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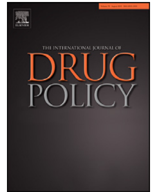
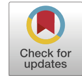


Research Paper

Does cannabis testing in the military drive synthetic cannabinoid use? Self-reported use motivations among justice-involved veterans



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ABSTRACT

Background: Though synthetic cannabinoid receptor agonists (SCRAs) were controlled after being introduced as a 'legal high,' SCRAs likely remain appealing to individuals subject to routine drug screens as not all testing programs consistently include SCRAs. Military populations have been linked to SCRAs due to the unconfirmed supposition that testing protocols led many to substitute SCRAs for cannabis. This study aimed to explore SCRA use prevalence, correlates, and use motivations among veterans, with a particular focus on whether United States military personnel substituted SCRAs for cannabis to subvert testing protocols.

Methods: All veterans appearing in one of eight civilian criminal courts in three U.S. states were invited to answer questionnaire items related to military service, court functionality, and substance use. Of the 579 veterans eligible, 54.9% chose to participate, yielding a cross-sectional sample of 318 veterans charged with a criminal offense by civilian authorities.

Results: Sixty-five (21.3%) justice-involved veterans reported lifetime SCRA use. Use while within the military was reported by 15.0% of veterans enlisting after 2008. Only eight (12.3%) reported SCRAs were used as a substitute for cannabis. Boredom (36.9%), experimentation (27.7%), and social aspects of SCRA use (32.3%) were more commonly reported motives. Logistic regression models indicated that use of cannabis (aPR=2.06, p<.05), hallucinogens (aPR=2.50, p<.01), and SCRAs (aPR=2.49, p<.05) while in the military were risk factors for SCRA use after leaving the military, whereas older age at time of military exist was a protective factor (aPR=.87, p<.01)

Conclusions: Drug testing programs within the military do not appear to have the unintended consequence of routing individuals to more risky drugs; however, SCRAs appear to have been an underappreciated problem within the military. Further, use extends beyond the military with many only initiating use after discharge, suggesting SCRA use may jeopardize the health of veterans post-service.

Military veterans are at heightened risk for substance use issues (Kehle-Forbes et al., 2019). Over one-third of United States (U.S.) veterans screen positive for alcohol use disorder (Fuehrlein et al., 2016; Eisen et al., 2012) with other studies suggesting that 7-20% meet the criteria for drug use disorders (Boden & Hoggatt, 2018; Lan et al., 2016). While U.S. veterans' experiences with alcohol, cannabis, and other common substances is well documented (Boden & Hoggatt, 2018), recent reports suggest that frequent testing for common substances within the military may have redirected some individuals to newer drugs associated with more problematic risk profiles (Loeffler et al., 2012; Cole, 2011; Morris and Stogner, 2017). However, the hypothesis that military personnel purposely select emerging drugs as a replacement for common substances has not been assessed.

This study examines the prevalence of use of synthetic cannabinoid receptor agonists (SCRAs), some of which may have served as an alternative for cannabis, within a sample of 318 U.S. military veterans who appeared in one of eight veterans treatment courts between 2016 and 2018. Among those who used SCRAs, motivations for use were explored, including whether SCRAs were predominately used as a replacement for cannabis among military personnel subject to routine drug screenings. Further, characteristics associated with SCRA use, schedules of use, and habitual usage patterns were evaluated to assist with management of future emerging drug issues. Though SCRA use appears to be decreas-

Abbreviations: SCRA, synthetic cannabinoid receptor agonist; NPS, new psychoactive substances; UNODC, United Nations Office on Drugs and Crime; VTC, veterans treatment court; MEVTC, Multisite Evaluation of Veterans Treatment Courts; JIV, Justice-involved veteran; PTSD, posttraumatic stress disorderp; SC, synthetic cannabinoids.

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ing outside of the military (Meich et al., 2021) and some marginalized populations (Gray et al., 2021; Norman et al., 2021), lessons related to these substances can help inform reactions to newer emerging substances both within and outside of the military, including the allocation of counseling and treatment resources to servicemembers most likely affected.

New psychoactive substances

New psychoactive substances (NPSs) have created a complex environment challenging communities, law enforcement agencies, and healthcare providers over the past two decades. The United Nations Office on Drugs and Crime (UNODC) has defined NPSs as "substances of abuse, either in a pure form or a preparation, that are not controlled by the 1961 Convention on Narcotic Drugs or the 1971 Convention on Psychotropic Substances, but which may pose a public health threat" (UNODC, 2016). NPSs are often developed to act as analogues or replacements for existing recreation drugs (Khey et al., 2013; Batisse et al., 2020). Colloquially, these drugs are sometimes referred to as "legal highs," though the term is often inaccurate (Peacock et al., 2019). The UNODC's (2021) Early Warning Advisory indicates that over 1,100 distinct NPSs have been identified, including numerous new opioids, hallucinogens, stimulants, and SCRAs. NPS use has been labeled a global epidemic (Zawilska & Andrzejczak, 2015) and has been reported in 133 countries (UNODC, 2021). Countries such as the U.S., Canada, the United Kingdom (U.K.), Japan, Turkey, and Finland have reported issues with more than 300 different NPSs (UNODC, 2021).

SCRAs, also referred to as synthetic cannabinoids (SCs), represent one of the larger NPS categories with 209 different variants (EMCDDA, 2021). While SCRAs were anticipated to produce effects similar to tetrahydrocannabinol (THC) such as euphoria and relaxation (Johnson et al., 2011; Palamar & Acosta, 2015), SCRA use has resulted in tachycardia, time distortions, agitation, and aggression (Akram et al., 2019; Mathews et al., 2019), as well as kidney injury, stroke, cardiac arrest, seizures, hyperemesis, and psychosis (Darke et al., 2020; Bernson-Leung et al., 2014; Hermanns-Clausen et al., 2013; Ibrahim et al., 2014; Papanti et al., 2013; Armstrong et al., 2019). The variability of these effects is partially due to dosage, experience with cannabis, and body composition but is also impacted by inconsistencies in samples and the variety of distinct SCRAs reaching the population (Cary, 2014; Castaneto, 2015; Khey et al., 2013; Zuba & Byrska, 2013). SCRA dependence also seems to be an issue as withdrawal symptoms and tolerance development are reported following frequent use (Craft et al., 2021; Macfarlane & Christie, 2015).

SCRA use and regulation

Use of SCRAs in the U.S. likely peaked between 2010 and 2012. A recurring national survey of high school seniors estimated the prevalence of use within the last year as 11.4% and 11.3% in 2011 and 2012, respectively (Meich et al., 2021). Use estimates from this ongoing study have dropped to 2.4% as of 2020 (Meich et al., 2021). Use among young adults in the U.S. is also now relatively rare with only 0.9% of those between 18 and 25 years old estimated to have used SCRAs in the last year (SAMHSA, 2021). However, numerous indicators suggest use is still high among specific groups, including those who are in community-based recovery programs (Smith & Staton, 2018), gender and sexual minorities (Stogner et al., 2021; Lowe et al., 2020), victims of intimate partner violence (Ihongbe & Masho, 2018), prisoners (Norman et al., 2021), and probationers (Smith & Staton, 2018). SCRAs are also still identified in U.S. emergency room data (Roehler et al., 2020), forensic laboratory reports (U.S. Drug Enforcement Administration, Diversion Control Division, 2020), and community wastewater samples (O'Rourke & Subedi, 2020).

Internationally, SCRA use seems to have followed a similar pattern of decreasing in recent years. The number of newly identified SCRAs in the last 5 years has been consistently below half of the peak years of 2011 to 2015 (EMCDDA, 2021); European SCRA seizures have also fallen since this time with most nationally representative studies in European countries indicating the prevalence of last year SCRA use now is around or less than 1% (EMCDDA, 2021). Reported prevalence of lifetime SCRA use among students varies between European countries (ranging from 1.1% in Slovakia to 5.2% in France), but an overall reduction in student use occurred between an initial measure in 2015 (4.2%) and 2019 (3.1%; ESPAD, 2020).

Despite use decreasing in many countries, SCRAs have resulted in numerous deaths in recent years including 60 in the U.K., 100 in Europe, and 70 in New Zealand (Gray et al., 2021). An Australian study of ambulance utilization suggests that SCRA harms recently increased despite use decreasing within the country (Grigg et al., 2020), and the increased SCRA harms in New Zealand are similar likely due to more dangerous SCRA preparations as opposed to a growing user base (New Zealand Drug Foundation, 2018). Much like the U.S., SCRA use within other countries is often reported in specific subgroups such as impaired drivers in France (Richeval et al., 2021), individuals incarcerated in Scottish prisons (Norman et al., 2021), Israeli adults enrolled in drug treatment (Shapira et al., 2020), probationers in Hong Kong (Cheng & Dao, 2020), German prisoners (Norman et al., 2021), and homeless individuals in the U.K. (Gray et al., 2021).

Most countries regulated SCRAs between 2012 and 2016. The U.S. enacted the Synthetic Drug Abuse Prevention Act in 2012 which effectively banned all CB1 agonists and some Synthetic cathinones. New Zealand passed the Psychoactive Substances Act in 2013 in an attempt control NPSs (Wilkins, 2014). China restricted over 100 NPSs, including 39 SCRAs, in 2015 (UNODC, 2015), which likely affected SCRA supply in many countries. The U.K.'s Psychoactive Substances Act 2016 created a de facto ban on all existing and future NPSs, with minor exceptions, but has been criticized due to being vague and failing to reduce harm (Shafi et al., 2020).

SCRAs and drug testing

Reports following the emergence of SCRAs reveal the complexities surrounding them and drug testing. Strict cannabis policies and frequent testing among groups in the U.S. were believed to incentivize use of SCRAs over the better understood natural alternative with fewer health risks (Cole, 2011; Fattore, 2016; Morris and Stogner, 2017; however, see Kurcevič and Lines (2020) which suggests lower cost was a motivating factor in Eurasian countries). Institutions that enforced a strict abstinence policy, such as the criminal justice system, corporations, and the military, found routine drug screenings ineffective as few were designed to effectively detect SCRA use (Loeffler et al., 2012; Richardson et al., 2016).

As a result, those desiring to use a cannabis-like substance but concerned about positive screens could turn to SCRAs (Bae et al., 2018; Caviness et al., 2015; Madras, 2016), and a ripe SCRA environment emerged. Products were distributed initially through legal smoke shops, which were falsely labeled as "incense" or "potpourri" and sold under brand names such as Spice or K2—these two brand names eventually became colloquial names for all SCRAs (Khey et al., 2013). Following legal restrictions, online and black markets continued to promote SCRAs as a powerful alternative to cannabis with the potential to deceive drug screening processes (Caviness et al., 2015; Marsh, 2017; Stogner & Miller, 2014). Though SCRAs were no longer a "legal high," veterans may have believed they had utility as a cannabis alternative that would not appear on drug screens. Frequent drug testing within the military, along with the need to manage complex stressors and trauma, may have made SCRAs more appealing to those serving than the broader population (Bebarta et al., 2012; Castaneto et al., 2014; Johnson et al., 2011); however, studies narrowly focusing on SCRA use within military community are sparse.

Substance use, SCRAs, and the military

The military culture and substance use have an intricate and complex relationship. Alcohol and tobacco are used as coping tools but create health risks among those who are expected to remain in peak physical condition. Similarly, shared excessive drinking may facilitate cohesion in a military unit but also fosters conflict and may lead to high levels of use (Vest et al., 2018). Members of the military are more likely to engage in excessive alcohol and drug use than the general population due to: 1) efforts to manage pain associated with injuries and the physical demands of military service (Oliva et al., 2015); 2) heightened stress and mental health issues, including depression and post traumatic stress disorder (PTSD), resulting from service (Seal et al., 2011); 3) the characteristics of military members overlapping with known correlates of substance use (such as young age and sensation-seeking traits; Tam et al., 2020); and 4) a culture that normalizes binge drinking (Ames et al., 2007). As a result, substance use disorders are disproportionately reported by veterans, but most reports focus on alcohol, prescription medications, or street drugs as opposed to NPSs (Boden & Hoggatt, 2018; Eisen et al., 2012; Fuehrlein et al., 2016; Kehle-Forbes et al., 2019; Lan et al., 2016).

Of the few NPS and SCRA studies that focus on use among U.S. military members, Loeffler et al. (2012) noted the military was severely impacted by substance misuse, specifically by emerging NPSs. Loeffler et al. (2012) highlighted the impact on military physicians, many of whom were unprepared to deal with the acute or chronic manifestations of NPS use, but also indicated that military populations may be disproportionately affected by the harms associated with NPSs. Walker et al. (2014) confirmed that SCRA use was emerging among active-duty personnel. Of those seeking treatment for substance use issues, 11.0% of active-duty respondents reported SCRA use, and 7.3% of respondents indicated that SCRAs were their drug of choice. SCRA use was also reported in case studies and small samples of military personnel, though while unable to depict use patterns or motivations, did confirm the emergence of SCRAs across military installations, branches, and rank (Bebarta et al., 2012; Berry-Cabán et al., 2013; White et al., 2016). Grant et al. (2016) found a significant association between veterans' reporting of traumatic stress symptoms and SCRA use. They attributed this connection to SCRAs being used by veterans seeking relaxation and tension reduction following deployment; however, their sample was cross-sectional and could not establish whether trauma preceded SCRA use among soldiers or if it was used to relieve stress specifically tied to military service. Additionally, Perrone et al. (2013) indicated that those anticipating a career in the military used SCRAs rather than cannabis due to the perceived lower likelihood that SCRA use would affect their admission into the military.

Though all CB1 agonists were banned by the U.S. government in 2012, U.S. military substance use regulations already in existence when SCRAs emerged were broad enough to ban cannabis analogues for active-duty personnel. SCRAs were explicitly banned within the U.S. military in 2011 (i.e., Bebarta et al., 2012; Brantley, 2012; U.S. Army regulation 600-85, NAVADMIN 108/10, and Airforce instruction 44-121). Despite earlier reports of a notable portion of positive results among those who did evaluate SCRAs (Brantley, 2012; Gould, 2013), Castaneto (2015) notes that military testing facilities had often omitted SCRAs from their analyses while testing was further complicated by the inability to test for all SCRAs and new SCRAs rapidly replacing older ones by the time adequate tests were developed. Military testing for SCRAs prior to December 2013 only occurred if there was "probable cause" to suspect illicit NPS use among specific servicemembers (Castaneto, 2015). Since the military only evaluated SCRA use in tests classified as "Collection Code PO" before this time, servicemembers could elude detection so long as they did not create probable cause for SCRA testing. Since 2014, the military has included SCRAs in a portion of urinalyses designated "Inspection Random" (Code IR) and "Competence for Duty" (Code CO; U.S. Army, 2020). While regulations require all tests screen for cannabis, cocaine, heroin, and amphetamines, SCRAs are considered "low prevalence" and may be included on a portion of screens as determined by the Executive Director, Force Resiliency (U.S. Department of Defense, 2020). Thus, a member of the military may still have reason to believe SCRA use is less likely to be detected than cannabis use. Other NPSs either do not appear in testing procedures or are only included if requested by a commanding officer (U.S. Army, 2020).

Study focus

The hypothesis that military personnel purposely selected an emerging drug such as a replacement cannabis is explored. Using a sample of U.S. veterans disproportionately affected by substance use issues (veterans charged with a criminal offense by a civilian authority and participating in a treatment court), we reported the prevalence of SCRA use, assessed motivations for use, determined whether SCRAs were used as a replacement for cannabis, identified characteristics associated with SCRA use, and described usage patterns. These analyses not only inform both military leaders and healthcare providers about previous SCRA use, but may also have the greatest utility in offering insight into how NPSs that emerge in the future might affect military personnel. Though results cannot be generalized beyond the U.S. military, findings likely have relevance to those concerned with military drug policy and programming in other countries due to the challenges shared by members of militaries across the globe (Adler et al., 2008; Vermetten et al., 2014) and indications that NPS use similarly affect European militaries (Hunter et al., 2018).

Methods

Sample

A cross-sectional sample of justice-involved veterans (JIVs) was employed to evaluate SCRA use within each of the major military branches. Inclusion in the sample required a civilian criminal charge which means findings are not generalizable to members of the military more broadly. JIVs report more combat-related issues, PTSD, physical injuries from their service, marital discord, and employment issues as compared to those veterans not under justice system supervision (Baldwin, 2017; Noonan & Mumola, 2007; Tsai et al., 2018; White et al., 2012). Those who identify as Black, non-Hispanic, or Hispanic were overrepresented in a national sample of 79 veteran-specific courts (Baldwin, 2017). Veterans of the Marine Corps were also disproportionately represented as are younger veterans (Baldwin, 2017). However, generalized samples are unlikely to include sufficient veterans that have used these less commonly-abused compounds for analysis. Participants in the veteran-specific court programs from which the sample was drawn often have extensive substance use histories (including 49.5% with pending substance-related charges; Baldwin, 2017) and, due to the court framework, felt comfortable providing detail about their past substance use.

Data were drawn from the National Institute of Justice's Multisite Evaluation of Veterans Treatment Courts baseline interviews (MEVTC; IRB-FY2016-83[1]). Just over 600 of these veterans treatment courts (VTCs), specialized civilian courts for JIVs, have been founded across the U.S. since the mid-2000s (Baldwin & Hartley, 2022). VTCs are largely modeled after other problem-solving court programs such as drug courts and mental health courts. VTC programs attempt to connect veterans charged with a civilian criminal offense with treatments and services specifically designed for their post-military needs (Miller & Johnson, 2009) and differential exposure to trauma, injuries, and other stressors (Dworkin et al., 2018; Tanielian et al., 2008). The MEVTC primarily addressed court functionality and processes but also included

[1] The present analysis was deemed exempt due to analyzing deidentified data collected under the cited approval.

data collected from participants; these veterans provided context for their military, court, and substance use histories.

Eight sites across three states were purposely chosen for the MEVTC study to ensure inclusion of varied court sizes, structures, lengths of operation, and demographic profiles. The present study used self-report participant baseline data collected between July 2016 and June 2018. All individuals physically appearing in one of the eight selected VTCs were offered the opportunity to participate in the study and receive a $20 gift card. The VTC coordinator made court participants aware of the study, and a member of the research team attended court regularly to recruit study participants (as VTC participants attend court weekly or biweekly for a minimum of several months, each participant had multiple opportunities to join the sample; phone calls were also made to participants who provided their phone numbers to the researchers in an effort to recruit them into the study). The survey was administered by a trained researcher who marked the participant's responses on a paper copy of the instrument.[2] For items with multiple response items, participants were shown and read cards with answer options. Research team members were trained to read questions exactly as written on the questionnaire in a neutral tone to avoid bias. Participants were informed that their answers would only be used for research purposes and that no individual data would be shared with court personnel or in any reports. Items were developed by a panel of subject experts and adapted from Baldwin (2013).

Measures

The MEVTC instrumentation included an item that asked, "In YOUR LIFETIME, have you ever used SYNTHETIC MARIJUANA (e.g., Spice, K-2)?"[3] Respondents who ever used SCRAs were asked whether their use occurred before the military, during military service, and/or after military service. They also selected *all* applicable reasons for use from a list of 18 provided possible motivations, reported whether any use was recent, if they ever combined SCRAs with other substances, and if their use had changed in the last 3 months. Due to some members of the sample being under VTC supervision for a lengthy period of time prior to data collection (which may include home confinement, inpatient care, incarceration, frequent drug tests, and substance abuse counseling), we focus on any SCRA use rather than use in the last year.

Analytic strategy

We have provided a summary of the prevalence of SCRA use among VTC participants, the timing of their use in relation to military service (before, during, after), and whether any reported recent use. Reported reasons for use were evaluated prior to examining SCRAs' potential tie to demographics, military branch, and other substance use experiences. Since responses were limited to use/no use and fewer than five reported SCRA use in some categories (such as females and non-cannabis users), Fisher's Exact test was used to determine if SCRA use was associated with these factors; when all cell counts exceeded five, we report p-values calculated from χ^2 tests. All analyses used an alpha level of .05 and were completed using StataSE 17. As some respondents chose not to provide some demographic details, they are excluded from that assessment but were included in others for which they had valid data (i.e., pairwise deletion). Any SCRA use, use before joining the military, use while in the military, and use after leaving the military were considered separately. Finally, we estimated two logistic regression models to identify potential risk-factors for use while in the military and after leaving the military, respectively. Only cases with full data were included in these logistic models.

[2] Study materials are in the process of being archived and will be available through the National Criminal Justice Reference Service at https://www.ojp.gov/ncjrs/new-ojp-resources.

[3] The emphasis is as it appeared on the questionnaire.

Results

Of the 579 eligible VTC participants, 318 participated in interviews (response rate=54.9%). The sample was mostly male (n=292, 91.8%). Those who served in the U.S. Army comprised 57.8% (n=181) of the sample with the remaining having served in the U.S. Marine Corps (n=55, 17.6%), U.S. Navy (n=50, 16.0%), and U.S. Air Force (n=27, 8.6%). Regarding race and ethnicity, 42.4% (n=133) identified as Non-Hispanic White, 27.4% (n=86) as Hispanic, 24.8% (n=78) as non-Hispanic Black, and 5.4% (n=17) as Native American, Asian American, or multiracial (grouped as "other").

Of the 305 veterans in the sample that responded to items related to SCRAs (11 did not reach/complete this portion of the study and two refused to answer), 65 (21.3%) reported using at least once in their lifetime. Six reported using before joining the military (2.0% of the sample; 11.3% of the 53 that joined the military after SCRAs became widely available in 2008). None of the six that used before military service indicated using while in the military, and only one of these veterans used after separating from the military. Twenty-five (8.2%) indicated that they used SCRAs at least once while in the military; however, 15.0% of veterans that served after 2008 reported using while in the military (25 of 167). Many that had used SCRAs (n=43; 66.1%) reported some use of SCRAs after leaving the military; eight of these reported their first use was during military service but 34 only used after they had left the military. Only seven reported any SCRA use in the last year (10.8% of those that used SCRAs, 2.2% of the sample): five used more than 6 months before their study interview (7.7% of those that used SCRAs) and two used within the last month.

A summary of the responses to an item that asked respondents to indicate all of the reasons that they used SCRAs is displayed in Figure 1. Of the 65 veterans reporting SCRA use, 27 (41.5%) only indicated one motivation for their use; the grey region of each bar indicates those that only reported that respective motive. Notably, the substance's psychoactive effects (n=17, 26.2%) did not rank among the four most common reasons for use. Boredom was the leading reported reason (24, 36.9%), followed by fun (n=22, 33.9%) and to be social (n=21, 32.3%). Among those that only listed one reason for use, "to experiment" was the most common response. In total, 39 different respondents (60.0%) were motivated to use SCRAs by boredom and/or experimentation. More than a fifth of veterans that had used SCRAs (n=14, 21.5%) linked peer pressure to use, and only eight (12.3%) reported selecting SCRAs "as a replacement for marijuana (legal, avoid positive drug tests, etc.)." Sixteen (23.1%) reported using SCRAs to cope with emotional pain, while six (9.2%) used SCRAs in effort to alleviate physical pain. Relatively few used SCRAs expecting to gain focus, alertness, or alter the effects of other drugs.

The percentage of various demographic and other characteristics of VTC participants who reported having used SCRAs is displayed in Table 1. The first group of columns represent use of SCRAs at any time. Fewer Hispanic veterans (n=10, 12.5%) reported SCRA use as compared to other racial/ethnic groups (p=.044), and use was more common among veterans between 18 and 29 years of age (n=18, 34.0%) at the time of the study than other age groups (p=.008). Use was less common among those with honorable (n=44, 19.0%) and general (n=3, 17.6%) discharges as compared to other discharge statuses (n=7, 53.8%, p=.014).[4] Fewer of those reporting injuries due to service reported

[4] The United States Department of Defense (DoD) authorizes six characterizations of service for military servicemembers to receive on discharge: (1) Honorable; (2) Under Honorable Conditions (General); (3) Under Other than Honorable (OTH) Conditions; (4) Bad Conduct; (5) Dishonorable, and (6) Uncharacterized. Honorable is the highest characterization indicating meritorious service meeting both conduct and performance standards. A General discharge status indicates the positive aspects of conduct and performance outweigh negative aspects. OTH indicates acts or a pattern of behavior that represent a significant departure from expectations. Bad Conduct status is a punitive result of bad

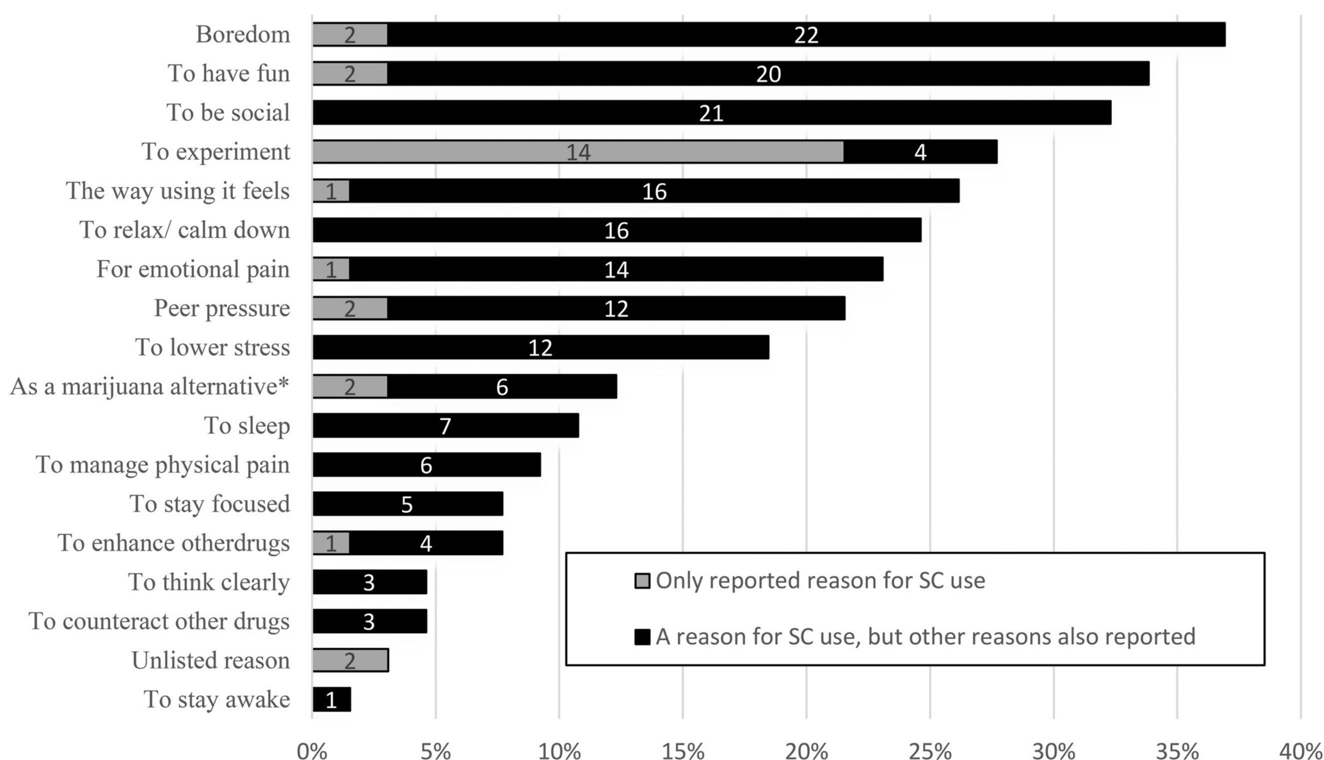

Fig. 1. Number of Veterans Reporting Each Motivation for Synthetic Cannabinoid Use (among 65 that have used SCRAs).

use (n=47, 18.4%) as compared to those not seriously injured while serving (n=15, 38.5%, p=.004). Cocaine or methamphetamine, depressants, cannabis, and hallucinogen use were all associated with SCRA use (as compared to non-use of those respective substances/categories; all p<.001). Several service-related stressors were evaluated as potential risk factors for or correlates of SCRA use: military hazing, sexual harassment, racial discrimination, physical abuse, traumatic brain injury (TBI), concussions, and depression. However, none of these were significantly associated with SCRA use for any outcome. Thus, they were omitted from the table to highlight relevant findings.

Relatively few veterans in the sample enlisted after SCRAs emerged in 2008 (n=53). We evaluated each of the characteristics listed in the table for a potential association with SCRA use before military service within this group (as those enlisting before this time were unlikely to have access to SCRAs pre-military). No factors were linked to SCRA use before service in this small portion of the sample; these are omitted from the table for brevity.

The second group of columns in Table 1 examine SCRA use during military service as opposed to at any time. These columns exclude any veterans who served entirely before the emergence of SCRAs (i.e., 2008). A larger percentage of veterans ages 18 to 29 reported use (n=13, 25.5%) compared to other age groups (p=.009), while fewer of those who received honorable discharge statuses reported SCRA use (n=16, 31.6%) compared to other statuses (p=.049). Similarly, cannabis use (p=.002), stimulant use (p<.001), depressant use (p=.020), and hallucinogen use (p<.001) were associated with SCRA use while in the military. A smaller portion of those who believed they suffered from PTSD claimed to have used SCRAs (n=19, 13.4%) relative to those who indicated no PTSD symptoms (n=6, 31.6%, p=.040). We repeated these analyses excluding veterans whose service was entirely before or after the timeframe when at least some SCRAs were effectively legal in the U.S. The results were largely redundant in terms of statistical significance, so these were omitted from Table 1 for parsimony. The number of cases in each category remained identical to the earlier analysis indicating that the careers of all those who used SCRAs while in the military included the period when they were legal. This does not necessarily indicate that use occurred only during that timeframe nor can it be argued that their use even occurred during this window. That data was not collected, but as many reported use after leaving the military and exit dates after 2012, it is clear that some use extended after the Synthetic Drug Abuse Prevention Act of 2012.

SCRA use after leaving the military (Table 1, final columns) was reported by a smaller percentage of veterans who held honorable (n=30, 12.9%) or general (n=1, 5.9%) discharge statuses as compared to other types of discharge statuses (n=5, 38.5%, p=.029). Fewer of those injured while in the military reported using after discharge (n=28, 10.9% vs. n=12, 30.8%, p=.001); use of stimulants (p<.001), depressants (p=.005), cannabis (p<.001), and hallucinogens (p<.001) were all linked to SCRAs.

Table 2 displays two logistic regression models evaluating potential predictors of SCRA use while in the military (Model 1) and after leaving the military (Model 2). Predictor variables were selected based on potential risk-factors for in-service and post-service SCRA use that necessarily preceded the respective dependent variable (i.e., cannabis use prior to joining the military necessarily preceded SCRA use while in the military). Due to the prevalence of the outcomes exceeding 10%, we present prevalence ratios as opposed to odds ratios (Bastos et al., 2015). Model 1 is restricted to those who served after SCRAs became available (2008 and later). Controlling for other factors, those who identified as Hispanic were less likely to report use of SCRAs while enlisted as com-

conduct not severe enough to warrant a Dishonorable status; repeated minor infractions can be sufficient for this designation. Dishonorable status is associated with separation resulting from offenses generally classified as felonies by civilian authorities or crimes of a military nature. Uncharacterized discharges of can result from entry-level separation, void enlistment, or dropping from the rolls (while those separated due to the former two reasons are unlikely to participate in VTCs, "dropping from the rolls" can occur as a result of confinement by civilian authorities (a civilian arrest and incarceration). (DOD Regulation: 38 U.S.C. § 4304; DoDI 1332.14 Enlisted Administrative Separations).

Table 1
Synthetic cannabinoid use by demographics and drug use.

	Any SCRA use			SCRA use while in military			SCRA use after military		
	(full sample; n=318)			(among those in military after emergence of SCRAs; n=176)			(full sample; n=318)		
Characteristics	Yes n (%)	No n (%)	p	Yes n (%)	No n (%)	p	Yes n (%)	No n (%)	p
Gender									
Male	61 (21.9)	217 (78.1)	.184	24 (15.8)	128 (84.2)	.343	40 (14.4)	238 (85.6)	.166
Female	2 (9.1)	20 (90.9)		1 (7.1)	13 (92.9)		1 (4.5)	21 (95.5)	
Race/ Ethnicity									
White, non-Hispanic	29 (23.2)	96 (76.8)	.044	11 (15.9)	58 (84.1)	.044	17 (13.6)	108 (86.4)	.300
Black, non-Hispanic	17 (22.7)	58 (77.3)		6 (23.1)	20 (76.9)		14 (18.7)	61 (81.3)	
Hispanic	10 (12.5)	70 (87.5)		4 (6.9)	54 (93.1)		7 (8.7)	73 (91.3)	
Multiracial/Other	7 (41.2)	10 (58.8)		4 (33.3)	8 (66.7)		3 (17.6)	14 (82.4)	
Age									
18-29	18 (34.0)	35 (66.0)	.008	13 (25.5)	39 (74.5)	.009	7 (13.2)	46 (86.8)	.830
30-39	28 (24.3)	87 (75.7)		12 (13.5)	77 (86.5)		17 (14.8)	98 (85.2)	
40-49	8 (16.0)	42 (84.0)		0 (0.0)	19 (100)		8 (16.0)	42 (84.0)	
50+	9 (11.0)	73 (89.0)		0 (0.0)	18 (100)		9 (11.0)	73 (89.0)	
Service Branch									
Army	37 (21.5)	135 (78.5)	.966	16 (16.7)	80 (83.3)	.783	21 (12.2)	151 (87.8)	.699
Air Force	5 (19.2)	21 (80.8)		3 (18.8)	13 (81.3)		3 (11.5)	23 (88.5)	
Marines	9 (18.4)	40 (81.6)		3 (10.3)	26 (89.7)		6 (12.2)	43 (87.8)	
Navy	10 (20.4)	39 (79.6)		3 (11.5)	23 (88.5)		9 (18.4)	40 (81.6)	
Discharge Status									
Honorable	44 (19.0)	188 (81.0)	.014	16 (13.2)	105 (86.8)	.049	30 (12.9)	202 (87.1)	.029
General	3 (17.6)	14 (82.4)		1 (9.1)	10 (90.9)		1 (5.9)	16 (94.1)	
Other Types	7 (53.8)	6 (46.2)		3 (50.0)	3 (50.0)		5 (38.5)	8 (61.5)	
Injured while in Military									
No	15 (38.5)	24 (61.5)	.004	5 (31.3)	11 (68.8)	.061	12 (30.8)	27 (69.2)	<.001
Yes	47 (18.4)	209 (81.6)		20 (13.5)	128 (86.5)		28 (10.9)	228 (89.1)	
PTSD									
No	13 (29.5)	31 (70.5)	.188	6 (31.6)	13 (68.4)	.040	9 (20.5)	35 (79.5)	.227
Yes	52 (20.6)	200 (79.4)		19 (13.4)	123 (86.6)		34 (13.5)	218 (86.5)	
Paranoia									
No	28 (19.0)	119 (81.0)	.242	11 (14.2)	67 (85.9)	.652	15 (10.2)	132 (89.8)	.038
Yes	37 (24.7)	113 (75.3)		14 (16.7)	70 (83.3)		28 (18.7)	122 (81.3)	
Cannabis Use									
No	0 (0.0)	55 (100)	<.001	0 (0.0)	33 (100.0)	.002	0 (0.0)	55 (100.0)	<.001
Yes	65 (26.1)	184 (73.9)		25 (18.7)	109 (81.3)		43 (17.3)	206 (82.7)	
Cocaine or Methamphetamine Use									
No	5 (4.1)	117 (95.9)	<.001	2 (2.6)	75 (97.4)	<.001	3 (2.5)	119 (97.5)	<.001
Yes	60 (33.3)	120 (66.7)		23 (26.1)	65 (73.9)		40 (22.2)	140 (77.8)	
Depressant Use									
No	22 (13.4)	142 (86.6)	<.001	9 (9.5)	86 (90.5)	.020	15 (9.1)	149 (90.9)	.005
Yes	43 (31.2)	95 (68.8)		16 (22.2)	56 (77.8)		28 (20.3)	110 (79.7)	
Hallucinogen Use									
No	19 (9.6)	179 (90.4)	<.001	10 (8.3)	110 (91.7)	<.001	13 (6.5)	185 (93.4)	<.001
Yes	46 (43.4)	60 (56.6)		15 (31.9)	32 (68.1)		30 (28.3)	76 (71.7)	

** indicates p<.01, * indicates p<.05, In the military after emergence of SCRAs is defined as any career that includes any years between 2008 and present. Some veterans chose not to provide all demographic details or answer questions about injuries and mental health. Data was excluded for any row for which they did not provide data (i.e., a participant who reported gender but not race would be included in gender analyses but not those related to race).

pared to those who identified as Asian American, Native American, or multiracial (aPR=.26, 95% CI=.08-.82). Age and prior use of drugs did not emerge as significant factors for SCRA use within the military. As seen in Model 2, age at time of military exit (Model 2, aPR=.87, 95% CI=.81-.94), cannabis use during military service (aPR=2.06, 95% CI= 1.05-4.02), hallucinogen use during military service (aPR=2.50, 95% CI=1.25-5.00), SCRA use during service (aPR=2.49, 95% CI 1.13-5.51), and military injuries (aPR=.54, 95% CI=.31-.92) were associated with SCRA use after exiting the military controlling for other factors. Use of cannabis, hallucinogens, and SCRAs during military service are risk factors for SCRA use afterwards whereas older age and sustaining an injury in the military are protective.

Discussion

Despite SCRA use only being reported by 0.9% of the young adult population (SAMHSA, 2021), SCRA use was not rare among VTC participants in the U.S. Overall, 21.3% reported SCRA use in their lifetime; 15.0% of the JIVs serving after 2008 reported using while in the U.S. military and 14.1% reported using after exiting the military. While nearly all studies focused on military SCRA use were case studies or small samples (Bebarta et al., 2012; Berry-Cabán et al., 2013; White et al., 2016), Walker et al. (2014) reports 11.0% prevalence of SCRA use while in the military among active-duty personnel receiving care for substance use issues. While this study's aforementioned 15.0% finding is largely consistent with Walker et al. (2014), the samples are distinct. Whereas Walker et al. (2014) focused on personnel still in the military in treatment, our sample was comprised of veterans in a VTC. Taken together, these findings suggest that SCRAs have been an underappreciated problem within the U.S. military as they have been associated with an array of side effects, both acute and chronic, and dependence (Cha et al., 2014; Van Hout & Hearne, 2017). Common acute effects of these drugs include tachycardia, anxiety, fear, and nausea (Müller et al., 2016; Soussan & Kjellgren, 2014), but more concerning are severe reac-

Table 2
Logistic regression models predicting persistent synthetic cannabinoid use among veterans during and following military service.

Model 1 SCRA use while in the military			Model 2 SCRA use after leaving the military		
	aPR	*aPR 95% CI*		*aPR*	*aPR 95% CI*
Gender (1=Male)	.88	.13-6.01	Gender (1=Male)	1.07	.24-4.81
Race‡			Race‡		
White, Non-Hispanic	.39	.14-1.07	White, Non-Hispanic	2.40	.46-12.39
Black, Non-Hispanic	.92	.35-2.46	Black, Non-Hispanic	3.78	.73-19.59
Hispanic	.26*	.08-.82	Hispanic	3.30	.59-18.41
Age at Enlistment	.91	.80-1.03	Age at Military Exit	..87**	.81-.94
Substance use (pre-service)			Substance use (while in military)		
Cannabis	3.92	.82-18.75	Cannabis	2.06*	1.05-4.02
Stimulants	1.35	.55-3.34	Stimulants	1.32	.71-2.45
Depressants	1.84	.62-5.44	Depressants	.93	.49-1.77
Hallucinogens	1.56	.76-3.20	Hallucinogens	2.50**	1.25-5.00
			SCRAs	2.50*	1.13-5.51
			Injured in the military	.54*	.31-.92
			Discharge status‡		
			General	.39	.07-2.35
			Other	1.14	.51-2.56
Constant	.57		Constant	1.375	
Model χ^2	24.78		49.224		
Pseudo R^2	.247		.326		
N	161		244		

** indicates p<.01, * indicates p<.05
‡ Multiracial/ Other Race (including Asian American and Native American) is the reference category for race; Honorable is the reference category for discharge status.
Age in the first model represents age at time of military entry; Model 2 uses age at discharge. Similarly, substance use variables in Model 1 refers to previous substance use (e.g., before the military), while Model 2 variables indicate use while in the military. SCRA use prior to service was not included as a predictor in Model 1 due to the small number of respondents who reported SCRA use before joining the military (none of whom used while in the military).

tions including amnesia, psychedelic effects, schizophrenic-type symptoms, derealization (Castaneto et al., 2014; Papanti et al., 2013; Satodiya & Palekar, 2020; Theunissen et al., 2021), death (Streich et al., 2014; Tait et al., 2016), and chronic issues which may impact the veteran long after use (Cohen et al., 2020; Soussan & Kjellgren, 2014).

Among JIVs within the sample, "boredom" was the most commonly reported reason for SCRA use. Curiosity also seems to be a major factor as many reported that their use was only tied to their desire to experiment. This implies that veterans were not frequently enticed to seek out SCRAs, but rather initially used them because an opportunity presented itself to resolve boredom and satisfy curiosity in the company of peers. As other studies report that cannabis is preferred over SCRAs (Palamar & Barratt, 2016; Stephens, 2011; White, 2017), it was believed that the desire to avoid legal, social, and occupational sanctions associated with positive cannabis tests motivated most use. However, only 12.3% of veterans who had used SCRAs reported that they used them as an alternative/replacement for cannabis (less commonly cited as a reason for use than nine other issues). As few used it for this purpose, it seems unlikely that the perceived ability to avoid detection/punishment is a key motivating factor. Military drug testing programs did not result in SCRA use, but future studies may wish to use a more direct measure of testing's influence.

An exploration of factors associated with use indicated that SCRAs are used by a similar portion of JIVs from each branch of service and in each VTC program. Younger veterans and those who did not receive an honorable or general discharge status were more likely to report use. It cannot be fully determined from the data whether substance use within the military contributed to these discharge statuses, if a negative discharge status exacerbated substance use issues, or they are instead spuriously related. However, Model 2 suggests that discharge status, controlling for other substance use, is not predictive of later SCRA use. Use of other substances was significantly related to SCRA use among veterans, consistent with other works that have found SCRA use linked to cannabis use and other drug use in civilian populations (Barratt et al., 2013; Caviness et al., 2015; Clements-Nolle et al., 2016; Winstock & Barratt, 2013). SCRA use was reported least frequently by Hispanic veterans, a trend which is distinct from civilian studies that found more use among Hispanic people (Meich et al., 2020; Stogner & Miller, 2014); however, Egan et al. (2016) previously found no association between Hispanic ethnicity and SCRA use in a sample drawn from one of the three states from which this study's sample was collected. Finally, those reporting a serious injury during their time in the military were less likely to report SCRA use. As this relationship was seen for use after discharge and not while in the military, it implies that SCRAs are rarely used to manage pain rather than those who use SCRAs were less likely to be injured while in the military. Our findings are insufficient to direct SCRA intervention campaigns to veterans of one branch or one demographic group but do indicate that SCRA use is more common among those who have used other illicit substances.

This study suggests that SCRA use within the military and among veterans after leaving the military reached a level that warrants increased attention. Use was not limited to the brief window prior to SCRA regulation as some veterans reported use in the year prior to data collection. As VTC participation often involves extensive drug testing (Baldwin, 2015), some of the sample may have stopped using when they began the VTC program, which is typically a minimum of 12-18 months (Baldwin, 2013). With boredom and curiosity being identified as frequent motivations for use, military health education groups may want to focus their SCRA-related messaging around other mechanisms for satiating curiosity and eliminating boredom. Highlighting the acute and chronic risks associated with use (Armstrong et al., 2019; Bernson-Leung et al., 2014; Darke et al., 2020; Hermanns-Clausen et al., 2013) may also be beneficial since few reported SCRA use resulting from a pressing need such as pain management. Some use may have been affected by military drug testing protocols as they suggested SCRAs were used as an alternative to cannabis, but this reason was reported by only one in eight veterans who had used SCRA. The argument that military SCRA use is largely a result of personnel seeking a cannabis-like high

with lower detection risk is not supported by this analysis. Military drug testing policy does not appear to be a major driver of NPS use.

The finding that SCRA use is often motivated by boredom and curiosity as opposed to the desire to find a substitute for cannabis likely has implications beyond the military and outside of the U.S. First, other militaries may similarly find testing protocols insufficient deterrents of SCRA use unless other motivating factors are addressed. Second, due to the similar profile of military personnel to those working in law enforcement, emergency services, and private military contractors, these groups are likely to have similar issues linked to SCRAs. If members of the military are at-risk for SCRA use partially due to a fast-paced risky physical job with excessive stressors, civilian first responders might be equally at risk. Finally, it may be inferred that drug screenings by employers are unlikely to affect SCRA use within the general population, particularly since job commitment is lower and it is perceived as easier to change employers outside of the military context (Schwartz & Wrzesniewski, 2016).

This study is not generalizable to all veterans due to its focus on ones in contact with VTCs. Many participants' contact with the VTC stemmed from use of other substances either directly (i.e., a drug-related arrest) or indirectly. Therefore, this group is arguably more likely to report substance use issues than a sample of veterans not charged with a criminal offense; however, using VTC data allowed for identification of a meaningful sample of veterans who used an oft overlooked category of substances. This sample is not ideal for quantifying recent use as many VTC participants had entered substance abuse treatment, been confined to their home, or engaged in some other programming that may have altered SCRA use. Future studies should attempt to collect data on last year and last month use at the point of arrest to estimate use among veterans prior to more extensive justice involvement. Additionally, we were unable to summarize the frequency or duration of SCRA use among these veterans as this was not included on MEVTC instrumentation. Similarly, the relative importance of each possible motive for individuals reporting multiple reasons cannot be examined as respondents did not rank order these factors. The exact cannabinoids that were used are also unknown as are the brand/street names used; however, the broad "synthetic marijuana" phrasing used in the MEVTC instrumentation avoids issues tied to individuals not knowing which SCRA they are using and the contents of similar packaging sold as SCRAs changing over time (Khey et al., 2013; Luzio et al., 2019; Uchiyama et al., 2010; Zuba & Bryska, 2013).

Future research should explore SCRA use among veterans to determine the relative importance of each motivating factor, how often SCRAs are used within and after military service, and what factors surround desistence. It is also prudent for research to explore potential new synthetic drugs which may reach military populations. While SCRA use has decreased over the last decade (Meich et al., 2021), new synthetics may eventually replace them and present similar or greater threats, particularly when healthcare providers are underinformed about them (i.e., Lank et al., 2013; Stogner et al., 2016). Military and veteran healthcare providers and educators, such as the U.S. Department of Veterans Affairs, must evolve with new emerging substances in order to best serve the Armed Forces. Understanding the emergence of past new drugs is particularly critical today as many recently introduced opioids and benzodiazepines are resulting in significant harm worldwide (UNODC, 2021).

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Ethics approval

The authors declare that the work reported herein did not require ethics approval because it did not involve animal or human participation.

The research involved secondary analysis of data collected for other purposes and was exempted.

Declarations of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2022.103756.

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