



A preliminary evaluation of synthetic cannabinoid use among adolescent cannabis users: Characteristics and treatment outcomes



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HIGHLIGHTS

- Heavy cannabis-using adolescents may be at increased risk of SC use.
- SC users report both positive SC subjective effects and adverse outcomes.
- SC users endorsed higher rates of cannabis use than SC nonusers.
- SC use was not associated with differential cannabis treatment outcomes.
- Rates of other psychoactive substance use did not vary by SC use.

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ABSTRACT

Little is known regarding the use of synthetic cannabinoids (SC), particularly use among adolescent substance users who may be at higher risk. The present exploratory study seeks to describe SC use and subjective effects among cannabis-using adolescents as well as compare the characteristics of cannabis users who do and do not use SC. Exploratory analyses evaluated cannabis treatment outcomes among SC users and non-users. Participants enrolled in a randomized, controlled intervention for cannabis-using high school students aged 14–19 ($N = 252$) completed questionnaires regarding their use of SC and other substances. Those who used SC in the past 60 days reported subjective effects of SC, consequences, and SC use disorder symptoms. Baseline characteristics, alcohol and other drug use, and treatment outcomes of SC users were compared to participants who never tried SC. Within this sample 29% had tried SC, and 6% used SC recently. Although most reported use at a relatively low rate, 43% of recent SC users reported SC use-disorder symptoms. Positive and negative subjective effects of SC were endorsed, with positive subjective effects reported more often. SC use was associated with more cannabis use, but not more alcohol or other (non-SC and non-cannabis) drug use. SC users did not differ from non-users on cannabis treatment outcomes. This exploratory study described SC use, and compared characteristics and treatment outcomes among SC users and non-users. Negative subjective effects of SC were reported as occurring less often, but SC use was associated with use disorder psychopathology. SC use was associated with more problematic cannabis use at baseline, but was not associated with use of other substances or differences in treatment outcome.

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Synthetic cannabinoids (SC) exploded into the market in the 2000s and mimic many of the psychotropic properties experienced in natural cannabis. Due to the similar effects that users experience, and the inability for standard drug tests to detect SC use, initial research suggests crossover between natural and synthetic cannabis users. Despite the

spike in SC popularity, little attention has been given to this substance and research into the short and long term consequences is scarce.

SC products are varied in their chemical composition and concentrations. This diverse group of substances (Dresen et al., 2010) is often referred to as *spice*, a popular brand when the drug emerged into more widespread public awareness (other street names include K2, Incense, Yucatan Fire, Genie, Moon Rocks, Zohai, etc.). Over 130 types of synthetic cannabinoids have been discovered (European Monitoring Center for Drugs and Drug Addiction, 2015). The current rate of SC use in the general public is difficult to ascertain, particularly because the substance is

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relatively new to the recreational market. Among those who report having tried SC, most endorse only occasional use. An anonymous online survey study found that approximately 17% percent of self-selected U.S. and U.K. adult respondents reported ever having tried SC (Winstock and Barratt, 2013). Among those who used SC within the past 30 days, one-third indicated they had used SC only once, while only 5% reported daily use (Winstock and Barratt, 2013). Epidemiological studies indicate that rates of use, at least among U.S. adolescents, have declined in recent years (Johnston, O'Malley, Miech, Bachman, and Schulenberg, 2015). For example, SC annual use prevalence among 12th graders fell from 11.4% in 2011 to 6% in 2014 (Johnston et al., 2015).

Rates of SC use among adolescents may continue to fluctuate as the legal status of SC and cannabis changes. As of March of 2011, the US Department of Justice placed the most commonly abused synthetic cannabinoids on the Schedule 1 list of the Controlled Substances Act (Drug Enforcement Administration, 2011). Additionally, in the last four years several states passed laws decriminalizing or legalizing recreational cannabis, notably recreational legalization in Colorado, Washington, Oregon, Alaska, and the District of Columbia. Changes in legal status of these substances may lead to significant regional variations in SC demand as well as rates of SC use, particularly among cannabis-using individuals. For example, SC use rates have declined following the federal ban (Johnston et al., 2015). It is possible that this decline in use may be more prominent in states in which recreational cannabis use is legalized, due to increased availability and permissibility of cannabis.

SC use can result in substance use disorders. For example, in a survey of U.S. adults with reported lifetime SC use (Vandrey, Dunn, Fry, and Girling, 2012), a significant minority of users reported symptoms consistent with SC abuse (37%) and dependence (12%). SC use is also accompanied by other drug and alcohol use, most notably cannabis (Vandrey et al., 2012; Winstock and Barratt, 2013).

Despite reported risks of SC use, few studies have investigated SC users, with even less exploration of SC use and consequences among adolescents (Castellanos, Singh, Thornton, Avila, and Moreno, 2011; Johnston et al., 2015). Although adolescents report relatively low perception of risk for experimental SC use (Johnston et al., 2015), they may be at greater risk for developing SC-related psychopathology than adult users. Furthermore adolescent substance users in particular warrant further attention as previous research has suggested that individuals who use other substances, especially cannabis and alcohol, may be at an elevated risk for SC use (Castellanos et al., 2011; Vandrey et al., 2012; Winstock and Barratt, 2013). Given that cannabis users are more likely to use SC, it is possible that SC users are more problematic users of cannabis.

If SC users are indeed more problematic cannabis users, such individuals may have differing cannabis treatment outcomes than those who do not use. No known study has evaluated this relationship. Additionally, no known study has investigated the subjective effects of SC among adolescent users. This investigation aims to fill a gap in the literature by describing SC use, subjective effects, and differences in cannabis treatment outcomes among a sample of heavy cannabis-using adolescents, thus informing future studies in this area.

Recent studies have also investigated the subjective effects of SC. Approximately 87% of adult respondents report experiencing a positive effect from SC use (e.g., feeling high), while 40% have reported negative or unwanted outcomes from use such as dry mouth, fatigue, lightheadedness, memory problems, and racing heart (Vandrey et al., 2012). Another study, which asked adult participants to compare the subjective effects of SC to natural cannabis, found the effects of SC are generally characterized as less pleasant than those of cannabis (Winstock and Barratt, 2013). However, subjective positive and negative experiences are rarely included in research. Serious negative effects of SC are documented within case studies which report adverse health effects, such as seizures or tachycardia (Harris and Brown, 2013;

Simmons, Cookman, Kang, and Skinner, 2011), as well as paranoia or psychotic symptoms (Every-Palmer, 2011; Harris and Brown, 2013; Oluwabusi, Loback, Aktar, Youngman, and Ambrosini, 2012; Simmons et al., 2011) and even mortality (European Monitoring Center for Drugs and Drug Addiction, 2015). The frequency at which these severe negative effects occur is unknown.

This paper used baseline data from the Teen Marijuana Check-Up-4 (TMCU), a recently completed randomized controlled trial in Seattle, Washington, aimed at motivating change in cannabis use within a voluntary sample of cannabis-using adolescents. Given the reports of SC use among cannabis users (Vandrey et al., 2012; Winstock and Barratt, 2013), it was expected that cannabis users would be more likely to use SC and experience negative consequences associated with use. The sample of cannabis-using adolescents, 75% of whom met diagnostic criteria for a cannabis use disorder, was also expected to be more likely to develop psychopathology related to SC use. This preliminary study had three goals: (1) to describe SC use and characteristics and subjective experiences of SC users in a sample of at-risk teen cannabis users; (2) to compare SC users to non-users on demographic variables, cannabis use and related problems, and perceived need for substance use treatment; and (3) to explore differences in cannabis treatment outcomes among SC users and non-users.

1. Methods

The parent trial was designed to evaluate the efficacy of adding check-ins to a Motivational Enhancement (MET) intervention for cannabis-using adolescents (Walker et al., submitted manuscript, 2016). Procedures were approved by institutional review boards at the University of Washington (UW HSD # 41405) and Virginia Tech (VT IRB # 10-556).

1.1. Participants

Participants were recruited from six high schools within the Seattle, Washington area. A total of 668 adolescents expressed interest in the study. Eligibility criteria included being at least 14 years of age; cannabis use on 9 or more days of the past 30; enrollment as either a freshman, sophomore, or junior; availability to complete follow-ups; and absence of a major medical or psychiatric condition that would impact participation. Of the 460 individuals who attended a screening appointment, 15 (3%) decided not to participate. An additional 178 were determined to be ineligible for a variety of reasons including using cannabis fewer than 9 days of the past 30 ($n = 154$; 34%), not being available to participate for the next year ($n = 27$; 6%), and a medical or psychiatric condition which would prevent participation ($n = 3$; 0.7%). In addition, students in their senior year of high school ($n = 19$; 4%) were excluded because they would not be in school to participate in all of the check-ins, resulting in 252 participants interested and eligible to participate in the trial. Participants ranged in age from 14 to 17 (mean = 15.84; $SD = 0.96$) and were cannabis users, smoking an average of 37.07 days of the 60 preceding baseline ($SD = 15.06$). The majority of the sample (75.0%) met diagnostic criteria for a cannabis use disorder. The sample was predominantly male (68%). Participants were primarily Caucasian (59%), while 19.8% identified as multi-racial, 6.0% African American, 4% identified as Asian, and 11% identified as other. Additionally, 10% of the sample identified as Hispanic or Latino.

1.2. Procedures

Adolescent cannabis users were recruited in Seattle area high schools via classroom presentations, lunch room information tables, and referrals from school staff or friends. The study was described as an opportunity to discuss and receive feedback about their cannabis use. All screening, baseline assessments, and intervention sessions took place in the schools. Students were able to express interest in the

project anonymously and then were called out of class and screened for eligibility criteria via a brief individual interview. Interested and eligible participants then completed a computerized baseline assessment and were randomly assigned to intervention condition: the Motivational Check-In (MCI; $n = 128$) or the Assessment-Only Check-In (ACI; $n = 124$). Participants in both conditions received two sessions of Motivational Enhancement Therapy in the first two weeks after baseline assessment. Participants then received check-in sessions at 4, 7, and 10-months post-baseline: the MCI group had a MET-based intervention and computerized assessment in the check-in session while the ACI condition only completed a computerized assessment. Participants also completed online follow-up evaluations at 6, 9, 12, and 15-months post-baseline. In addition, both MCI and ACI condition participants were offered optional CBT sessions through the 12-month follow-up assessment. For more information on study procedures, see the main outcome paper for the trial from Walker et al. (in press).

Overall outcomes from the study indicated that individuals in both the MCI and ACI conditions significantly reduced rates of cannabis use, cannabis-related problems, and cannabis use disorder symptomatology through the 15-month follow-up timepoint. Individuals in the MCI condition reported significantly fewer days of use, problems, and symptoms at the 6-month timepoint, but these significant differences were not evident at later timepoints.

1.3. Measures

1.3.1. Substance use and problems

Participants completed questions online adapted from items on the Global Appraisal of Individual Needs (GAIN-I) (Dennis, Titus, White, Unsicker, and Hodgkins, 2003) to assess self-reported SC use, cannabis use, alcohol use, and other drug use. The assessment window was modified to 60 days for the purposes of assessing substance use in this study. The GAIN-I has exhibited good reliability and validity in studies of adolescents and adults (Dennis, Funk, Godley, Godley, and Waldron, 2004), similar to the Timeline Followback (Dennis et al., 2004). Participants were also asked to report additional information about their cannabis use, including times per day of cannabis intoxication, age of first cannabis use, and age at which regular cannabis use was initiated (regular cannabis use was defined as use on 3 or more days per week, on average, for a period of 30 days).

Specifically, questions regarding SC use were prompted in the following way: "The following question(s) ask about experiences you may have had with 'Spice'. When we ask about Spice, we are referring to synthetic or 'fake' types of marijuana such as K2, herbal incense, Wicked, Blaze, Genie, Zohai, JWH-018, etc. Please include your use of any type of synthetic marijuana when asked about 'Spice'." Participants who reported SC use within the past 60 days were asked to report symptoms of SC abuse and dependence, using GAIN-I items assessing DSM-IV symptoms of abuse and dependence. This measure is a validated self-report method for assessing abuse and dependence symptomatology (Dennis et al., 2004). The same GAIN items were used to assess abuse and dependence symptoms for cannabis. Total counts of dependence and abuse symptoms were calculated separately to determine whether participants met criteria for either disorder.

Cannabis-related problems were assessed using the 23-item Marijuana Problem Inventory (MPI) (Johnson and White, 1995), which was adapted from the Rutgers Alcohol Problems Index (RAPI) (White and LaBouvie, 1989). The MPI assessed the frequency with which participants experienced problems as a result of their cannabis use within the past 60 days on a scale of 1 (never) to 5 (>10 times). A mean score was computed by averaging items ($\alpha = 0.86$).

1.3.2. SC subjective effects

Participants who used SC within the past 60 days were asked to report their subjective impressions of the effects of SC, using a list of possible effects of SC derived from SC exploratory studies and case reports

available in 2011 (e.g., Every-Palmer, 2011; Simmons et al., 2011) as well as commonly reported effects expectancies of natural cannabis (e.g., Schafer and Brown, 1991). Participants rated the frequency with which subjective effects were experienced on a scale of 1 (almost never/never) to 5 (almost always/always) and were asked to compare the effects of SC to those of natural cannabis using the same scale.

1.3.3. Treatment need

Several questions were asked in order to assess participants' need for or utilization of substance use treatment. Participants were asked to indicate whether anyone had suggested they receive treatment for their substance use, whether they had ever received substance use disorder treatment, and whether they had ever attended a 12-step meeting (e.g., Alcoholics Anonymous, Marijuana Anonymous) or other self-help group.

1.4. Analysis plans

Descriptive statistics examined rates of SC use among all participants. Rates of SC use disorder as well as endorsement of subjective SC effects were evaluated among individuals who endorsed use within the last 60 days. Characteristics of all study participants were compared based on their SC use status. Two SC-use groups were compared: participants who never used SC (Never Use), and participants who had used SC during their lifetime (both within the past 60 days and those who had used sometime in their lifetime; Lifetime Use). Chi-Square tests were used to determine whether there were significant differences between groups on categorical variables. Analysis of Variance (ANOVA) analyses were used to compare groups on continuous variables of interest. Post-hoc tests were used to determine the nature of these group differences. Exploratory GLM analyses with the SC use variable as between-subject factor were used to examine any differences among all participants in rates of use, problems, and cannabis use disorder symptoms over the course of five timepoints: BL, 6-month, 9-month, 12-month, and 15-month timepoints. The effects of time and time by SC use were evaluated. All analyses utilized IBM SPSS Version 21.0 (IBM Corporation, 2012).

2. Results

2.1. SC use and use disorder symptomatology

Of the 252 participants, 72 (29%) reported ever having tried SC. Only 15 (6%), however, reported recent SC use (i.e., within the past 60 days). Recent users reported days of use in the past 60 ranging from 1 to 15, with a mean of 2.80 ($SD = 4.09$). One recent-SC user did not complete items assessing SC use disorder psychopathology. Among the 14 recent users with complete data, four met DSM-IV criteria for SC abuse and two met criteria for SC dependence.

2.2. Characteristics of SC users

2.2.1. Demographics

Analyses found no significant differences among the Never Use and Lifetime Use groups on participant gender or age. Descriptive statistics and parameter estimates for demographic analyses are displayed in Table 1.

2.2.2. Cannabis and other substance use

Table 1 displays analyses evaluating differences among SC-use groups on cannabis-use variables. The SC-use groups differed significantly on rates of cannabis use, with the Lifetime Use group exhibiting more cannabis use, cannabis use more times per day, earlier cannabis initiation, and earlier regular use than the Never Use group. There were no significant group differences in cannabis-related problems.

Table 1

Descriptive statistics compared among synthetic cannabinoid (SC) groups with ANOVA and Chi-Square analyses.

	Descriptive statistics by group		
	Never use (<i>n</i> = 180)	Lifetime use (<i>n</i> = 72)	ANOVA <i>F</i> (<i>p</i>) or Chi-Square χ^2 (<i>p</i>)
Demographics			
Age <i>M</i> (<i>SD</i>)	15.87 (0.94)	15.7 (1.02)	0.59 (<i>p</i> = 0.45)
Gender <i>N</i> (%)			0.73 (<i>p</i> = 0.46)
Male	120 (66.7)	52 (72.2)	
Female	60 (33.3)	20 (27.8)	
Cannabis use			
Days used of past 60 <i>M</i> (<i>SD</i>)	34.90 (14.82)	42.50 (14.34)	13.77 (<i>p</i> < 0.01)
Times per day <i>M</i> (<i>SD</i>)	2.56 (2.42)	3.56 (3.60)	6.49 (<i>p</i> = 0.01)
Age of 1st use <i>M</i> (<i>SD</i>)	13.70 (1.48)	12.60 (1.86)	24.62 (<i>p</i> < 0.01)
Age of regular use <i>M</i> (<i>SD</i>)	14.96 (1.24)	13.99 (1.73)	23.38 (<i>p</i> < 0.01)
Cannabis problems <i>M</i> (<i>SD</i>)	1.59 (0.44)	1.65 (0.47)	0.92 (<i>p</i> = 0.34)
Other substance use			
Alcohol – days used <i>M</i> (<i>SD</i>)	7.61 (8.48)	9.11 (10.08)	1.45 (<i>p</i> = 0.23)
Other drugs – days used <i>M</i> (<i>SD</i>)	1.77 (6.31)	2.78 (5.27)	1.42 (<i>p</i> = 0.24)
Need for treatment			
Treatment recommended <i>N</i> (%)			2.28 (<i>p</i> = 0.09)
Yes	28 (15.6)	17 (23.6)	
No	152 (84.4)	55 (76.4)	
12-Step attended <i>N</i> (%)			6.25 (<i>p</i> = 0.03)
Yes	6 (3.3)	8 (11.4)	
No	174 (96.7)	62 (88.6)	
Substance treatment attended <i>N</i> (%)			0.72 (<i>p</i> = 0.42)
Yes	23 (12.8)	12 (16.9)	
No	157 (87.2)	59 (83.1)	

Additionally, there were no significant differences in rates of alcohol and other drug use.

2.2.3. Need for treatment

Effects trended towards significance in analyses that evaluated whether participants had engaged in or were encouraged to participate in prior substance use disorder treatment (See Table 1) such that the Lifetime Use group were likely to have treatment recommended. Significant differences among groups were observed for 12-step attendance: participants in the Never Use group were less likely to have attended a 12-step group. There were no significant differences among groups in past substance use treatment.

2.2.4. Cannabis treatment outcomes

Main effects from analyses evaluating treatment outcome differences through 15-months by baseline SC use category indicated that participants decreased their rates of use ($F(4, 215) = 10.60, p < 0.01$), problems ($F(4, 211) = 14.26, p < 0.01$), and cannabis use disorder symptoms ($F(4, 217) = 26.52, p < 0.01$) over the course of time. However, analyses of time by SC use indicated that the reductions were not significantly different based on SC use ($ps > 0.05$).

2.2.5. SC subjective effects

The subjective effects of SC as perceived among recent users ($N = 15$) are displayed in Table 2. Both positive and negative subjective effects of SC were endorsed, with positive subjective effects being reported as experienced more commonly. All of the positive subjective effects except “good flavor” were endorsed by at least 50% of the sample as occurring at least some of the time or more. The most commonly endorsed negative effect was feeling tired. Eighty percent of participants reported that spice was more intense than cannabis. Interestingly, less than half of participants reported that spice was easier to get than cannabis.

Table 2

Subjective effects of spice as reported by recent (past 60 days) synthetic cannabinoid (SC) users.

Subjective effects (<i>n</i> = 15)	Almost never/never	At least some of the time
Positive effects		
Good mood	20%	80%
Good flavor	60%	40%
Heightened senses	27%	73%
Laughing	7%	93%
Tuned into thoughts/feelings	40%	60%
Had fun	7%	93%
Thought differently	33%	67%
Helped relax	20%	80%
Liked the effects	13%	87%
Average positive effects	25%	75%
Negative effects		
Irritable	53%	47%
Tired	27%	73%
Headaches	67%	33%
Feel less coordinated	33%	67%
Feel nervous/panicky	47%	53%
Heart racing	40%	60%
Paranoia	33%	67%
Irritated throat/lungs	40%	60%
Nauseous	47%	53%
Difficulty breathing	67%	33%
Hallucinations	60%	40%
Unpleasant effects	47%	53%
Average negative effects	47%	53%
Compared to cannabis		
The effects lasted longer	60%	40%
Spice was cheaper	27%	73%
The effects were more intense	20%	80%
Spice made me feel more relaxed or tired	60%	40%
Spice made me feel more happy or excited	33%	66%
Spice made me feel more nervous or paranoid	40%	60%
Spice was easier for me to get	53%	47%

3. Discussion and conclusions

The present paper provides an examination of SC use, subjective effects, and relationship to cannabis use and related constructs among a sample of adolescent cannabis-users. Lifetime rates of use were substantially higher within this at-risk sample than in larger studies of adolescents (Johnston et al., 2015), college students (Stogner and Miller, 2014) and more diverse adult users (Vandrey et al., 2012). However, use within the past 60 days was relatively uncommon. Furthermore, days of use was low among recent users, with the most days of use reported by SC user on only 15 of the past 60 days. Despite the relative infrequency of use, a subset of the sample reported symptoms consistent with either SC abuse or dependence. This finding is notable in that adolescents may experience use disorder symptoms even as a result of relatively low rates of SC use. It is difficult to ascertain how the rates of use reported in the present paper compare to adolescents within the general population, as the only known epidemiological studies of adolescent use reported only annual rates of use (Johnston et al., 2015). However, it is possible that the results may be explained by cannabis use, given the similarity of the substances. Additionally, it was expected that rates of use among this cannabis-using sample would be higher than the general public, given the relationship between SC use and cannabis use (Vandrey et al., 2012; Winstock and Barratt, 2013).

Participants endorsed both positive and negative experiences. Participants generally endorsed more positive effects of SC; however, they were divided on whether using SC was an overall enjoyable experience. Negative subjective effects of SC were reported as occurring with relative infrequency. Consistent with case reports of psychosis (Every-Palmer, 2011; Harris and Brown, 2013; Oluwabusi et al., 2012; Simmons et al., 2011), a subset of participants reported serious negative subjective effects including paranoia and hallucinations. SC was

generally not perceived to be notably different than cannabis. Although SC was generally thought to be cheaper than cannabis, it was not often thought to be easier to obtain. Within the present sample of cannabis users, most adolescents may have easy access to cannabis (which, although illegal for use in adolescents, was legalized for recreational use among adults in Washington state) and be less inclined to use SC, a substance banned in the state of Washington prior to recruitment for this study. Additionally, previous research has noted a decline in SC following a federal ban (Johnston et al., 2015). Future studies should also examine relationships between SC use and cannabis use in areas of less cannabis availability. Despite the current attempt to characterize the acute subjective effects of SC, it should be noted that SC subjective effects are difficult to predict due to variability in psychoactive ingredients among different synthetic cannabinoid products (Rosenbaum, Carreiro, and Babu, 2012). Additionally, it is possible that negative subjective effects would be more common among lifetime versus recent SC users. Future studies should examine this possibility.

Participants who had never used SC were compared to SC lifetime users on a variety of variables. No demographic differences were found among the groups. This finding is inconsistent with a previous study that found that male college students were more likely to have tried SC (Stogner and Miller, 2014). Significant differences based on SC use status did emerge, however. Participants who reported having tried SC were more likely to use cannabis with more frequency and intensity and at an earlier age, which is consistent with other research that has highlighted the relationship between use of the substances (Vandrey et al., 2012; Winstock and Barratt, 2013). However, the groups did not differ in terms of reported problems as a result of cannabis use. As such, recent SC users may be at particular risk for more cannabis-related psychopathology, even among a sample of problematic cannabis users. However, these differences did not translate into significant discrepancies in treatment outcomes.

There were mixed findings as to whether SC users were more likely to need or access substance use treatment. Participants who had tried SC were more likely to have attended a 12-step group. Group differences also approached significance for whether treatment was recommended, with recent SC users being more likely to have treatment recommended to them. These findings further indicate that SC users may represent more problematic substance users who may be more likely to experience future problems with substance use, despite the fact that there were no differences in other drug use. Although the relationships between SC and variables related to treatment outcome are unlikely causal, SC use may serve as an indicator of perceptions of more problematic use.

A significant limitation of data analyses in the present study is the relatively small sample size of recent SC users. As such, reporting of subjective effects of use may be restricted and between-group comparisons may have lacked power to find significant differences between groups. In particular, analyses revealed no significant differences by SC user group in cannabis treatment outcomes. An additional limitation of the study is the nature of the sample, which consisted exclusively of cannabis-using adolescents. As a result, the present results may not generalize to the general population or other adolescent groups. Additionally, it is possible that reporting of negative outcomes, such as use disorder symptoms, associated with SC use may be partially attributed to cannabis use. Given that we did not assess for use among high school seniors due to the longitudinal nature of the parent treatment trial, these results may not generalize to older high school users or those with a later onset of SC use. However, the sample is also a notable strength of the study in that 100% of the sample was under the age of 18 and thus adds to existing literature on adolescent use. An additional weakness of the study was our measurement of abuse and dependence symptoms, which utilized DSM-IV criteria, and our measurement of SC subjective effects. The list of subjective effects in the present study does not represent a validated scale, as no known such measure exists; however, the effects included are similar to those presented by Vandrey et al.

(2012). Additionally, this measure was only administered to participants who endorsed SC use within the last 60 days. Thus, it may not represent the full subjective effects of the substance. However, the limited data gathered in the present study may help to guide future research aimed at measuring a comprehensive list of SC subjective effects in order to develop SC effects scales. Despite these weaknesses, the present findings have implications for treatment providers and school administrators, as SC use was associated with substance use disorder psychopathology, more problematic cannabis use, and greater need for treatment. Results suggest that high school students may benefit from psychoeducation on effects of SC use and consequences, particularly high school students with a history of cannabis use. Longitudinal research with SC users will be helpful to determine whether SC use predicts negative outcomes prospectively.

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Contributors

Authors RS, RR, and DW designed the parent study and wrote the protocol. Authors CB and KB conducted literature searches and provided summaries of previous research studies. Authors CB and KB conducted the statistical analyses and wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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