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Synthetic Cannabinoids: Use and predictors in a Community Sample of Young Adults

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Abstract

Background: Synthetic cannabinoids (SCs) are a class of drugs of abuse with deleterious consequences. Despite governmental regulations related to distribution and sale, SC variants are still available online. More research is needed to determine SC use prevalence and factors associated with SC use, especially among young adults.

Methods: One thousand eighty individuals, 18-25 years old, were surveyed, between January 2012 and July 2013, during recruitment for a randomized controlled trial investigating health behaviors in young adults. Advertisements were placed online and in community locations seeking individuals “who had recently used marijuana or alcohol.” Respondents were queried about their use of alcohol and drugs, including SCs, in the last month.

Results: Participants averaged 21.4 years old and were 53.4% male. Nearly 59% were Non-Hispanic White, 15% were African American, 15% were Hispanic, 11% identified as Other. Approximately 9% reported SC use in the last month, a level higher than the reported use of opioids, cocaine, or hallucinogens. SC use was significantly associated with male gender, not being enrolled in school, and with use of cigarettes, binge alcohol drinking, daily and weekly marijuana use, and other drugs of abuse. There was a significant decrease in SC use after the federal ban in July, 2012.

Conclusions: SC use was common in the past month and often overlaps with other drug use, particularly marijuana use, and should be asked about during clinical encounters with young adults.

Keywords

Spice; synthetic cannabinoids; young adults; community sample

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AUTHOR CONTRIBUTIONS

Author Caviness is the study project manager and wrote the first draft of the manuscript. Author Tzilos helped with the initial manuscript conception, first draft, and all subsequent revisions. Author Anderson ran the statistical analyses. Author Stein is the principal investigator. He was involved in the initial manuscript conception and all manuscript revisions.

INTRODUCTION

Beginning in the mid-2000s, a variety of “herbal blends” and “incense” labeled “not for human consumption” became widely available across Europe, the United States, and on the internet. This labeling was misleading, however, as these herbal mixtures contained a sprayed-on synthetic cannabinoid (SC), most often branded “Spice” or “K2”, and were seen as a legal alternative to marijuana¹. Currently available for purchase not only over the internet, but also at gas stations, convenience stores, and head shops, SCs, which are smoked similarly to marijuana, are undetectable on standard drug tests for marijuana and have been perceived as safe by consumers²⁻⁵. Although new drug test systems do include options for SC testing, the rapidity with which SC variations are becoming available makes it difficult for testing to keep pace.

In early studies, prevalence rates of SC use have ranged from 7.4 to 16.8%, depending on age and population sampled⁶⁻¹⁰. As SCs have risen in popularity, so have reports of deleterious effects from their use. Reported symptoms, often unanticipated and severe, include psychosis, kidney injury, tachycardia, agitation, and seizures^{2, 11-17}. Calls to U.S. poison control centers increased dramatically^{18, 19} through 2012, although evidence suggests they decreased in 2013¹⁸. In 2010 there were over eleven thousand reported emergency department visits related to SCs¹³ and there continues to be localized reports of outbreaks of heavy emergency department visits across the United States tied directly to SC use^{20, 21}. Further, according to one survey of reported SC users, 2.4% reported experiencing symptoms severe enough to require immediate emergency care in the previous twelve months¹⁵. Even when unanticipated negative symptoms do not require emergency care, they are unpleasant, and frequently experienced²².

Synthetic cannabinoids are not listed as active ingredients on the package label²³, and type and concentration of active compound is not consistent across different products, or even within batches of the same product⁴. Many SC products contain multiple SCs²⁴, and other psychoactive ingredients². SCs may affect the central nervous system differentially than natural cannabis, and the full array of potentially toxic effects of the identified compounds remains unknown¹². For example, SCs are often full cannabinoid receptor type 1 and 2 agonists, while Δ^9 -tetrahydrocannabinol, the active ingredient in cannabis, is only a partial agonist^{2, 24}. Additionally, as SCs break down in the bloodstream, they may remain potent, and potentially hazardous²⁴, increasing the risk of deleterious effects.

In response to increasing use and abuse, and rising reports of negative effects across Europe and the United States, government agencies have taken legal steps to limit the sale and distribution of SCs^{16, 23, 25}. In 2011, the Drug Enforcement Agency utilized its emergency scheduling powers to put five known SCs in Schedule 1. In July, 2012, known SCs which were cannabinoid receptor type 1 agonists, and not specifically exempt, were placed in Schedule I according to the Food and Drug Safety and Innovation Act (Subtitled: Synthetic Drug Abuse Prevention Act of 2012)²⁶. The act also allowed for any newly discovered SCs to be placed in Schedule I by the DEA. In the United States, bans in individual states are occurring piecemeal; for example, in Rhode Island, where the current study took place, a

law banning the sale of SCs was not enacted until July, 2013^{27, 28}, making it one of the last states to ban such products.

Due to its relative newness, growing numbers of reports of negative consequences, and rapidly shifting legal status, SC use is an emerging area of interest for substance abuse researchers. SC use was recently added to the Monitoring the Future's annual, national survey conducted with representative samples of 8th, 10th, and 12th grade students and high school graduates followed into adulthood. SCs were found to be the second most commonly used illicit substance, surpassed only by marijuana, among high school seniors in 2011 and 2012^{7, 29}, something that did not change, even after the federal ban. However, data from 2013 suggests high school seniors decreased their use of SCs significantly (11.3% in 2012 down to 7.9% in 2013)³⁰, perhaps due to increased media coverage of adverse effects, or individual state regulations making access more difficult.

Research to date has found SC users are significantly more likely to be male^{3, 6, 7, 9, 10, 31} than female. Age is also related to use, with adolescents more likely to be SC users than young adults^{6, 9, 32}, although this is not true across all studies^{3, 31}. Additionally, Stogner and Miller⁹ found sexual orientation to be a significant predictor of SC use, where lesbian, gay, bisexual and transgender (LGBT) young adults were significantly more likely to be SC users than their straight counterparts. This finding is unique in the literature and warrants further study.

SC users report using other drugs and alcohol at very high rates. For example, alcohol, marijuana, and tobacco use are extremely high among SC users^{3, 9, 10, 31}. Beyond these substances, SC users, at least those recruited from a college campus and an internet survey, consumed other drugs of abuse at high levels as well³¹, especially compared with their non-SC using peers⁹.

A clear picture of the socioeconomics of SC users has not emerged from the extant literature. Although the Monitoring the Future data show SC use is higher among those who are college-aged, those who are not full-time students use SCs more often than those who are³², perhaps indicating an association with economic opportunity as reflected by college enrollment. The majority of studies have been conducted in exclusively college populations^{6, 8, 9}. The purpose of the current study is to better our understanding of SC use and its correlates in a community sample of young adults responding to an advertisement for a research study involving alcohol or marijuana use.

The current study adds to the growing body of literature describing SC users' demographic and substance use profile among a community sample of young adults. Supporting previous findings, we hypothesize that SC users will report using other substances at significantly higher rates than those who have not used SCs, and that SC use will be higher among those not currently enrolled in school.

METHODS

Screening survey data from participants recruited for the larger RCT between January 2012 and July 2013 were used for the current study. We included responses from all persons

screened (regardless of their eligibility for the larger RCT) except those outside of the 18-25 age range. Recruitment occurred in several formats; online through Craigslist and Facebook targeted at Southeastern New England, and through advertisements placed in local college newspapers, on public transportation, and on commercial radio. The advertisement read, “Men and Women between 18 and 25: Have you recently used marijuana or alcohol? You may be eligible to participate in a research study about the health behaviors of young adults.”

Interested persons called the study phone number or sent an email to the study address to receive a return call to be screened. Screening was anonymous with verbal informed consent. The study protocol was approved by the Institutional Review Board at a research hospital in Southern New England.

Measures

The ten-minute phone screen included questions related to demographics and living situations, substance use over the last month, (cigarettes, opioids, inhalants/hallucinogens, cocaine, stimulants, marijuana, and binge alcohol drinking), prescribed medications, sexual activity, mental health, and general health. Binge drinking was defined as 5 or more drinks for men and 4 or more drinks for women “within a couple of hours.” Response options for frequency of marijuana and binge alcohol use ranged from “0, Never” to “5, Once a day or more”. Use of any cigarettes, daily cigarette smoking, opioids, inhalants/hallucinogens, cocaine, and stimulants in the past month was dichotomized for presence or absence of use in the previous month. Education status was queried with the question “Are you currently in school?” Response options were “Full time, part time, not in school.” SC use was measured by a single item: “In the past month, have you used K-2 or Spice?” The response options were “yes” or “no.”

Analytical Methods

Descriptive statistics summarize the characteristics of the cohort. The Pearson χ^2 test of independence and t-tests for differences in means is used to compare those reporting and not reporting use of SCs. The χ^2 test is also used to compare those who reported using SCs prior to and after enactment of the federal ban on July 9th, 2012.

RESULTS

Among the full cohort of 1,080 persons aged 18-25 years, just over half (53.4%) of all of the participants were male, their mean age was 21.4 (\pm 2.1) years, 635 (58.9%) were non-Hispanic White, 159 (14.8%) were African-American, 164 (15.2%) were Hispanic, and 120 (11.1%) were of other ethnic or racial origins (Table 1). Almost 85% identified their sexual orientation as straight, and 491 (45.5%) were in school either part- or full-time. One hundred individuals (9.3%) reported using K-2 or Spice in the past month. Prior to the federal ban on July 9th, 2012, 42/275 (15.3%) individuals screened used SC, compared to 58/805 (7.2%) after the ban ($\chi^2 = 15.88$, $p < .001$). Just over 40% reported daily marijuana use, and an additional 29.3% reported using at least once a week in the past 30 days; 185 (17.1%) reported no use of marijuana in the past month. Nearly 46% of participants reported binge

drinking at least weekly in the previous month. Over half (57.1%) reported any (past month) use of cigarettes, and 35.9% were daily cigarette smokers. Seventy-eight (7.2%) reported using inhalants or hallucinogens, 71 (6.6%) reported using opiates or opioids, 72 (6.7%) used cocaine, and 159 (14.8%) reported using stimulants, in the past month.

Persons reporting use of SCs were significantly ($\chi^2 = 8.16, p = .004$) more likely to be male (Table 1). In this cohort of persons 18-25 years old, use of SCs was not associated with age. Use of SCs was also not significantly associated with the 4-category indicator of ethnicity (Table 1). However, a somewhat higher proportion of SC users were of Hispanic origin; indeed, a comparison contrasting those of Hispanic origin to all other racial and ethnic groups is statistically significant ($\chi^2 = 5.20, p = .023$). Persons using SCs were significantly ($\chi^2 = 10.63, p = .001$) less likely to be in school. Use of SCs was not associated with sexual orientation.

Use of SCs was significantly associated with frequency of marijuana use ($\chi^2 = 34.91, p < .001$) and frequency of binge drinking ($\chi^2 = 28.29, p < .001$) (Table 1); 62% of SC users reported daily use of marijuana and an additional 31% reported using marijuana at least weekly. By comparison, rates of daily and weekly marijuana use among those reporting no use of SCs were 38.4% and 29.1%, respectively. Only 1 SC user reported no use of marijuana. SC users were significantly ($\chi^2 = 48.87, p < .001$) more likely to report any use of cigarettes, daily use of cigarettes ($\chi^2 = 80.77, p < .001$), any use of inhalants or hallucinogens ($\chi^2 = 15.69, p < .001$), any use of opiates or opioids ($\chi^2 = 54.49, p < .001$), any use of cocaine ($\chi^2 = 26.94, p < .001$), and any use of stimulants ($\chi^2 = 4.63, p = .031$).

DISCUSSION

The current study took place in one of the last states to ban SC use, just prior to legal limits being set on the sale and distribution of SCs due to increasing reports reporting its deleterious effects. Although SC use was federally outlawed at the time of this study, SCs were widely available in convenience stores, smoke shops, and other retailers until the prohibition through state law was enacted. Our survey extends recent work by describing SC use in a large diverse sample of 18-25 year olds recruited from the community, who responded to an advertisement for recent alcohol or marijuana use. Importantly, this study sampled both college students and non-college students, and included persons using alcohol and drugs at various levels. Given that substance use across almost all classes of drugs is lower among college students than their non-college peers²⁹, we were able to compare SC use through the years of young adulthood in both college and non-college enrolled individuals.

Interestingly, SC use was more frequently endorsed in this sample prior to the broad federal ban enacted in July, 2012 (15.3%), than after (7.2%). This is surprising, given how widely available SCs continued to be in the state at gas stations, convenience stores, and head shops, as was true in other regions³³, and over the internet, even after the federal ban, and the high rate of other illicit substance use in this population. We would not have hypothesized that federal legality of SCs would have been a motivating factor for discontinued use among this group of users. It is possible that media coverage of adverse

effects leading up to, and accompanying the federal ban also played a role in the decreased frequency of use. It is also possible that individuals no longer saw advantages over marijuana once SC was also criminalized.

Our findings support the 2012 and 2013 Monitoring the Future results^{29, 32} that found those not in college were twice as likely to report using SCs, (8.5% vs. 15.5% in 2012; 4.3% vs. 9.4% in 2013), despite a decrease in SC use over that time period^{29, 32}. Our data do not allow us to distinguish between those not in school due to college graduation and those who never enrolled, however, our pattern of results are similar to those found by Johnson et al.,^{29, 32}. The greater use of SCs among those not in college and in the workforce could be explained by this group being more motivated to avoid positive drug tests on employer toxicology screens, or wanting what they perceive as a legal alternative to natural marijuana, easily purchased over the internet. Gunderson et al.,²² surveyed cannabis users regarding their SC use, and a majority indicated avoiding positive drug screens was a motivating factor. It is possible our sample, who also used marijuana heavily, switched to SC leading up to a known drug test in order to avoid a positive screen, or that in this sample, that was not their leading motivation for SC use.

Stogner et al.,⁹ studying only college students, found indicators of socioeconomic (SES) status in addition to education and employment factors, such as higher family income, to be predictive of SC use. These authors speculated that their findings were due in part to more affluent college students having more disposable income available to spend on SCs, which at the time of their study, were much more expensive than natural marijuana. We did not measure family income in the current study, but this would be an interesting line of inquiry to explore further, especially given findings in contrast with the Monitoring the Future data and the current results regarding college attendance.

SC use was more common in males than in females. Male gender seems to be a stable predictor of SC use as it has consistently been found across studies^{3, 6, 7, 9, 10, 31}. However, contrary to one previous report, we did not find sexual orientation to be significantly related to SC use⁹. The majority of our sample who identified as LGBT, self-identified as bisexual. This may be different than the population sampled in the previous report and account for the divergent findings. Given the dearth of information related to sexual orientation and SC use, more investigation is warranted.

SC users in the current study were much more likely to endorse binge drinking at all levels, smoking cigarettes and natural marijuana, and using inhalants/hallucinogens, opioids, cocaine and stimulants. This is consistent with previous findings, whereby SC users had consistently riskier drug use profiles than their non-SC using counterparts^{3, 9, 31}, and smoked cigarettes at high rates^{3, 10, 22}. Of note, only one individual reported using SC but not natural marijuana in this study. This association between marijuana and SC is consistent with the literature. Most studies do find high rates of overlap between the two drugs, with 96% of SC users also using marijuana in one study by Barratt and colleagues³, although the near-universal overlap we found is the highest rate reported. Winstock and Barratt¹⁰ found a strong preference for natural marijuana among SC users despite the perceived benefits of

SCs over marijuana, including SC use not being detectable on many standard drug tests and its relative safety. Our results are consistent with these findings.

This study has important strengths. Data were collected from a large sample of 18-25 year old young adults through a variety of community advertising methods. The sample was diverse across gender, race and ethnicity, sexual orientation, and levels of substance and alcohol use, and unlike previous work in this area, more than fifty percent of our participants were not currently attending any form of higher education, increasing the generalizability of these results to the larger population of young adults.

There are also study limitations worth noting. First, SC use was measured using a single-item question and we do not have any information on the frequency of use, age of first use, or preference for SCs as compared to other drugs. Second, this sample was recruited for a study specifically seeking young adults who used alcohol or marijuana and therefore our sample reported higher levels of use of these substances than has been found in large national surveys^{32, 34}. Third, our findings may not generalize to other age groups or other regions. Indeed, our data were collected during a period, and in a state, where SCs were not yet banned. SC use was banned federally part way through out data collection, although our overall rates of SC use were similar to others' findings. Fourth, we were not able to fully evaluate the impact of SES on SC use in this cohort. Finally, when seeking information about stimulant use, we asked if participants had used either prescription and non-prescription stimulants, therefore this finding should be interpreted with caution as a number of these respondents may have been using a medication as prescribed (e.g., Adderall); however, there is a high propensity for stimulant medications to be abused, diverted, and misused in this age group³⁵.

SCs are understudied, rapidly evolving, synthetic drugs which warrant careful consideration from lawmakers, medical professionals, researchers, and SC users themselves. The current study adds to the growing literature by describing those who endorse SC use in a community sample of alcohol and/or marijuana users. While regulations have seemingly reduced access to and use of SCs, it is unlikely SCs will disappear as the ingredients added to SCs are constantly changing to work around the regulations, and "legal" formulations are readily available online. Health service practitioners can engage young adults about their SC use and in doing so may find an opportunity to discuss legal, educational, health, and alcohol and drug concerns, including marijuana use, which is now legal in several states. As the current study found, SC users tend to engage in high risk drug use, in addition to their SC use. Querying young adults who use marijuana, especially young men who are not attending college, about SC use may be a non-threatening way to begin a conversation about a number of high risk behaviors. Additionally, it is important to continue to study the impact of SCs on individuals, in concert with other drug use, and on our medical and legal systems, as this will inform ways to improve regulatory and intervention efforts.

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TABLE 1

Background Characteristics, Past Month Marijuana Use, and Binge Drinking by Self-Reported Use of Spice (n = 1,080)

	<i>Mean (± SD) or n (%)</i>			<i>t (p =) or χ² (p =)</i>
	Full Cohort (n = 1,080)	Used Spice		
	No (n = 980)	Yes (n = 100)		
Gender				
Male	577 (53.4%)	510 (52.0%)	67 (67.0%)	8.16 (.004)
Female	503 (46.6%)	470 (48.0%)	33 (33.0%)	
Years Age	21.4 (± 2.1)	21.4 (± 2.2)	21.1 (± 2.1)	1.37 (.171)
Ethnicity				
White	635 (58.9%)	585 (59.8%)	50 (50.0%)	
Af-American.	159 (14.8%)	143 (14.6%)	16 (16.0%)	6.00 (.112)
Hispanic	164 (15.2%)	141 (14.4%)	23 (23.0%)	
Other	120 (11.1%)	109 (11.2%)	11 (11.0%)	
After Federal Ban				
No	275 (25.5%)	233 (84.7%)	42 (15.3%)	15.88 (<.001)
Yes	805 (74.5%)	747 (92.8%)	58 (7.2%)	
Sex. Orientation (Straight)	909 (84.4%)	829 (84.6%)	80 (80.0%)	1.62 (.203)
In School (Yes)	491 (45.5%)	461 (47.0%)	30 (30.0%)	10.63 (.001)
Frequency of MJ Use				
Never	185 (17.1%)	184 (18.8%)	1 (1.0%)	
< 1 / Mo.	17 (1.6%)	15 (1.5%)	2 (2.0%)	
1 / Mo.	43 (4.0%)	42 (4.3%)	1 (1.0%)	34.91 (<.001)
2-3 Times / Mo.	81 (7.5%)	78 (8.0%)	3 (3.0%)	
Weekly	316 (29.3%)	285 (29.1%)	31 (31.0%)	
Daily	438 (40.6%)	376 (38.4%)	62 (62.0%)	
Frequency of Binge Drinking				
Never	201 (18.6%)	190 (19.4%)	11 (11.0%)	
< 1 Mo.	37 (3.4%)	36 (3.7%)	1 (1.0%)	
1 / Mo.	132 (12.2%)	121 (12.4%)	11 (11.0%)	28.29 (<.001)
2-3 Times / Mo.	214 (19.8%)	197 (20.1%)	17 (17.0%)	
Weekly	475 (44.0%)	423 (43.2%)	52 (52.0%)	
Daily	21 (1.9%)	13 (1.3%)	8 (8.0%)	
Any Cigarettes (Yes)	616 (57.1%)	526 (53.7%)	90 (90.0%)	48.87 (<.001)
Daily Cigarettes (Yes)	388 (35.9%)	311 (31.7%)	77 (77.0%)	80.77 (<.001)
Inhalant/Hallucinogen (Yes)	78 (7.2%)	61 (6.2%)	17 (17.0%)	15.69 (<.001)
Opiates/Opioids (Yes)	71 (6.6%)	47 (4.8%)	24 (24.0%)	54.49 (<.001)

	<i>Mean (± SD) or n (%)</i>			
	Full Cohort (n = 1,080)	Used Spice		t (p =) or χ^2 (p =)
		No (n = 980)	Yes (n = 100)	
Cocaine (Yes)	72 (6.7%)	53 (5.4%)	19 (19.0%)	26.94 (<.001)
Stimulants (Yes)	159 (14.7%)	137 (14.0%)	22 (22.0%)	4.63 (.031)

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