.9	13.2
Missing data	7.9	9.2	3.8	4.3	4.6	5.2
Nicotine use, n (%)						
Past year	5.7	2.5	12.3	15.8	17.0	17.6
No past-year use	25.6	31.4	13.1	7.6	5.6	3.9
Missing data	68.7	66.1	74.6	76.6	77.4	78.5

Abbreviation: MTF, Monitoring the Future.

[a] Nonuse was defined as never used in one's lifetime; noncurrent (0 occasions), monthly (1 or 2 occasions), weekly (3–9 occasions), and near-daily use (10 or more occasions) were defined as the occasion numbers of cannabis use in the past 30 days.

[b] "Other" category is not defined in the publicly available MTF codebook.

their corresponding percentage within each level of cannabis use (range, 12.3%-13.7%). In addition, when comparing the postpandemic period with the prepandemic period, across use frequencies, odds were lower postpandemic, with statistically significant 95% CIs.

Poor Academic Performance

Frequency of cannabis use was strongly associated with all measures of low academic achievement in a dose-response manner, with 2 to 5 times adjusted odds compared with nonusers (eFigure 2). Compared with nonusers, cannabis

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TABLE 2. Adjusted Odds of Adverse Psychosocial Indicators Among Monitoring the Future Adolescent Respondents, by Frequency of Cannabis Use, Nonuse Group as the Control Group[a,b]

	Frequency of Cannabis Use,[b] aOR (95% CI)				
Adverse Psychosocial Indicator	**Nonuse (N = 119 931)**	**Noncurrent (N = 21 431)**	**Monthly (N = 7802)**	**Weekly (N = 5853)**	**Near Daily (N = 7515)**
Academic functioning					
Low GPA	1.00	1.82 (1.72–1.93)	2.20 (2.02–2.39)	2.64 (2.41–2.90)	3.93 (3.61–4.29)
Truancy	1.00	1.75 (1.65–1.87)	2.18 (2.01–2.36)	2.98 (2.70–3.30)	3.75 (3.43–4.11)
No college plans	1.00	1.42 (1.33–1.52)	1.30 (1.17–1.45)	1.63 (1.45–1.83)	2.77 (2.50–3.06)
Social engagement					
No extracurricular activities	1.00	1.26 (1.15–1.39)	1.41 (1.22–1.62)	1.58 (1.35–1.85)	2.34 (2.00–2.74)
No close friends	1.00	1.00 (0.88–1.14)	0.85 (0.70–1.02)	0.87 (0.67–1.13)	1.18 (0.95–1.47)
No social outings	1.00	0.80 (0.76–0.84)	0.62 (0.57–0.67)	0.58 (0.51–0.65)	0.55 (0.50–0.61)
Impulsivity and self-regulation					
Fighting	1.00	1.97 (1.73–2.26)	2.19 (1.82–2.62)	3.08 (2.46–3.85)	3.66 (3.02–4.45)
Danger seeking	1.00	1.47 (1.38–1.57)	1.72 (1.56–1.89)	1.71 (1.52–1.92)	2.00 (1.79–2.23)
Prefers risk-seeking friends	1.00	1.26 (1.14–1.40)	1.40 (1.22–1.61)	1.43 (1.18–1.72)	1.35 (1.15–1.59)
Emotional state					
Anhedonic	1.00	1.39 (1.28–1.51)	1.42 (1.27–1.60)	1.72 (1.49–1.99)	2.04 (1.81–2.30)
Low self-esteem	1.00	1.17 (1.06–1.29)	1.21 (1.04–1.41)	1.50 (1.26–1.79)	1.48 (1.27–1.72)
Anxious	1.00	1.18 (1.08–1.30)	1.11 (0.97–1.27)	1.01 (0.85–1.20)	1.27 (1.09–1.47)
Existential	1.00	1.10 (1.01–1.19)	1.32 (1.17–1.50)	1.11 (0.97–1.27)	1.07 (0.94–1.23)

Abbreviations: aOR, adjusted odds ratio; GPA, grade point average.
[a] From the 2018–2022 Monitoring the Future datasets. The comparison group was nonuse. Odds ratios are adjusted for age, sex, race and ethnicity, community type, parental education, and alcohol and nicotine use.
[b] Nonuse was defined as never used in one's lifetime; noncurrent (0 occasions), monthly (1 or 2 occasions), weekly (3–9 occasions), and near-daily use (10 or more occasions) were defined as the occasion numbers of cannabis use in the past 30 days.

users had greater odds of no college plans (aOR, 1.30–2.77), truancy (aOR, 1.75–3.75), and low GPA (aOR, 1.82–3.93) (Table 2). Effect sizes of the association of frequency of cannabis use with poor academic achievement ranged from nearly medium to large (Cohen *d*, 0.44–1.23) in a dose-response manner (Figure 1).

Low Social Engagement

Cannabis use was associated with no extracurricular activities (aOR, 1.26–2.34) in a dose-response manner but was not significantly associated with no close friends or no social outings measures (Table 2). Effect sizes of the association of frequency of cannabis use with low social engagement were insignificant (Figure 1).

Poor Impulsivity and Self-Regulation

Frequency of cannabis use was associated with high impulsivity and aggression in a stepwise gradient manner, with 2 to 3 times adjusted odds compared with nonusers (eFigure 2). Compared with nonusers, cannabis users had greater odds of getting into fights (aOR, 1.97–3.66), seeking danger (aOR, 1.47–2.00), and preferring risk-seeking friends (aOR, 1.26–1.43) (Table 2). Effect sizes of the association of frequency of cannabis use with impulsivity and aggression ranged from small to large (Cohen *d*, 0.46–0.93) in a dose-response manner (Figure 1).

Adverse Emotional State

Symptoms of anxiety, existential distress, low self-esteem, and anhedonia were associated with frequency of cannabis use in a dose-response manner, with 1.5 to 2 times adjusted odds compared with nonusers (eFigure 2). Cannabis users, compared with nonusers, had greater odds of reporting anxiety (aOR, 1.01–1.27), existential distress (aOR, 1.07–1.32), low self-esteem (aOR, 1.17–1.50), and anhedonia (aOR, 1.39–2.04). Effect sizes of the association of frequency of cannabis use with poor emotional states ranged from small to medium (Cohen *d*, 0.32–0.49) in a dose-response manner.

Age-Modified Associations Between Frequency of Cannabis Use and Adverse Psychosocial Indicators

Adjusted odds of adverse psychosocial indicators were greater in adolescents younger than 16 years than in those aged 16 years and older. Odds increased with frequency of cannabis use in a dose-response relationship, with effects even on low-frequency users. These patterns were consistent across psychosocial indicators excluding social

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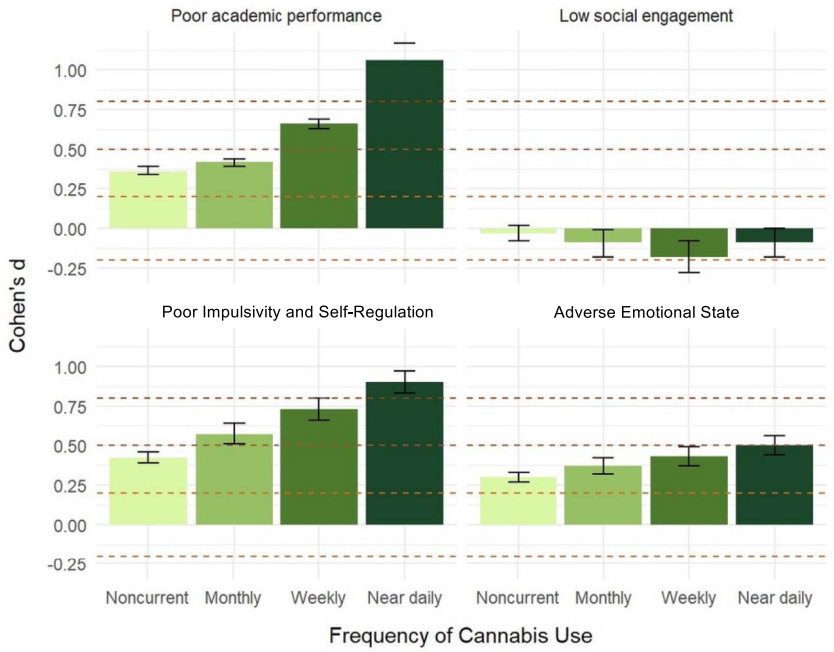

FIGURE 1.
Effect sizes (Cohen *d*) of adverse psychosocial categories among Monitoring the Future adolescent respondents, by frequency of cannabis use, with nonuse group as the control group. Nonuse was defined as never used in one's lifetime; noncurrent (0 occasions), monthly (1 or 2 occasions), weekly (3–9 occasions), and near-daily use (10 or more occasions) were defined as the occasion numbers of cannabis use in the past 30 days.

engagement, which showed no significant age-related differences (Figure 2).

Sex-Stratified Associations Between Frequency of Cannabis Use and Adverse Psychosocial Indicators

Compared with male adolescents, adjusted odds of low GPA and danger seeking were greater among female adolescents who reported frequent cannabis use. However, for the remainder of indicators examined, there were no significant sex-related differences (eFigure 1).

Effect Sizes of Cannabis Affordability, Availability, and Risk Perception on Frequency of Use

High availability and low-risk perception of cannabis were strongly associated with cannabis use, in a stepwise gradient with frequency of use (Figure 3). Friends using cannabis had a large effect size across all frequencies of cannabis use, with a stepwise gradient from $d = 1.04$ to 1.93. Ease of obtaining cannabis had a large effect size across all frequencies of cannabis use, with a stepwise gradient from $d = 0.83$ to 1.22. Low risk perceived from cannabis experimentation had a medium to large effect size across the spectrum of cannabis use frequency, with a gradient from $d = 0.62$ to 0.85. Affordability was not significantly associated with cannabis use and had a small to medium effect size across all frequencies of cannabis use, with a stepwise gradient from $d = 0.29$ to 0.62.

DISCUSSION

In a nationally representative sample of US adolescents, cannabis use was linked to adverse psychosocial indicators in a dose-dependent fashion, with significant associations between academic performance, impulsivity and self-regulation, and emotional state even for low levels of cannabis use. These associations could reflect impacts of early cannabis use on disruption of neurodevelopment,[20–22,26,42,51] common shared risk factors, or use of cannabis to cope with other academic and social difficulties. Regardless of the directionality of these relationships, these findings underscore the importance of identifying youth using cannabis, even those using it infrequently.

Consistent with previous research, cannabis use was strongly correlated with poor academic performance. Prior studies have shown that frequent cannabis use is associated with worsened executive functioning, verbal IQ deficits, lower high school completion rates, poorer academic performance, lower GPA, and increased likelihood of school dropout.[17,29,41,52,53] Even low-frequency users (noncurrent or monthly) are more associated with low GPA, truancy, and no college plans than nonusers. These findings concur with prior studies showing that even minimal usage during critical developmental periods can have lasting effects on cognitive functions that are essential to academic performance, including working memory and perceptual reasoning.[42,44,52,54] Although low-frequency use is linked to

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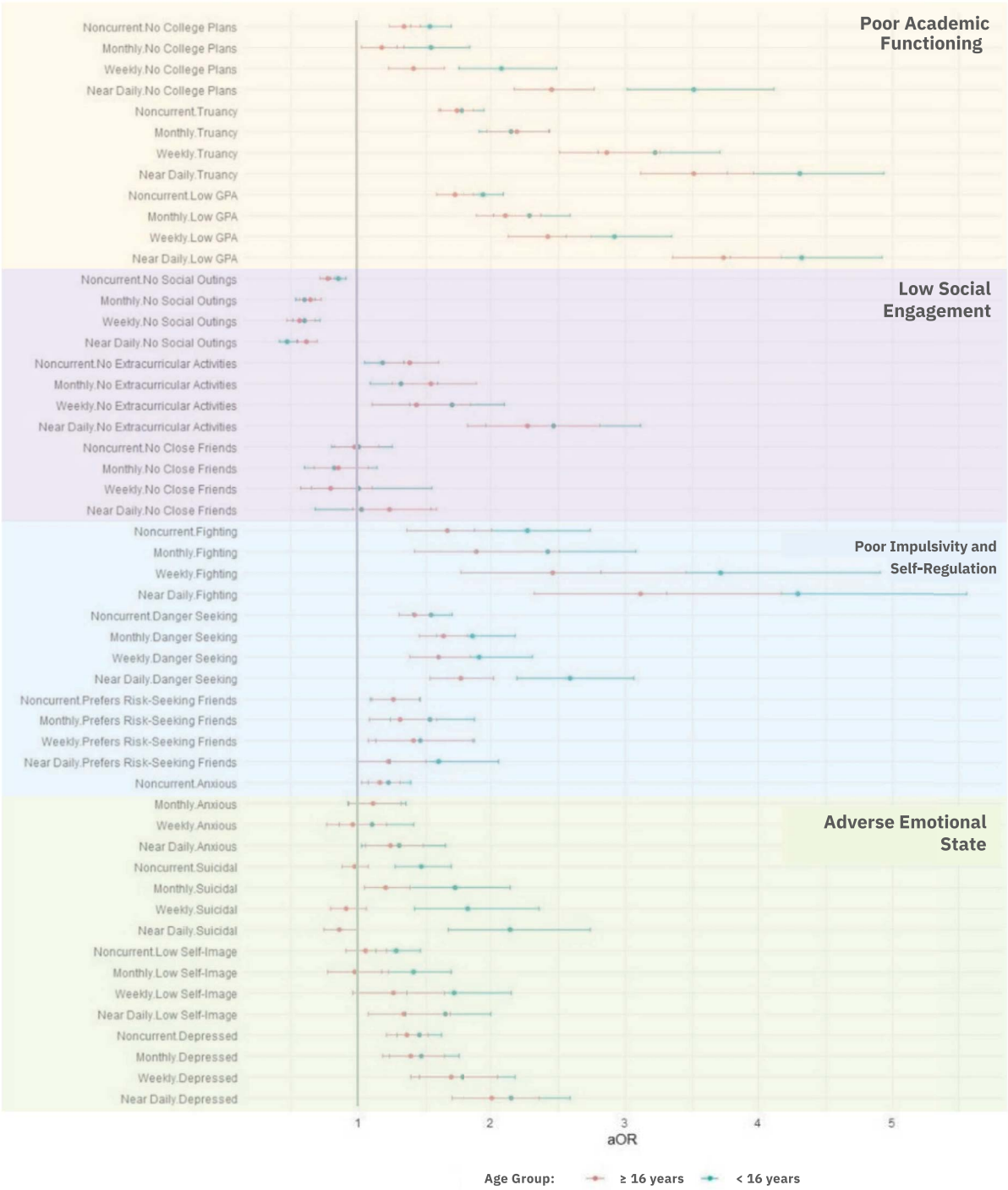

FIGURE 2.

Adjusted odds of adverse psychosocial indicators by frequency of cannabis use, stratified by age, with nonuse group as the control group. Nonuse was defined as never used in one's lifetime; noncurrent (0 occasions), monthly (1 or 2 occasions), weekly (3–9 occasions), and near-daily use (10 or more occasions) were defined as the occasion numbers of cannabis use in the past 30 days. Odds ratios are adjusted for sex, race and ethnicity, community type, parental education, and alcohol and nicotine use.

Abbreviation: GPA, grade point average.

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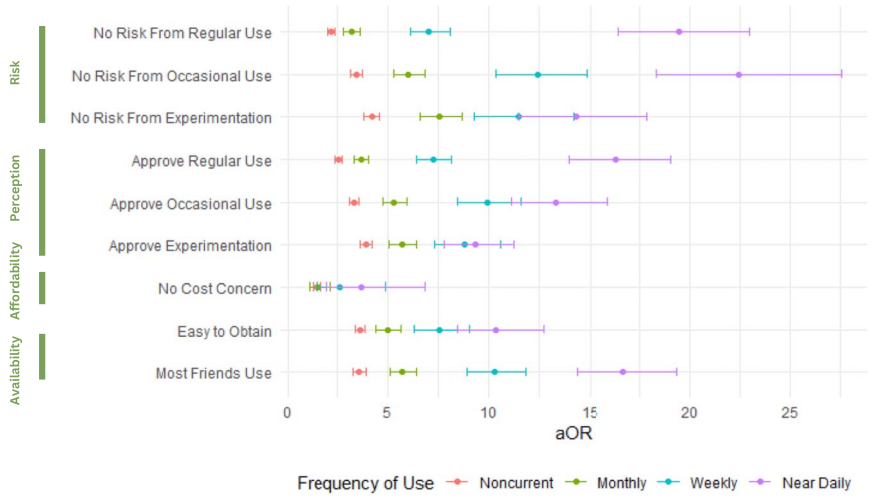

FIGURE 3.

Adjusted odds of cannabis risk, perception, affordability, and availability, by frequency of cannabis use, with nonuse group as the control group. Odds ratios are adjusted for age, sex, race and ethnicity, community type, parental education, and alcohol and nicotine use. Nonuse was defined as never used in one's lifetime; noncurrent (0 occasions), monthly (1 or 2 occasions), weekly (3–9 occasions), and near-daily use (10 or more occasions) were defined as the occasion numbers of cannabis use in the past 30 days.
Abbreviation: aOR, adjusted odds ratio.

negative effects on attendance (ie, more truancy) and college plans, it remains unclear whether low-frequency use coincides with lower eventual educational attainment at the population level among today's youth. A well-controlled longitudinal cohort analysis found that only frequent cannabis use, and not occasional use, predicted lower educational attainment by young adulthood.[16] As legalization expands access, frequency of use may be increasing in some individuals, potentially strengthening the academic and developmental associations observed in this group. Alternatively, these associations might reflect use of cannabis to cope with distress related to not meeting societal expectations among youth who are struggling in school. Reevaluation over time is needed as policies and products evolve.

The relationship between frequency of cannabis use and social engagement varied across social indicators. Prior research has shown that solitary cannabis use by adolescents predicts greater cannabis problems,[55] so most isolated cannabis users may develop heavier use and more adverse consequences. Participation in extracurricular activities decreased with more frequent cannabis use, which might reflect adoption by cannabis-using youth of an alternative lifestyle that does not include traditional youth social activities.[41,56] However, adolescents with fewer extracurricular involvements may have greater opportunity for substance use, and younger youth with more problem behaviors may be more inclined to initiate cannabis as part of a risk behavior cluster. These findings generally support prevention and treatment approaches focused on promoting healthy social interactions and supporting youth in engaging in non–substance-related extracurricular activities.

We observed a significant stepwise association between frequent cannabis use and indicators of poor self-regulation (eg, fighting and impulsive behavior), and this relationship was stronger than the association between cannabis use and emotional states. The directionality and mechanisms linking cannabis use and violence are not clear. Additionally, cannabis exposure appears to disrupt brain regions involved in emotional processing, and impaired capacity to regulate negative emotions may cause increased aggression.[57] Alternatively, poor self-regulation may also cause cannabis use, and it is likely that the relationship is bidirectional. A meta-analysis of studies comprising nearly 300 000 adolescents and young adults found an overall moderate association (OR, 2.11) between cannabis use and physical violence, with preliminary evidence of a dose-dependent effect.[58] The present findings extend prior research by demonstrating a strong dose-response relationship in a large and nationally representative sample of adolescents. Notably, we found the relationship between cannabis use frequency and fighting to be stronger among girls than boys, although a previous meta-analysis did not find a difference between sexes and further exploration of these findings is warranted.[58]

Frequency of cannabis use was linked to negative emotional states (ie, symptoms of anxiety and depression) in a stepwise gradient manner, with medium effects for daily use and small to medium effects for even noncurrent or monthly use. Substantial past literature has explored the connection between cannabis use and mental health, establishing that high-frequency cannabis use, particularly from an early age, is associated with increased risk of depressive and anxiety disorders, psychosis, and suicidal ideations, even without a preexisting condition.[8,18,19,31,33,34,37–39]

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Additionally, frequent cannabis use has also been shown to exacerbate preexisting anxiety or depressive conditions.[59,60] Our findings build on these relationships by showing a dose-dependent relationship between frequency of cannabis use and affective symptoms. However, anxiety was not as strongly linked to cannabis use as anhedonia and low self-esteem, with near-daily users having only 1.3 times greater odds of anxiety than nonusers.

After stratifying cannabis use frequency by age, we found that odds of adverse emotional state were consistently greater for adolescents aged 16 years and under. Early adolescence is a period of brain sensitivity, during which cannabis exposure may affect impulsivity and self-regulation.[61] Earlier use is also linked to anxiety and depression,[18] as well as underlying vulnerabilities to childhood trauma,[62] highlighting the importance of careful evaluation and consideration of early adolescents who are using cannabis.

Our results also show that cannabis use is associated with low perceived risk and peer use, similar to previous studies.[63,64] Peer use may also reinforce use through shared social norms.[64] Notably, our data span pandemic periods. While overall cannabis use declined after the pandemic, there were no observed significant changes in associations before and after the pandemic. Prior work has also reported no pandemic-related impact on substance use among adolescent psychiatric inpatients,[65] suggesting heterogeneity in pandemic effects. Affordability plays a minor role, possibly due to limited measurement that may not capture the complexity of cannabis pricing.[66]

Limitations

This study relied on self-reported data which can be susceptible to biases including over or underreporting. The potency and dose of cannabis is not included in the MTF dataset, which could result in misclassification of the intensity of use, which was based on frequency alone. The indicators relied on single-item questionnaire measures. Our study methods relied on cross-sectional data to measure associations that do not allow for causal inferences. The current study found relevant associations with low-frequency use, suggesting that further research should continue investigating low-frequency users, including subgroups within the noncurrent use group. In this exploratory study, no adjustments were also made for multiple comparisons; therefore, the CIs should be interpreted with caution. Additionally, residual confounding, including by unmeasured state-level cannabis legalization and socioeconomic indicators, may affect results.

CONCLUSIONS

In a US nationally representative cross-sectional survey of adolescents, frequency of cannabis use was strongly associated in a dose-dependent manner with academic and impulsivity self-regulation indicators, with notable effects even at low levels of use. Our findings underscore the importance of routinely inquiring about cannabis use in adolescents, which can signal high risk for adverse psychosocial consequences.

ABBREVIATIONS

aOR: adjusted odds ratio
GPA: grade point average
MTF: Monitoring the Future
OR: odds ratio

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