






Cannabis Vaping Is Associated With Past 30-Day Suicide Attempts and Suicidal Ideation Among Adolescents in a Psychiatric Inpatient Setting

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Objective: Increasing evidence links adolescent cannabis use (CU) to suicidal thoughts and behaviors. CU may be associated with both developing and self-medicating psychiatric symptoms. Although relatively new, cannabis vaping is increasing among adolescents. This chart review investigation evaluated the association between cannabis vaping and suicidal thoughts and behaviors among adolescents experiencing acute psychiatric symptomatology.


Method: The sample included 470 adolescents (ages 11-18; 64% biological female) admitted to an inpatient psychiatric hospital between 2021 and 2023. Adolescents completed an assessment battery measuring CU, psychiatric symptoms, and suicidal thoughts and behaviors. Separate regressions tested links between cannabis vaping and 2 outcomes—past 30-day suicide attempt and suicidal ideation (SI)—controlling for age and biological sex.

Results: In this sample, 26.8% reported past 30-day suicide attempts; 44.3% endorsed ever using cannabis, and 31.5% reported past 30-day CU. Of adolescents who ever used cannabis, 30.8% reported their most frequent method was vaping. Vaping as the most frequent cannabis method was associated with past 30-day suicide attempts (adjusted odds ratio = 2.38, $p = .002$) and greater SI ($b = 8.71$, $p = .020$). The association remained significant for suicide attempts, but only marginally significant for SI ($p = .087$), after controlling for depressive symptoms, impulse control, psychosocial impairment, and past 30-day substance use.

Conclusion: Vaping as the most frequent method of CU was significantly associated with suicide attempts and SI. Because data are cross-sectional, causality cannot be inferred. Nonetheless, cannabis vaping is important to assess among adolescents with acute psychiatric concerns because it may place them at higher risk for suicidal thoughts and attempts.

Plain language summary: Vaping can deliver higher potency cannabis than other routes of administration, and adolescents are increasingly vaping to consume cannabis. This chart review study of 470 adolescents admitted to an inpatient psychiatric hospital found that vaping is the most frequent way of using cannabis. Vaping was associated with a greater likelihood of a past 30-day suicide attempt and worse suicidal thoughts compared to adolescents who never used or who smoked cannabis as their primary method. Adults should be aware of how adolescents are consuming cannabis, especially if it is occurring in the context of psychiatric disorders.

Key words: adolescents; cannabis; suicide attempt; suicidal ideation; vaping

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A growing body of evidence is linking adolescent cannabis ($\Delta 9$ -tetrahydrocannabinol [THC]) use (CU) to suicidal thoughts and behaviors (STBs).¹⁻⁵ CU has been postulated to be both a risk factor for the development of psychiatric disorders (eg, depression) and a means by which individuals self-medicate their psychiatric symptoms.^{6,7} Vaping is one method of CU that is associated with cannabis of higher potency and consequently has been linked to more serious psychiatric sequelae.^{8,9} Of concern, rates of cannabis vaping among

adolescents have been increasing, particularly among youth with psychiatric conditions.^{10,11} Although adolescents with psychiatric conditions are more likely to vape cannabis and have higher rates of STBs than adolescents without psychiatric conditions,¹²⁻¹⁴ the associations between cannabis vaping and STBs have not been investigated among adolescents with acute symptoms requiring inpatient psychiatric care, a group who may be at highest risk for repeat STBs and death by suicide. Given the increased vulnerability to STBs in this population, the objective of the current study

was to evaluate the link between cannabis vaping and STBs among adolescents whose acute symptomatology required inpatient psychiatric care.

Cannabis Use, Psychiatric Conditions, and STBs

Similar to other substances, CU tends to co-occur with psychiatric symptoms and disorders, including depression and psychosis.¹⁵ In fact, psychiatric conditions are linked to greater CU and more potent routes of administration, including vaping and the use of concentrates.¹⁴ Researchers have investigated whether cannabis serves a coping function in the context of already existing psychiatric disorders (eg, self-medication hypothesis¹⁴) or whether CU may precede the onset of psychiatric impairment and disorders, or both.¹⁶ With respect to the former, the rate of endorsing CU to cope with negative feelings (ie, self-medication hypothesis vs for social or other reasons) has doubled among adolescents in the United States over the past 40 years of annual data collection.⁶ With respect to the latter, data also indicate that CU precedes psychiatric symptomatology (see Chadwick *et al.*¹⁷ for review). Yet regardless of the directionality, addressing CU among youth with co-occurring psychiatric symptoms is a public health priority because youth with co-occurring CU and psychiatric symptoms are more likely to develop a CU disorder, require specialty treatment, and initiate use of other illicit substances.^{18–20}

There is a growing body of evidence linking CU and STBs.^{2–4,15,21} Moreover, Schmidt *et al.*⁴ conclude in their systematic review that among individuals who use cannabis, adolescents, as compared to adults, are at greatest risk for suicidal behavior. With respect to suicidal ideation (SI), using data from the Youth Risk Behavior Survey (YRBS), Chadi *et al.*⁵ found that adolescent CU was associated with significantly greater odds of SI as compared to adolescents not reporting CU. A recent longitudinal meta-analysis found that CU initiated in adolescence was associated with greater likelihood of SI (odds ratio [OR] = 1.50, 95% CI = 1.11–2.03) and suicide attempts (OR = 3.46, 95% CI = 1.53–7.84) in young adulthood.¹⁵ With regard to suicide attempts, recent work suggests that CU may have a direct causal link, which was not observed for alcohol or tobacco use.²² In a large sample of adolescents in the United States collected between 2001 and 2004, the association between CU and STBs remained even after controlling for major depressive disorder.² Along those lines, depressive symptoms and impulsivity have been associated with both CU and STBs.⁴

Biological Sex, CU, and STBs

Epidemiologic and clinical data consistently find that adolescent girls report STBs at a greater rate than adolescent

boys.^{23–25} Several decades ago, adolescent boys had a significantly higher rate of CU than adolescent girls; however, despite this gap swiftly closing, there is still much less known about CU in adolescent girls.²⁶ Yet cannabis may have different effects for males and females, especially as it relates to their endocannabinoid systems.^{27,28} Differential effects by sex are consistent with the finding that females may progress more quickly to problematic use after CU onset than males.²⁹ Among adolescents, the most recent YRBS data from 2021 indicate that females are significantly more likely than males to currently use cannabis.²³ Moreover, although the percentage of adolescent boys surveyed who currently used cannabis declined between 2011 and 2021, this was not true for girls, in whom percentage of current use remained stable.

Cannabis Vaping in Adolescence

Cannabis vaping is the process by which cannabis (in the form of concentrates, liquid, or plant material) is heated to a temperature that releases aerosolized cannabinoids with water vapor, which are then inhaled.^{11,30} Multiple devices can be used to inhale cannabis through vaping, such as vape pens (reusable or disposable) and tabletop vaporizers.¹¹ Vaping has the potential to be substantially more potent as a delivery method due to the ability to consume higher-strength cannabis compared with traditional routes of administration, such as smoking cannabis plant material in the form of a joint.^{8,11,31} To illustrate, in a double-blind crossover trial with adults,³¹ vaping cannabis resulted in higher blood THC concentration and greater subjective, cognitive, and psychomotor effects compared with smoking cannabis, holding all other factors constant (eg, dose). The researchers theorized that vaping may be more efficient at delivering THC than smoking due to the method of combustion of the latter and ability for THC to escape via noninhaled smoke. Additionally, adolescents' preferences appear to be shifting to using concentrates and oils over dried flower.³² Although either form can be consumed via vaping, concentrate/oil products can have an exponentially greater THC content than flower material (eg, >90% vs 1%–30%; see¹⁴). Among adolescents, vaping is a rapidly increasing route of administration, potentially due to its convenience and more discrete nature as compared to other methods^{11,33} (eg, joints). Although cannabis vaping in the United States only began to be assessed in the annual Monitoring the Future Study in 2017, all grade levels had significant increases comparing 2017 and 2022,³⁴ with the rates of annual cannabis vaping essentially doubling among students in 8th (3%–6%), 10th (8.1%–15.0%), and 12th (9.5%–20.6%) grades. Further, rates of cannabis vaping were significantly greater in 2022 than in 2021 for US

students in 8th, 10th, and 12th grades, despite other drugs not returning to their higher, pre-COVID-19 levels.³⁴ These rates are also cause for concern because initial evidence suggests that vaping is associated with symptoms related to respiratory, gastrointestinal, oral, and mental (eg, psychosis, mania) health as well as impaired cognitive performance.³⁵

Mechanisms for the Relation Between Vaping and STBs

Several theories hypothesize a mechanism by which vaping cannabis may be associated with a greater likelihood of negative outcomes relative to other routes of administration. The first comes from the literature on e-cigarette use, which posits that vaping devices result in oxygen deprivation to the brain, causing greater impulsivity.³⁶ Animal research as well as studies of adolescents indicate that exposure to vapor from e-cigarettes and vaping, respectively, were associated with impulsive behavior.^{36,37} Because impulsivity is also a risk factor for suicidal behavior, it is crucial to investigate this process in vulnerable groups, such as adolescents with psychiatric disorders. The second theory is based on consistent evidence indicating that vaping is the route by which individuals consume a higher concentration of cannabis^{9,38} (either due to cannabis type selected for vaping or as a function of efficient vape delivery³¹), which may have both acute and chronic effects. According to this perspective, ingestion of higher-potency cannabis is more likely to lead youth to engage in substance-induced risk behaviors, including STBs.³⁹ This theoretical perspective is in line with research on alcohol use indicating that higher blood alcohol concentration is associated with greater engagement in STBs.⁴⁰ With regard to the chronic impact, high-potency cannabis may have a more pronounced neurobiological effect, particularly during brain development in adolescence, that is facilitated by the endocannabinoid system.⁴¹ Over time, these effects may give rise to psychiatric-related symptoms arising from neural alterations,⁴¹ although this is currently an active area of inquiry.

Current Study

The objective of this investigation, conducted between 2021 and 2023, was to evaluate the link between cannabis vaping and STBs (past 30-day suicide attempt and SI) among adolescents requiring acute psychiatric hospitalization, given their increased vulnerability to STBs. We hypothesized that endorsing cannabis vaping as the most frequent method of CU would be associated with a significantly greater likelihood of having attempted suicide before hospitalization and worse SI.

METHOD

Sample and Procedures

The sample included 470 adolescents (ages 11-18) admitted to an inpatient psychiatric hospital in the northeastern United States between 2021 and 2023 who had complete data on their responses to intake questions regarding whether they had ever used cannabis and whether they had made a suicide attempt in the past 30 days and responses to an SI questionnaire (all described in this section). The present study was a cross-sectional, institutional review board–approved retroactive chart review of self-report measures administered during intake assessments as part of clinical treatment and for which informed consent was waived. Adolescents completed the assessment battery within the first few days of admission. If adolescents had more than one hospital admission during this time, only their initial admission was used in the present study. Specific measures included in the chart review are described next.

Measures

Demographics. Adolescents completed a self-report demographics form assessing age, biological sex (ie, sex assigned at birth), gender identity, sexual identity, and race/ethnicity.

Suicide Attempts. Adolescents responded yes or no to “Have you made any suicide attempts in the 30 days before you came to the hospital?”

Suicidal Ideation. The Suicidal Ideation Questionnaire-JR (SIQ-JR)⁴² is a 15-item measure designed to assess the severity and frequency of SI among children and adolescents. The possible range of scores is 0 to 90, with higher scores indicating greater SI. Previous research has established a clinical cutoff score of 31 or higher.⁴² Reliability in the current sample was 0.97.

Substance Use. A selection of questions from the 2021 YRBS Standard High School Questionnaire assessed use of nicotine, alcohol, and cannabis, including whether they had ever tried it (lifetime use) and past month use.²³ If adolescents denied using a substance, they answered no further questions on that topic in their assessment battery. Routes of administration questions were adapted from the Marijuana History and Smoking Questionnaire regarding whether they currently used certain modes of self-administration (smoke, vape, eaten), and, if they had ever used cannabis, what was their most frequent mode used.⁴³ A binary variable was created for this study indicating if adolescents reported vaping as their most frequent CU

method. Additional questions assessed motives for CU (ie, social, to cope with negative feelings, or to feel positive effects) as well as most frequent motive for use.

Depressive Symptoms. The Self-Report Patient Reported Outcomes Measurement Information System (PROMIS) Pediatric Depressive Symptoms–Short Form⁴⁴ was administered to measure negative mood within the past week. The 8-item measure assesses negative mood, views of self, social cognition, decreased positive affect, and anhedonia. Scores are derived by summing the items, such that higher scores indicate greater negative mood, with a possible range of 8 to 40. The PROMIS measure has well-established reliability and validity.⁴⁴ Reliability in the current sample was 0.96. Of note, only a subset of the sample completed this measure (Table 1).

Impulse Control. To account for impulsivity influencing suicidal behavior in sensitivity analyses, the Impulse Control Difficulties subscale of the Difficulties in Emotion Regulation Scale–Short Form (DERS–Impulse)⁴⁵ was used. Reliability in the current sample was 0.95. This subscale has a possible range of 3 to 15, with higher scores reflecting greater difficulty with impulse control.

Psychosocial Impairment. A 5-item self-report psychosocial impairment survey, the Work and Social Adjustment Scale–Youth Version (WSAS–Y),⁴⁶ was administered and included in sensitivity analyses to account for impairment. Scores ranged from 0 to 40, with higher scores indicating more impairment. Reliability in the current sample was 0.88.

Statistical Analyses

Data were analyzed in R version 4.1.0 (<https://www.R-project.org/>). Two separate regression models were run for the primary analyses and included the full sample. Covariates were age and biological sex. A logistic regression evaluated vaping as the most frequent method of CU (yes/no) with past 30-day suicide attempts (yes/no). ORs adjusted for covariates were calculated and presented in text as standardized for effect size interpretation. A linear regression tested the link between vaping as the most frequent method of CU (yes/no) with SI (a continuous variable).

Sensitivity analyses evaluated whether significant associations remained when accounting for factors associated with STBs based on prior theory. Specifically, the models adjusted for depressive symptoms, impulse control, psychosocial impairment, and past 30-day substance use (ie, alcohol, e-cigarette, and CU). Post hoc analyses evaluated whether the primary analyses were moderated by biological

sex. Some measures used for sensitivity analyses do not include the full sample size of 470 because the measures were either added or discontinued during data collection (see Table 1 for sample sizes).

To evaluate whether findings were driven by adolescents who endorsed vaping as their primary method of CU, 2 regression models were run, with one variable indicating primary cannabis method (never used, vaping, smoking, eating) in relation to past 30-day suicide attempt and SI (separate models), with the vaping group serving as the reference. Categorical (factor) independent variables in R are automatically dummy-coded in regression models. Sensitivity analyses were also conducted on these models to determine whether significant associations remained after adjusting for factors related to STBs described previously.

RESULTS

Sample Descriptives

In the entire sample of 470 adolescents, 26.8% reported attempting suicide in the 30 days before admission; 44.3% endorsed lifetime CU; 31.5% reported CU in the past 30 days; and 24.5% of adolescents endorsed lifetime vaping cannabis: 2.3% reported vaping dried cannabis plant material, 17.7% reported vaping cannabis concentrate (defined as hash oil, wax, butane hash oil [BHO], shatter dabs, 710, shatter/budder/honey oil), and 4.5% did not report what they vape. There were no significant differences by biological sex in lifetime CU (male = 39%, female = 47%; $\chi^2 = 2.31, p = .13$) and past 30-day CU (male = 28%, female = 33%; $\chi^2 = 1.25, p = .263$). Table 1 provides demographic information, past 30-day substance use rates, and descriptive statistics of measures for the entire sample.

For adolescents who used cannabis ($n = 208$), the most frequent methods of CU were as follows: 63.5% smoking, 30.8% vaping, and 5.8% eating. Of adolescents who reported CU, 49% reported their primary motive was to cope with negative feelings, 14.4% reported social motives, 30.3% reported a motive to feel positive effects, and 6.3% reported other.

Primary Analyses

Endorsing vaping as the most frequent method of CU was associated with significantly greater adjusted odds of having attempted suicide in the 30 days before admission (Table 2) (standardized OR = 1.35, categorized as a very small effect⁴⁷), and significantly greater SI (Table 2). When the independent and dependent variables were switched, results remained significant.

TABLE 1 Characteristics of Full Sample and by Cannabis Method Group

Variables	Full sample (N = 470)			No CU (n = 262)		Vaping not primary method (n = 144)		Vaping as primary method (n = 64)		p
	n	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Age, y	470	15.00	(1.70)	14.47	(1.69)	15.72	(1.42)	15.56	(1.59)	<.001***
		n	(%)	n	(%)	n	(%)	n	(%)	
Biological sex	470									.248
Male		168	(36)	102	(39)	47	(33)	19	(30)	
Female		302	(64)	160	(61)	97	(67)	45	(70)	
Gender identity	470									
Male		156	(33)	95	(36)	44	(31)	17	(27)	
Female		185	(39)	86	(33)	69	(48)	30	(47)	
Transgender male to female		8	(1.7)	4	(1.5)	3	(2.1)	1	(1.6)	
Transgender female to male		32	(6.8)	21	(8.0)	6	(4.2)	5	(7.8)	
Queer nonbinary		76	(16)	49	(19)	16	(11)	11	(17)	
Unsure		23	(4.9)	15	(5.7)	6	(4.2)	2	(3.1)	
Transgender, do not identify as male or female		6	(1.3)	5	(1.9)	0	(0)	1	(1.6)	
Prefer not to answer		11	(2.3)	8	(3.1)	3	(2.1)	0	(0)	
Sexual identity	470									
Asexual		26	(5.5)	20	(7.6)	4	(2.8)	2	(3.1)	
Bisexual/pansexual		188	(40)	92	(35)	65	(45)	31	(48)	
Gay/lesbian		41	(8.7)	25	(9.5)	12	(8.3)	4	(6.2)	
Heterosexual/straight		149	(32)	76	(29)	49	(34)	24	(38)	
Do not identify as any/not listed		34	(7.2)	26	(9.9)	6	(4.2)	2	(3.1)	
Prefer not to answer		35	(7.4)	26	(9.9)	7	(4.9)	2	(3.1)	
Not sure/questioning		13	(2.8)	10	(3.8)	2	(1.4)	1	(1.6)	
Race/ethnicity	470									
American Indian or Alaskan Native		29	(6.2)	17	(6.5)	7	(4.9)	5	(7.8)	
Asian		20	(4.3)	15	(5.7)	1	(0.7)	4	(6.2)	
Black		83	(18)	44	(17)	27	(19)	12	(19)	
Hawaiian or Pacific Islander		9	(1.9)	5	(1.9)	4	(2.8)	0	(0)	
Middle Eastern		7	(1.5)	4	(1.5)	1	(0.7)	2	(3.1)	
White		300	(64)	173	(66)	89	(62)	38	(59)	
Other race		27	(5.7)	16	(6.1)	9	(6.2)	2	(3.1)	
Hispanic		139	(30)	67	(26)	49	(34)	23	(36)	
Past 30-day substance use	470									
Cannabis		148	(31)	0	(0)	102	(71)	46	(72)	1.00
E-cigarette		173	(37)	29	(11)	95	(66)	49	(77)	<.001***
Alcohol		108	(23)	16	(6.1)	64	(44)	28	(44)	<.001***
Psychiatric correlates										
Suicidal ideation	470	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	.041*
		n	(%)	n	(%)	n	(%)	n	(%)	
Past 30-day suicide attempt	470	126	(27)	62	(24)	36	(25)	28	(44)	.004**
Depressive symptoms	354	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	.097

(continued)

TABLE 1 Continued

Variables	Full sample (N = 470)			No CU (n = 262)		Vaping not primary method (n = 144)		Vaping as primary method (n = 64)		p
	n	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Psychosocial impairment	457	16.74	(11.29)	15.96	(11.23)	17.25	(11.87)	18.73	(9.98)	.177
Impulse control difficulties	469	7.33	(3.96)	7.07	(3.96)	7.33	(3.68)	8.41	(4.42)	.054

Note: The results of post hoc follow-up tests for significant group differences are as follows: both cannabis groups significantly differed from the no-cannabis group on age; presence of past 30-day e-cigarette use was significantly associated with being a member of both cannabis groups and significantly negatively associated with membership in the no-cannabis group; endorsing past 30-day alcohol use was significantly positively associated with both cannabis groups and significantly negatively associated with membership in the no-cannabis group; the group endorsing vaping as a primary method and no-cannabis group significantly differed from each other on suicidal ideation; having attempted suicide within 30 days of hospitalization was significantly associated with being in the vaping as a primary method group. CU = cannabis use.
*p < .05; **p < .01; ***p < .001.

Sensitivity Analyses

The link between cannabis vaping as the most frequent CU method and past 30-day suicide attempts remained significant (standardized OR = 1.40, categorized as a very small effect⁴⁷) when including factors associated with suicide attempts (SI; psychosocial impairment; depressive symptoms; impulse control; using alcohol, e-cigarettes, or cannabis in the past 30 days), as shown in Table 3. When a sensitivity analysis accounted for these factors in the statistical prediction of SI, cannabis vaping as the most frequent method became marginally significant (Table 4).

Relation to Biological Sex

For the link between cannabis vaping and suicide attempts, biological sex as female was a significant covariate in the model (standardized OR = 2.36, categorized as a small effect⁴⁷) (Table 2), indicating female sex is associated with greater odds of a past 30-day suicide attempt, which remained significant after sensitivity analyses (Table 3). Female sex was also a significant covariate in the model investigating cannabis vaping as the most frequent CU method with SI (Table 2), indicating female sex is associated with greater SI, but sex was no longer significant in the sensitivity analysis (Table 4).

To explore how biological sex may explain the link between vaping as the most frequent method of CU and STBs, we tested biological sex as a moderator in the 2 primary models. The interaction between biological sex and vaping as the most frequent method of CU was not a significant predictor of suicide attempts (*b* = 0.26, *p* = .693) or SI (*b* = 3.49, *p* = .665).

Comparison by Cannabis Method Group

The logistic regression model including all participants categorized by cannabis method indicated that adolescents who had never used cannabis (standardized OR = 0.42, small effect⁴⁷) and adolescents who endorsed smoking as their primary method (standardized OR = 0.42, small effect⁴⁷) had significantly lower odds of a past 30-day suicide attempt compared with adolescents who endorsed vaping as their primary method (Table 5). Adolescents who had never used cannabis and those who endorsed eating as their primary method of CU had significantly lower associations with SI compared with adolescents who endorsed vaping as their primary method (Table 5). Sensitivity analyses for Tables 4 and 5 are provided in Tables S1 and S2, available online. Adjusting

TABLE 2 Vaping as Most Frequent Cannabis Method With Past 30-Day Suicide Attempt and Suicidal Ideation (N = 470)

Variables	Past 30-day suicide attempt			Suicidal ideation		
	OR	95% CI	p	Estimates	95% CI	p
Intercept	0.19	0.03 to 1.26	.088	38.34	15.73 to 60.96	.001**
Vaping as primary CU method	2.38	1.35 to 4.16	.002**	8.71	1.38 to 16.04	.020*
Age	1.00	0.88 to 1.13	.960	-0.67	-2.14 to 0.81	.376
Sex	2.36	1.48 to 3.85	<.001***	15.31	10.11 to 20.52	<.001***

Note: Adjusted ORs are not standardized. CU = cannabis use; OR = odds ratio.
*p < .05; **p < .01; ***p < .001.

TABLE 3 Sensitivity Analysis of Hierarchical Logistic Regression Testing Vaping as Most Frequent Cannabis Method Predicting Suicide Attempts Controlling for Suicidal Ideation, Depressive Symptoms, Impulse Control, Psychosocial Impairment, and Past 30-Day Substance Use

Variables	Step 1 (N = 470)			Step 2 (n = 341)			Step 3 (n = 341)			Step 4 (n = 341)		
	OR	CI	P	OR	CI	P	OR	CI	P	OR	CI	P
Intercept	0.14	0.02–0.94	.044*	0.03	0.00–0.50	.015*	0.06	0.00–1.06	.058	0.06	0.00–1.00	.053
Age	1.02	0.91–1.16	.716	1.10	0.93–1.30	0.289	1.04	0.87–1.25	.638	1.05	0.88–1.26	.581
Sex (female)	2.41	1.52–3.93	<.001***	2.20	1.18–4.26	.016*	2.26	1.20–4.44	.014*	2.25	1.18–4.43	.016*
Suicidal ideation				1.05	1.03–1.07	<.001***	1.05	1.04–1.07	<.001***	1.05	1.04–1.07	<.001***
Depressive symptoms				0.94	0.90–0.99	.014*	0.94	0.89–0.98	.009**	0.94	0.89–0.98	.011*
Psychosocial impairment				0.98	0.95–1.01	.156	0.98	0.95–1.01	.189	0.98	0.95–1.01	.169
Impulse control difficulties				1.02	0.95–1.09	.558	1.02	0.95–1.10	.568	1.01	0.94–1.09	.719
30-day CU							2.03	0.89–4.66	.092	1.58	0.67–3.75	.296
30-day E-cigarette							0.69	0.31–1.50	.356	0.63	0.28–1.39	.263
30-day alcohol							1.21	0.57–2.57	.611	1.17	0.55–2.50	.677
Vaping as primary CU method										2.62	1.18–5.87	.018*

Note: Adjusted ORs are not standardized. CU = cannabis use; OR = odds ratio. *p < .05; **p < .01; ***p < .001.

for depressive symptoms, impulse control, psychosocial impairment, and past 30-day substance use, adolescents who endorsed smoking as their primary method had significantly lower odds of a past 30-day suicide attempt compared with adolescents who endorsed primarily vaping (standardized OR = 0.28, medium effect⁴⁷). For SI, after adjusting for these factors, smoking as the primary method, as compared to adolescents who primarily vaped, became marginally significant.

DISCUSSION

In this sample of adolescents hospitalized at a psychiatric inpatient hospital, we investigated vaping as the most frequent method of CU and its association with factors necessitating acute psychiatric hospitalization—recent suicide attempt and SI. Additionally, we characterized the rates of CU, routes of administration, and motives of use. Almost half of the sample reported any CU in their lifetime and nearly one-third reported CU in the past 30 days, indicating high rates of CU among these psychiatrically vulnerable adolescents. For comparison, in a 2022 national sample, lifetime CU among US adolescents in 8th, 10th, and 12th grade ranged from 11% to 38.3% and past 30-day CU ranged from 5% to 20.2%.³⁴ Notably, half of the adolescents with lifetime CU reported that their primary motive for use was to cope with negative feelings, supporting the theory that self-medication plays a prominent role in CU for youth with mental health concerns.^{14,48} This warrants further attention because cannabis used to cope with negative affect is associated with recent CU⁶ as well as an increased risk for developing CU disorder and psychiatric disorders.¹⁹

Our primary objective explored the associations between vaping as the most frequent method of CU and suicide attempts and ideation. Consistent with our hypothesis, endorsing vaping as the most frequent method of CU was associated with significantly greater odds of having attempted suicide in the 30 days before admission and greater SI. Adolescents who had never used cannabis and those who endorsed smoking as their primary cannabis method had significantly lower odds of a recent suicide attempt compared with adolescents who primarily vaped cannabis. Adolescents who had never used cannabis and those who endorsed eating as their primary cannabis method had a significantly lower association with SI compared with adolescents who primarily vaped cannabis. Findings from our sensitivity analysis highlighted the robustness of the link between cannabis vaping and suicide attempts, whereas SI became marginally significant. That is, aligning with prior research demonstrating a link between CU and suicide attempts beyond the effects of depression,²

TABLE 4 Sensitivity Analysis for Link Between Vaping as Most Frequent Cannabis Method and Suicidal Ideation, Controlling for Depressive Symptoms, Impulse Control, Psychosocial Impairment, and Past 30-Day Substance Use (n = 341)

Variable	Estimates	95% CI	p
Intercept	-10.39	-32.03 to 11.25	.346
Vaping as primary CU method	5.90	-0.86 to 12.67	.087
Age	-0.64	-2.03 to 0.75	.368
Sex	3.34	-1.42 to 8.11	.169
Depressive symptoms	1.83	1.55 to 2.11	<.001***
Psychosocial impairment	0.34	0.11 to 0.57	.004**
Impulse control difficulties	0.18	-0.42 to 0.78	.552
30-day CU	-5.62	-12.34 to 1.10	.101
30-day e-cigarette	0.64	-5.42 to 6.70	.836
30-day alcohol	3.16	-2.92 to 9.24	.309

Note: CU = cannabis use.
p < .01; *p < .001.

our results showed that the association between vaping as the most frequent method of CU and past 30-day suicide attempt remained significant when controlling for a host of other factors linked to attempts—SI, psychosocial impairment, depression, impulse control, and past 30-day substance use (e-cigarettes, alcohol, and CU). Although these data are cross-sectional and cannot address the question of causality, results are consistent with prior research indicating that CU is directly linked to suicide attempts.²² Our results are also consistent with previous findings indicating that CU is more strongly related to suicide attempts than ideation.^{3,15} This phenomenon could be due to impulsivity as a proximal risk factor preceding suicide attempts, self-medication/coping motives,¹⁴ a direct causal link between

cannabis and suicide attempts,²² as well as the fact that SI is strongly associated with depression, whereas suicide attempts are associated with a broader range of psychiatric symptoms.²⁵ A similar pattern has been found for other psychiatric symptoms having a stronger relation to suicide attempts than SI.²⁵

Given that vaping is associated with delivery of greater concentrations of cannabis compared with other methods of use and that high-potency cannabis may be linked to more serious psychiatric consequences of use,^{5,8,9} this study sought to specifically explore rates of cannabis vaping in this high-risk population. Results indicated that vaping was the second most common route of administration after smoking, and 30% of adolescents with lifetime CU reported that vaping was their most frequent method of CU. The rate of lifetime cannabis vaping in the current study (24.5%) is comparable to the 24.2% of US 10th-grade students in 2022 endorsing lifetime cannabis vaping.³⁴ Furthermore, these high rates of endorsement are consistent with prior research indicating that rates of vaping are increasing among adolescents,^{10,11,34} emphasizing the need for assessment and intervention research, especially for adolescents with psychiatric concerns who might be particularly vulnerable to the negative impacts of vaping.

Results from the current study extend the literature by showing a specific link between vaping cannabis as the most frequent CU method and recent suicide attempts, underscoring the significance of this particular method of CU as a potent risk factor for adolescents with mental health concerns. These data were collected in 2021 through 2023, which is notable because of both the increased potency and the changing use patterns of cannabis that have dramatically altered the landscape over the past decades.¹¹ For example, longitudinal studies that investigated adolescent CU as a risk for adult psychiatric disorders and suicidality¹⁵ collected their data before 2017 when the potency of CU and

TABLE 5 Cannabis Use Group Compared to Vaping as Most Frequent Cannabis Method With Past 30-Day Suicide Attempt and Suicidal Ideation (N = 470)

Variables	Past 30-day suicide attempt			Suicidal ideation		
	OR	95% CI	p	Estimates	95% CI	p
Intercept	0.46	0.05 to 4.02	.481	50.28	24.45 to 76.12	<.001***
Smoking as primary CU method	0.42	0.22 to 0.80	.008**	-6.61	-14.83 to 1.61	.115
Eating as primary CU method	0.54	0.13 to 1.91	.353	-17.17	-34.17 to -0.17	.048*
No CU	0.42	0.23 to 0.76	.004**	-9.58	-17.31 to -1.85	.015*
Age	0.99	0.87 to 1.14	.940	-0.88	-2.45 to 0.69	.270
Sex	2.34	1.46 to 3.83	.001**	15.44	10.20 to 20.68	<.001***

Note: Vaping as primary cannabis use method is the reference group. Adjusted ORs are not standardized. CU = cannabis use; OR = odds ratio.
*p < .05; **p < .01; ***p < .001.

methods of use were quite different (arguably, less risky); even so, their results illustrate the risk to young people for developing depression and suicidality. Changes in CU trends in the past several years may indicate increasing psychiatric risks for adolescents, particularly given the prevalence of youth who use cannabis (ie, although not all adolescents who use cannabis will develop psychiatric symptoms, as the prevalence increases it is the case that a greater number of adolescents may be impacted). In sum, although our results are cross-sectional and do not establish temporality, our study benefits from assessing a method of CU that is rapidly increasing among adolescents.³⁴

The current findings indicate that female sex was associated with greater odds of past 30-day suicide attempt and greater SI, consistent with prior literature.²⁶ Regarding the outcome of past 30-day suicide attempt, vaping as a primary method of CU remained significant in a hierarchical logistic regression sensitivity analysis despite the larger magnitude effect of female sex, which serves as another indication of the robustness of this vaping finding. The additive effects of female sex and vaping as a primary method of CU may warrant particular attention when designing interventions. That is, evidence of a telescoping effect, where females develop CU disorder faster than male counterparts,²⁹ suggests that adolescent girls who use cannabis, particularly those who vape as a primary method of use, may need earlier CU assessment and treatment to mitigate risk for negative psychiatric sequelae.

Our findings linking cannabis vaping in adolescents to current STBs among youth with acute psychiatric distress, paired with results indicating that many of these youth use cannabis to cope with negative emotions, suggest the potential for a cyclical connection between CU and psychiatric symptoms.^{6,19} That is, symptoms may motivate CU as a means of coping, and, in turn, CU may lead to intensification of symptoms and related maladaptive behavior (ie, suicide attempts). Therefore, the results of this study have important clinical implications, given the high rates of CU reported and the associations between CU and STBs. For clinicians working with adolescents experiencing mental health concerns, especially acute psychiatric distress, assessing CU is imperative. Our findings also highlight the importance of assessing methods of cannabis intake among adolescents, as vaping may be a unique risk factor for suicide. These concerns may be particularly relevant for adolescents living where recreational CU is legal for adults, given that cannabis vaping among youth is more prevalent in these areas.³⁵ Youth and families may be unaware of the high potency of cannabis in vaping products and links to physical health and psychiatric concerns; thus, interventions aimed at providing CU education may be an important first

step in effective treatment. Furthermore, the high rate of CU to cope with negative feelings highlights the need for clinicians to assess why adolescents are using cannabis. Evidence suggests that self-medication with cannabis for psychiatric symptoms, such as depression and anxiety, is unlikely to relieve distress in the long term and has been shown to lead to CU disorder in adults.⁴⁹

While this study provides novel insights into the association between CU and STBs among adolescents with acute psychiatric concerns, there were limitations. First, only cross-sectional data were available from the intake assessments, precluding any conclusions regarding causality. It remains uncertain whether CU directly contributes to increased risk for suicidal behavior or if other confounding factors play a role. Second, the sample was admitted to an inpatient psychiatric hospital, so findings may not be representative of adolescents experiencing psychiatric concerns and receiving outpatient care. This sample introduces potential selection bias, as adolescents admitted to inpatient care may exhibit more severe psychiatric symptoms and a higher likelihood and severity of STBs. Third, although this study included a relatively diverse sample of adolescents, we were limited by the sample size in our ability to explore racial and ethnic differences in CU characteristics and links to SI and attempts across ethnic/racial groups. Future studies will need to consider the impact of sociodemographic factors on CU patterns and risk for suicide, especially with respect to the applicability of findings to diverse and minoritized populations. Fourth, despite conducting sensitivity analyses to account for potential confounding factors, there are other contextual factors that may influence this relation that were not assessed in this study, such as neighborhood risk, socioeconomic status, and family substance use. Future research should employ longitudinal designs to establish causal connections and understand the temporal dynamics of these associations, consider a larger and more diverse adolescent population, and explore additional contributing factors to delineate the complex connection between CU and suicide risk in this vulnerable group.

In conclusion, endorsing vaping as the most frequent method of CU has a robust and specific association with past 30-day suicide attempts, as effects held when accounting for multiple risk factors for suicidality. Moreover, among psychiatrically hospitalized adolescents, CU in general, and vaping in particular, are prevalent, with many youth reporting CU to cope with negative feelings. Taken together, these findings indicate the importance of assessing CU frequency as well as method of intake among psychiatrically vulnerable adolescents. It is crucial to develop effective interventions for CU that emphasize more adaptive ways of coping, particularly for youth at risk

for STBs. Although the mechanism is unknown, it is important to consider cannabis vaping as an indicator of higher risk for STBs among adolescents with acute psychiatric concerns.

CRedit authorship contribution statement

Sarah A. Thomas: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Elizabeth C. Thompson:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Micaela M. Maron:** Writing – review & editing, Writing – original draft, Data curation. **Samuel N. Meisel:** Writing – review & editing, Writing – original draft, Methodology. **Anthony Spirito:** Writing – review & editing, Methodology. **Jennifer C. Wolff:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization.

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