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# Synthetic cannabinoid use in a nationally representative sample of US high school seniors

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## ARTICLE INFO

*Article history:*

Received 17 November 2014

Received in revised form 6 January 2015

Accepted 31 January 2015

Available online 11 February 2015

*Keywords:*

Synthetic cannabinoids

Marijuana

Adolescents

Sociodemographics

## ABSTRACT

**Background:** Synthetic cannabinoids are marketed as “legal highs” and have similar effects to cannabis (marijuana). Although prevalence of synthetic cannabinoid use is now declining in the US, use has been associated with tens of thousands of poisonings and hospitalizations, particularly among teens. It is important to examine which teens are at highest risk for use of these new, potentially deleterious drugs as they are understudied and continue to emerge.

**Methods:** Data were analyzed from a nationally representative sample of high school seniors in the Monitoring the Future study (2011–2013; Weighted  $N = 11,863$ ; modal age: 18). Bivariable and multivariable models were used to delineate correlates of recent (12-month) synthetic cannabinoid use.

**Results:** Ten percent reported any recent use and 3% reported more frequent use (used  $\geq 6$  times). Females were at low odds for use and going out 4–7 evenings per week for fun consistently increased odds of use. Black and religious students were at low odds of use until controlling for other drug use, and higher income increased odds of use until controlling for other drug use. Lifetime use of alcohol, cigarettes and other illicit drugs all robustly increased odds of use, but frequency of lifetime marijuana use was the strongest correlate with more frequent use further increasing odds of synthetic cannabinoid use. Only 0.5% of non-marijuana users reported use of synthetic cannabinoids.

**Conclusions:** This is among the first national studies to delineate correlates of synthetic cannabinoid use. Results can inform national and local efforts to prevent use and adverse consequences resulting from use.

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## 1. Introduction

Synthetic cannabinoids are a large family of compounds that produce similar effects to  $\Delta^9$ -tetrahydrocannabinol (THC), the main psychoactive ingredient in cannabis (marijuana; Department of Justice [DOJ], 2014; Wiley et al., 2013). There are numerous compounds, mixtures and brands of synthetic cannabinoids, and two of the most well-known brands are K2 and Spice. Although many compounds are now illegal to possess or sell in the US (DOJ, 2014), synthetic cannabinoids remain available in many head shops and over the Internet, and they are often sold as herbal incense “not intended for human consumption.” Despite efforts to control sales, new compounds continue to emerge worldwide (European Monitoring Centre for Drugs and Drug Addiction, 2013) and many compounds are not yet illegal or detectable (Castaneto et al., 2014).

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Use has led to numerous adverse health outcomes and there is a strong need for population data to help guide prevention efforts (Castaneto et al., 2014).

Novel psychoactive drugs such as synthetic cannabinoids are often used because they are “legal” and use generally does not result in arrest (Van Hout and Brennan, 2011). Many individuals also use synthetic cannabinoids as opposed to natural marijuana to avoid detection during drug screenings (Castaneto et al., 2014; Vandrey et al., 2012). However, synthetic cannabinoids may be particularly dangerous as they may be perceived to be safe (Van Hout and Brennan, 2011), marketed products are not regulated, and neither the scientific community nor the public has an adequate understanding of the potential risks involved with use.

While effects of synthetic cannabinoids are often similar to effects of THC in natural marijuana, they have been found to be much more potent and to have stronger effects than THC. The stronger effects in particular appear to have led to numerous adverse outcomes (“poisonings”), which have often been more serious than adverse consequences resulting from natural marijuana use (Castaneto et al., 2014; Forrester et al., 2012;

Kronstrand et al., 2013; Winstock and Barratt, 2013a). Adverse effects include severe agitation and anxiety, intense hallucinations, psychotic episodes, suicidal and other harmful thoughts or actions, hypertension, tachycardia, nausea and vomiting, muscle spasms, seizures, tremors, kidney injuries, and myocardial infarction and stroke, often in otherwise young healthy individuals (AAPCC, 2014; Bernson-Leung et al., 2013; Castaneto et al., 2014; Centers for Disease Control and Prevention, 2013a,b; Forrester et al., 2012; Hoyte et al., 2012; Hurst et al., 2011; Mir et al., 2011; Winstock and Barratt, 2013b). Use has also been found to be associated with more severe withdrawal when compared to natural marijuana (Nacca et al., 2013).

Some 11,561 poisonings were reported to AAPCC between January, 2009 and April, 2012 with the highest percentage of use among 13–19-year olds (Wood, 2013), and national data from the Drug Abuse Warning Network confirm that individuals at ages 18–20 are at highest risk for poisoning (60.8 per 100,000-population; Substance Abuse and Mental Health Services Administration, 2013). Although reported poisonings have begun to decrease nationally, there were at least 3359 reported poisonings in the US in 2014 (AAPCC, 2014). Although reports do not always adequately reflect incidence, particularly when a new drug emerges, some areas appear to be experiencing increases in use. In New York City (NYC), for example, there was a 220% increase in reports of related poisonings by mid-2014 (NYC DHMH, 2014). Increases in reported poisonings have often occurred in clusters due to “bad batches” (Centers for Disease Control and Prevention, 2013a; Hoyte et al., 2012; NYC DHMH, 2014).

Monitoring the Future (MTF) is one of few national surveys that ask about synthetic cannabinoid use. Results suggest that in 2011, annual prevalence of synthetic cannabinoid use was 11.4% among high school seniors (modal age: 18) making it the most prevalent drug used after natural marijuana (Johnston et al., 2014a). Likewise, the Global Drug Survey, conducted via Internet respondent-driven sampling, surveyed 3300 Americans in 2012 and results suggest that 14% of respondents used synthetic cannabinoids that year (Rogers, 2012). However, recent MTF reports now suggest that use began to decline in 2013, with prevalence dropping to 6% among high school seniors in 2014 (Johnston et al., 2014a, 2015).

Although use appears to be declining, we know very little about use in national samples because the very few epidemiological studies have been based on small, self-selected or convenience samples, or from adverse outcomes reported to emergency rooms (Castaneto et al., 2014; Community Epidemiology Work Group, 2013). We thus also know very little about higher-frequency use at the national level. This study seeks to help fill in the gaps and provide researchers, policymakers, and educators, information regarding which teens and young adults are at highest risk for this potentially deleterious drug.

## 2. Methods

### 2.1. Procedure

MTF is a nationally representative study of US high school students. A cross-section of students is surveyed every year in approximately 130 public and private schools throughout 48 states. MTF uses a multi-stage random sampling procedure: geographic areas are selected, then schools within areas are selected, and then classes within schools are selected. Approximately 15,000 high school seniors are surveyed every year. MTF assesses consent through six different survey forms, which are distributed randomly. All forms assess sociodemographic factors and use of various licit and illicit drugs; however, only survey Forms 3 and 6 assess (last 12-month) use of synthetic cannabinoids.

Therefore, use is only assessed in about a third of the sample. MTF began asking about synthetic cannabinoid use in 2011. In order to have adequate power, this analysis focused on aggregated (and weighted) data collected from the three most recent cohorts with available data (2011–2013). MTF protocols were approved by the University of Michigan Institutional Review Board (IRB) and the authors' IRB approved this secondary data analysis.

### 2.2. Measures

Students were asked to indicate their sex, age (predefined as <18, ≥18 years) and race/ethnicity (i.e., Black, White, Hispanic). Population density of students' residences were pre-defined as non-, small-, or large-metropolitan statistical areas (MSAs). Small MSAs are defined as counties or groups of counties with at least one city of ≥50,000 inhabitants and the 24 largest MSAs are defined as large MSAs. Non-MSAs are the remaining areas. Level of religiosity was assessed via two ordinal items that asked about level of religious attendance and importance. These items were computed into a composite and divided into tertiles indicating low (1.0–2.0), moderate (2.5–3.0) and high (3.5–4.0) religiosity. To assess family composition, students were asked which parent(s) they resided with. Answers were coded into no parents, one parent or two parents. Students were also asked about level of educational attainment of each parent and answer options were (1) grade school, (2) some high school, (3) high school graduate, (4) some college, (5) college graduate, and (6) graduate school. A mean score for both parents (or a raw score if only one parent) was coded into tertiles representing low (1.0–3.0), medium (3.5–4.0), and high (4.5–6.0) education. Students were also asked how much money they earn during the average week from (1) a job or other work, and (2) from other sources. Responses for each of these two income items were coded into \$10 or less, \$11–50, or \$51 or more. Coding of sociodemographic variables was based on previous MTF analyses that focused largely on socioeconomic status (SES; Palamar et al., 2014a; Palamar and Ompad, 2014; Wallace et al., 2009).

Lifetime use of marijuana (“pot, weed, hashish”) was assessed and answer options were (1) 0 occasions, (2) 1–2 occasions, (3) 3–5 occasions, (4) 6–9 occasions, (5) 10–19 occasions, (6) 20–39 occasions, and (7) 40 or more occasions. Lifetime alcohol use was assessed using the same answer options and use was dichotomized into yes/no. Lifetime use of the following other illicit drugs was also assessed: powder cocaine, crack, LSD, hallucinogens other than LSD, heroin, and nonmedical use of opioids (other than heroin), tranquilizers (e.g., benzodiazepines), sedatives (e.g., barbiturates) and stimulants (e.g., amphetamine). Use of each was dichotomized and an indicator variable was created to indicate whether the student reported use of any. This variable was computed if the student provided data for at least six of these other illicit drugs. Therefore, those who did not provide responses for at least six other illicit drugs were removed from the analytic sample. Lifetime cigarette use was also assessed and answer options regarding use were: (1) never, (2) once or twice, (3) occasionally, but not regularly, (4) regularly in the past, and (5) regularly now.

Synthetic cannabinoid use was assessed via the following question: “During the last 12 months, on how many occasions (if any) have you taken ‘synthetic marijuana’ (‘K2’, ‘Spice’) to get high?” Answer options were the same as for other drugs previously mentioned and we dichotomized responses into 12-month (“recent”) use: yes/no. In addition, to examine more “frequent” recent use we also created a variable indicating whether the student reported using on >6 occasions.

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