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Is recovery from cannabis use problems different from alcohol and other drugs? Results from a national probability-based sample of the United States adult population

John F. Kelly^{a,*}, M. Claire Greene^b, and Brandon G. Bergman^a

^aRecovery Research Institute, Massachusetts General Hospital, Harvard Medical School, 151 Merrimac Street, 6th Floor, Boston, MA 02114, United States

^bJohns Hopkins Bloomberg School of Public Health, 624 North Broadway, Baltimore, MD 21205, United States

Abstract

Background—The policy landscape regarding the legal status of cannabis (CAN) in the US and globally is changing rapidly. Research on CAN has lagged behind in many areas, none more so than in understanding how individuals suffering from the broad range of cannabis-related problems resolve those problems, and how their characteristics and problem resolution pathways are similar to or different from alcohol [ALC] or other drugs [OTH]. Greater knowledge could inform national policy debates as well as the nature and scope of any additional needed services as CAN population exposure increases.

Method—National, probability-based, cross-sectional sample of the US non-institutionalized adult population was conducted July–August 2016. Sample consisted of those who responded “yes” to the screening question, “Did you used to have a problem with alcohol or drugs but no longer do?” (63.4% response rate from 39,809 screened adults). Final weighted sample ($N = 2002$) was mostly male (60.0% [1.53%]), aged 25–49 (45.2% [1.63%]), non-Hispanic White (61.4% [1.64%]), employed (47.7% [1.61%]). Analyses compared CAN to ALC and OTH on demographic, clinical, treatment and recovery support services utilization, and quality of life (QOL) indices.

Results—9.1% of the US adult population reported resolving a significant substance problem, and of these, 10.97% were CAN. Compared to ALC ($M = 49.79$) or OTH ($M = 43.80$), CAN were significantly younger ($M = 39.41$, $p < 0.01$), had the earliest onset of regular use (CAN $M = 16.89$, ALC $M = 19.02$, OTH $M = 23.29$, $p < 0.01$), and resolved their problem significantly earlier (CAN $M = 28.87$, ALC $M = 37.86$, OTH $M = 33.06$, $p < 0.01$). Compared to both ALC and OTH, CAN were significantly less likely to report use of inpatient treatment and used substantially less outpatient treatment, overall ($p < 0.01$), although CAN resolving problems more recently were more likely to have used outpatient treatment ($p < 0.01$). Lifetime attendance at mutual-help

*Corresponding author at: Center for Addiction Medicine, 151 Merrimac Street, 6th Floor, Boston, MA 02114, United States. jkelly11@mgh.harvard.edu (J.F. Kelly).

Conflict of interest

None.

meetings (e.g., AA) was similar, but CAN ($M = 1.67$) had substantially lower recent attendance compared to ALC ($M = 7.70$) and OTH ($M = 7.65$). QOL indices were similar across groups.

Conclusion—Approximately 2.4 million Americans have resolved a significant cannabis problem. Compared to ALC and OTH, the pattern of findings for CAN suggest similarities but also some notable differences in characteristics and problem resolution pathways particularly regarding earlier problem offset and less use of formal and informal services. Within a shifting policy landscape, research is needed to understand how increases in population exposure and potency may affect the nature and magnitude of differences observed in this preliminary study.

Keywords

Cannabis; Marijuana; Policy; Recovery; Remission; Problem resolution; Treatment; Services; Mutual-help; Self-help

Introduction

The recent changes in the policy landscape regarding cannabis in the US and other countries (Ammerman, Ryan, & Adelman, 2015; Bestrashniy & Winters, 2015; Budney & Borodovsky, 2017) introduces new challenges for public health, health care policy, and international drug treaties and conventions. Beginning in the 1970s in the US, the declaration of the war on drugs by the Nixon administration established a broad and largely punitive rhetoric condemning all forms of psychoactive drug use (other than alcohol and nicotine which were already legally available and commercialized). This categorical policy view pertaining to illicit psychoactive substances lasted many decades until special interest groups and public health and criminal justice reform advocates began to suggest that not all illicit psychoactive substances carry the same risk (Weiss, Howlett, & Baler, 2017).

This has been particularly true in the case of cannabis (marijuana). While cannabis use still causes life-impacting problems in 6 million US adults, corresponding with 30% of those who use it (Hasin et al., 2015, 2016), research has shown its clinical, public health, and public safety profiles are more benign compared to other drugs including alcohol (Lachenmeier & Rehm, 2015; Nutt, King, Saulsbury, & Blakemore, 2007). Together these trends have led to a re-examination of the long-standing uniform prohibition policy pertaining to all psychoactive drugs. Specifically, more nuanced discussions have considered the depth and range of associated health and safety harms resulting from differing policy positions ranging from prohibition to the decriminalization, legalization, and commercialization of different psychoactive substances. This new openness and debate has ultimately promoted policies and legislation relating to decriminalization and medicalization of cannabis use in most states, and legalization for purely recreational use in an increasing number of states (Carliner, Brown, Sarvet, & Hasin, 2017). Interest in the potential therapeutic properties of cannabis in treating pain has heightened also in the midst of the current US opioid overdose crisis. Emerging research, for example, has observed that states with medical cannabis laws have lower levels of opioid overdose deaths (Bachhuber et al, 2014), that appears to imply a causal connection between greater cannabis use and less opioid use. More recent prospective epidemiological data, however, suggest cannabis use leads to increases, and not decreases, in opioid use (Olfson, Wall, Liu, & Blanco, 2017).

Compared to other drugs, such as alcohol or opioids, much less is known about the clinical and public health consequences of cannabis at population levels. Also, while it is known that about 3 in 10 individuals who are using cannabis in the past year also meet criteria for a cannabis use disorder (e.g., continuing to use despite physical and psychological consequences, impaired control over use, tolerance, withdrawal; Hasin et al., 2015), very little is known regarding whether, and how, people who suffer from these disorders or the broader array of cannabis-related problems, resolve those problems. Also generally not known is whether such problem resolution prevalence and processes are similar to or different from those involved in resolving problems related to other substances.

When considering substance-related harms and problem resolution, it is necessary to go beyond purely clinical diagnostic groups (e.g., cannabis use disorder) to examining the broader array of affected individuals because many people who misuse substances actually do not meet diagnostic criteria for an alcohol or other drug (AOD) disorder but can still suffer from significant problems and contribute substantially to the economic and public health burden of disease. For example, more than 66 million Americans report hazardous/harmful alcohol consumption (i.e., consuming 5+ standard drinks within two hours; Surgeon General's Report, 2016) at least once during the past month, increasing risk of accidents, social problems, violence, and alcohol-poisonings. While only a minority of these individuals meet diagnostic threshold for alcohol use disorder, harmful consumption accounts for three-quarters of the yearly economic burden attributable to alcohol (Centers for Disease Control and Prevention [CDC], 2015). Also, in 2015, almost 13 million individuals reported past year misuse of a pain reliever—increasing risk for a variety of consequences including overdose—but only 2.9 million met diagnostic criteria for a prescription medication disorder from the perspective of the diagnostic and statistical manual of mental disorders, 5th edition (DSM-5; Surgeon General's Report, 2016). Given the public health and safety burden conferred by this broad population of individuals engaging in various degrees of problem use, understanding more about them and how they resolve such problems is important, regardless of whether or not they meet criteria for an AOD disorder, per se. Furthermore, shifts in national emphasis in public health and health care policy in recent decades emphasize the need to examine an array of substance-related impairment from individuals' own perspective. There has been a push, for example, to move from "provider-centered" to "patient-centered" care, and more recently to the more holistic, "person-centered" care (National Academies of Sciences, Engineering, and Medicine, 2017). This shift has been particularly true in addiction and mental health, as these problems are typified by heterogeneous and dynamic phenotypic expression that can be resolved through a variety of different bio-psycho-social therapeutic inputs (Papadimitriou, 2017). For the broad array of self-defined alcohol and other drug (AOD) problems, these salutary inputs have been shown to come successfully from the individual sufferers themselves (i.e., unassisted or "natural recovery") as well as from more formal treatment (i.e., "assisted recovery"), including medications. Very little is known, however, about the characteristics of this large heterogeneous population of individuals with self-identified AOD problems (i.e., beyond a clinical diagnosis derived from epidemiological studies that use structured diagnostic interviews), and even less is known about how these individuals resolve and overcome this broad array of AOD problems.

With the likely expansion of cannabis legalization across states, subsequent increased population exposure to cannabis, and related increases in the public health burden attributable to cannabis problems (Cerdeira, Wall, Keyes, Galea, & Hasin, 2012; Hasin et al., 2015), policy makers will need data on how individuals suffering from a broad array of cannabis-related problems resolve those problems, so that they can make evidence-based decisions when levying cannabis taxes and fiscal appropriation for treatment and other recovery support services. It is conceivable, for example, that because cannabis use does not produce life-threatening withdrawal syndromes (Budney & Hughes, 2006), or is unlikely to produce dramatic behavioral impairments with intoxication that can often result in accidents (Andreuccetti et al., 2017), rates of formal medical detoxification and addiction treatment services utilization among primary cannabis users may be lower compared to individuals with other commonly used primary substances, such as alcohol, opioids, and stimulants. A further area of interest is how individuals who have suffered from problems associated with different drug classes (e.g., cannabis, alcohol, other drugs) function after they have resolved their specific drug-related problems. For example, it is conceivable that substances that may not alter and impact individual users' lives so dramatically, such as cannabis, may be associated with less psychological distress, and greater quality of life and happiness once the substance-related problems have abated.

To this end, using a national probability based population sample of the non-institutionalized US population, this study: 1. Provides valid estimates of the proportion of US adults who identify as having successfully resolved a significant cannabis problem; 2. Describes and contrasts the demographic, clinical, and treatment and other recovery support service use histories of those resolving a primary cannabis use problem, with those resolving a primary alcohol or other drug use problem; and, 3. Compares those resolving a primary cannabis use problem with those resolving a primary alcohol or other drug use problem on indices of psychological distress, quality of life, happiness, self-esteem, and recovery capital.

Methods

Sample and procedure

The National Recovery Survey (NRS; Kelly, Bergman, Hoepfner, Vilsaint, & White, 2017) target population was the US noninstitutionalized civilian population 18 years or older that had resolved an AOD problem, indicated by affirmative response to the screener question: "Did you used to have a problem with drugs or alcohol, but no longer do?". Data were collected by the survey company GfK, using its "KnowledgePanel" probability sampling. (GfK, 2013). The KnowledgePanel uses address-based sampling (ABS) to randomly select individuals from 97% of all U.S. households based on the U.S. Postal Service's Delivery Sequence File. If necessary, GfK provides individuals with a web-enabled computer and free Internet service. Using this ABS approach, GfK is able to include households that a) have unlisted telephone numbers, b) do not have landline telephones, c) are cell phone only, d) do not have current internet access, and e) do not have devices to access the internet. This type of broad scale sampling helps redress socioeconomic differences in landline telephone use and internet access. For the current study, a representative subset of 39,809 individuals from the GfK KnowledgePanel received the screening question (no more than one survey per week

can be made available to individual members). In order to draw this subsample, GfK uses a probability proportional to size (PPS) sampling approach, a patented strategy (U.S. Patent No. 7,269,570) unique to GfK. PPS assures that subsamples from a finite panel membership remains a reliable approximation of the entire U.S. Population. See [http://www.knowledgenetworks.com/knpanel/docs/knowledgepanel \(R\)-design-summary-description.pdf](http://www.knowledgenetworks.com/knpanel/docs/knowledgepanel%20(R)-design-summary-description.pdf) for more information on GfK's probability-based sampling methodology. Of those in the initial sampling frame (N = 39,809), 25,229 individuals responded to the screening question (63.4%). This response rate is comparable to most other current nationally representative surveys, including the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III; 60.1%; Grant et al., 2015) the 2015 National Survey on Drug Use and Health (NSDUH; 58.3%; Center for Behavioral Health Statistics and Quality, 2016) and the 2013–2014 National Health and Nutrition Examination Survey (NHANES; 68.5%; CDC National Center for Health Statistics, 2013). Data were weighted to accurately represent the civilian population using the method of iterative proportional fitting (Battaglia, Hoaglin, & Frankel, 2009).

Weights were computed via comparisons to benchmarks from the March 2015 Current Population Survey (CPS; United States Census Bureau, 2015) along eight dimensions: (1) gender (male/female); (2) age (18–29, 30–44, 45–59, and 60+ years); (3) race/Hispanic ethnicity (White/Non-Hispanic, Black/Non-Hispanic, Other/Non-Hispanic, 2+ Races/Non-Hispanic, Hispanic); (4) education (Less than High School, High School, Some College, Bachelor and beyond); (5) census geographical region (Northeast, Midwest, South, West); (6) household income (under \$10k, \$10K–\$25k, \$25 K–<\$50k, \$50 K–<\$75k, \$75+); (7) home ownership status (Own, Rent/Other); and (8) metropolitan area (yes/no). Data were collected in July and August 2016 and analyzed between December 2016–April 2017. Median time to completion of the NRS was 24 min (IQR = 18–36 min). A thorough systematic investigation of response patterns (Thomas, 2014) led to removal of 45 cases who had to have at least two red flags for invalid survey completion (e.g., did not list a problem substance, unrealistic survey completion time, qualitative responses indicating incorrectly selected “yes” to the screening question), resulting in a final sample of 2002 individuals. Because excluded cases constituted only 2.2% of the original sample (N = 2047), derived weights remained valid (Thomas, 2014). Non-Hispanic Black individuals were significantly more likely to be excluded than Whites, males were significantly more likely to be excluded than females ($p < 0.05$). All study procedures were approved by the Partners HealthCare Institutional Review Board.

Measures

Demographic characteristics—*Demographic characteristics* were derived from GfK's existing KnowledgePanel data (collected prior to the survey) as well as from survey data for variables not assessed by GfK. Regarding existing demographic data, participants reported on their age, level of education, household income, marital status, urbanicity, degree of religiosity and spirituality. Information on race/ethnicity, religious affiliation and sexual orientation were collected from GfK's existing KnowledgePanel data.

Substance use history—*Substance use history* was self-reported using questions about use of 15 substance classes using items from the Global Appraisal of Individual Needs (GAIN-I; Dennis, Titus, White, Unsicker, & Hodgkins, 2002). Substance classes were categorized as cannabis, alcohol or other illicit drugs (i.e., cocaine, heroin, opioids other than heroin, methadone, buprenorphine and its formulations, amphetamines, benzodiazepines, barbiturates, hallucinogens, synthetic drugs, inhalants, steroids and other drugs. Participants reported whether they used drugs from a given class ten or more times in their life as well as age at first use, age of first regular use, whether the substance was perceived as a problem, whether they are still using the substance, and the age at which they stopped using (if they reported no longer using the substance). We used these data to calculate “addiction career” duration, the number of years from age of first use for any substance to the age at which they resolved their alcohol or other drug problem. Participants were also asked to report their primary problem substance (i.e. drug of choice) and whether they had ever been diagnosed with an alcohol or other drug use disorder. Nicotine use was assessed also, but was not included in the current analysis as a “primary substance” as this drug does not cause the kinds of intoxication-related impacts and impairments that other common intoxicants do, and people typically do not consider themselves to be in recovery from nicotine dependence.

Medical history—*Medical history* was assessed by asking participants to report whether they had been diagnosed with one or more of the following nine chronic physical diseases: alcohol-related liver disease, hepatitis C, tuberculosis, HIV/AIDS, a sexually transmitted infection, chronic obstructive pulmonary disease, cancer, cardiovascular disease or diabetes.

Criminal justice history—*Criminal justice history* was measured using adapted items from the Form-90 (Miller & Del Boca, 1994). Participants reported whether they had ever been arrested (yes/no). If yes, they reported how many times, how many times since resolving their alcohol or drug problem, and whether they had ever participated in drug court (yes/no).

Treatment and other recovery support services—*Treatment and other recovery support services* were measured using a questionnaire that assessed participation in nine psycho-social treatment and recovery services including inpatient or residential treatment, outpatient treatment, state or local recovery community organizations, faith-based recovery services, recovery community centers, collegiate recovery programs/communities, recovery high schools, sober living environments and mutual help organizations (MHOs; Institute of Behavioral Research, 2002). If they reported participating in residential or outpatient substance use treatment, they also reported the number of treatment episodes. If they reported MHO participation (12-step or other), we inquired about lifetime attendance, regular attendance (i.e. at least once per week), number of meetings in past 90 days, and age of first attendance (Kelly, Urbanoski, Hoepfner, & Slaymaker, 2011). The questionnaire also included questions about detoxification and medications. Items regarding detoxification/stabilization were similar to those about inpatient and outpatient treatment (described above). For medications, participants reported whether they had ever been prescribed a medication to prevent them from drinking alcohol or using opioids. If they responded yes to

either item, participants were administered follow-up questions including the specific type of medication and whether they were still taking the medication. The survey also asked participants about their use of psychiatric medications for health conditions (yes/no).

Problem resolution/recovery history—*Problem resolution/recovery history* assessed the number of “serious attempts” made to resolve their alcohol or drug problem before they “overcame” it and time (in years/months) since they resolved their problem. Participants also reported whether they currently consider themselves to be “in recovery” (yes/no).

Recovery capital—*Recovery capital* was measured using the 10-item Brief Assessment of Recovery Capital (BARC-10; Vilsaint, Kelly, Groshkova, Best, & White, 2016), an abridged version of the Addiction Recovery Capital Scale (Groshkova, Best, & White, 2012). The BARC-10 asks participants their level of agreement from 1 = *strongly disagree* to 6 = *strongly agree* with statements related to their recovery, environmental support and wellbeing (e.g., “I regard my life as challenging and fulfilling without the need for using drugs or alcohol”; Range: 10-60). The BARC-10 has demonstrated excellent concurrent validity with the original measure of recovery capital ($r = 0.92$) as well as internal consistency in a test sample ($\alpha = 0.95$) as well as the study sample ($\alpha = 0.95$).

Psychological distress—*Psychological distress* was measured using the Kessler-6 (Kessler et al., 2003), a six-item scale that asks participants to rate how often, from 0 = *none of the time* to 4 = *all of the time*, they felt each of six symptoms (e.g., nervousness, depression) during the past 30 days (Range: 0-24).

Quality of life—*Quality of life* was measured using the EUROHIS-QOL (Schmidt, Muhlan, & Power, 2006), which is a widely used eight-item measure adapted from the World Health Organization Quality of Life - Brief Version (WHOQOL-BREF). Responses to questions such as, “How satisfied are you with your personal relationships”, were measured on a Likert Scale from 1 = *very dissatisfied* to 5 = *very satisfied* (Range: 8-40). The measure has strong psychometric properties including good predictive validity, convergent validity ($rs = 0.4-0.6$), and internal consistency in a test sample ($\alpha = 0.83$) as well as the current study population ($\alpha = 0.90$).

Happiness—*Happiness* was reported by participants using a single-item Likert scale ranging from 1 = *completely unhappy* to 5 = *completely happy* (Meyers & Smith, 1995). They also rated the extent to which “I have high self-esteem” is true on a single item Likert scale ranging from 1 = *not very true* to 5 = *very true* (Robins, Hendin, & Trzesniewski, 2001), which was used to measure *self-esteem*.

Statistical analysis

The primary problem substance was categorized as cannabis (CAN), alcohol (ALC) or other drugs (OTH). The OTH group included cocaine, heroin, opioids other than heroin, methadone, amphetamine, methamphetamine, benzodiazepines, barbiturates, hallucinogens, synthetic cannabis/drugs, inhalants or other. Approximately 12% of the sample did not report a primary problem substance and were thus excluded from the analysis. We compared

the distribution of demographic, clinical and recovery indices as a function of primary problem substance using weighted cross-tabulations as well as unadjusted linear, logistic and Poisson regression analyses for categorical, continuous and count variables, respectively. Given the exploratory nature of this study and multiple comparisons across groups, we used $p < 0.01$ as the cutoff indicating statistical significance.

Results

Prevalence of cannabis problem resolution in the US population

A weighted prevalence of 9.1% of the sample responded yes, to the question of whether they “once had a problem with drugs or alcohol but no longer do”; of these we report that 10.97% of these had resolved a cannabis problem (i.e., were in the CAN group), which translates into 2.4 million American adults. Approximately one-half (51.2%) and one-quarter (25.3%) of eligible respondents reported an alcohol (i.e., ALC group) or other drug problem (i.e., OTH group), respectively. Approximately 12% of the sample did not report a primary problem substance and were removed from the analytic sample. Considering only those who reported a primary problem substance, 12.6% reported having resolved a cannabis problem as compared to 58.5% and 28.9% of the sample reporting having resolved an alcohol or other drug problem, respectively.

Differences between primary cannabis, alcohol, and other drug problem resolution groups on demographic, clinical, treatment and recovery support service use

On average, CAN were approximately 10- and 4-years younger than ALC (99% CI: -14.52, -6.24; Table 1a) and OTH (99% CI: -8.73, -0.04), respectively, and less likely to be widowed, divorced or separated (CAN vs. ALC OR = 0.35; 99% CI: 0.17, 0.71; CAN vs. OTH OR = 0.31, 99% CI: 0.15, 0.66). There were no differences observed between CAN and ALC or OTH in terms of sex or education ($p > 0.01$). CAN also reported being more religious relative to OTH, but were similar to ALC. ALC was more likely than OTH to be male (OR = 1.73, 99% CI: 1.16, 2.59) and to have a bachelor's degree or higher level of education (OR = 2.21, 99% CI: 1.40, 3.50). There were no differences between any of the primary substance groups with regards to household income, urbanicity, employment, religious group or spirituality ($p > 0.01$).

History of physical, mental health, and substance use problems (Table 1b)

CAN were significantly less likely to report a history of chronic physical disease compared to ALC, but not OTH. As expected, all participants had a history of substance use problems within their primary problem substance class (e.g. all CAN reported a history of cannabis use problems). CAN were significantly more likely to report a history of other drug use problems relative to ALC (OR = 2.18, 99% CI: 1.14, 4.17). On average, CAN reported using 3.47 substances ten or more times during their lifetime (99% CI: 2.90, 4.04), which was significantly more than ALC (M = 2.75, 99% CI: 2.49, 3.00) and fewer than OTH (M = 5.06 substances, 99% CI: 4.57, 5.56). Forty-three percent of CAN reported complete abstinence (i.e., from alcohol, cannabis, and other drugs, excluding nicotine) in the past 90 days, which was similar to OTH (39%; $p = 0.55$) and significantly less than ALC (59%; OR = 0.52, 99% CI: 0.28, 0.96). However, 63% of CAN reported being abstinent from their primary

substance (i.e., cannabis), which was similar to ALC ($p = 0.668$) and significantly less than OTH (79%; OR = 0.44, 9% CI: 0.21, 0.94).

The age of first use of primary substance was 15.26 years (99% CI: 14.26, 16.28) for CAN, which was similar to ALC (M = 14.90 years, 99% CI: 14.46, 15.35), but significantly younger than OTH (M = 21.70 years, 99% CI: 20.60, 22.79). The age of onset for regular cannabis use among CAN was 16.89 years (99% CI: 15.53, 18.24), which was significantly younger than the age of onset for regular alcohol use among ALC (M = 19.02 years; 99% CI: 18.41, 19.63) and other regular drug use among OTH (M = 23.28 years; 99% CI: 22.16, 24.41). Years since a substance use problem was resolved was similar between groups and ranged from 10.7 years in CAN to 12.3 years in ALC, on average. In contrast, the duration of the average addiction career for CAN was 11.74 years (99% CI: 9.33, 14.16), which was significantly shorter than ALC (M = 18.39 years; 99% CI: 17.05, 19.74) and similar to OTH (M = 9.37 years; 99% CI: 8.02, 10.71). The average age at problem resolution was also significantly younger for CAN (M = 28.87 years; 99% CI: 26.46, 31.29) relative to ALC (M = 37.86 years; 99% CI: 36.50, 39.21) and OTH (M = 33.06 years; 99% CI: 31.40, 34.73).

Treatment and recovery support services (Table 1c)

On average, participants reported 5.35 attempts to resolve their alcohol or other drug problem (99% CI: 4.05, 6.64), which was similar among the three groups (CAN v. ALC: $p = 0.495$; CAN v. OTH: $p = 0.587$); however, there were several significant differences observed with regards to problem resolution pathways. Overall, the majority of participants resolved their problem without formal services; however, CAN were significantly less likely to utilize formal treatment services (18.1%) relative to OTH (41.6%; OR = 0.31, 99% CI: 0.14, 0.68). With regard to treatment and recovery processes, there were no differences in lifetime current or medication use for alcohol, opioids or other psychiatric conditions ($p > 0.01$). The most common services utilized by all participants were mutual help organizations (44.4%) and outpatient treatment programs (16.8%). Utilization of outpatient treatment programs was significantly less common among CAN compared to OTH (OR = 0.34, 99% CI: 0.14, 0.85). Among participants that reported utilizing outpatient treatment programs, CAN reported significantly fewer outpatient treatment episodes relative to ALC (Mean Diff: -1.12; 99% CI: -1.97, -0.27) and OTH (Mean Diff: -1.56; 99% CI: -2.76, -0.37), respectively. Moreover, utilization of inpatient treatment was significantly less common among CAN compared to both OTH (OR = 0.14, 99% CI: 0.04, 0.43) and ALC (OR = 0.33, 99% CI: 0.11, 0.99). CAN participants that reported utilizing inpatient treatment reported significantly fewer inpatient treatment episodes relative to OTH participants that reported utilizing inpatient treatment (Mean Diff: -1.47; 99% CI: -2.36, -0.59). There was no difference in the number of inpatient treatment episodes among participants reporting a history of inpatient treatment in the CAN and ALC groups (99% CI: -1.13, 0.08).

Past 3-month MHO attendance was significantly lower in CAN (M = 1.66 meetings, 99% CI: 0.58, 2.75) relative to ALC (M = 7.7 meetings, 99% CI: 3.2, 12.2) and OTH (M = 7.7 meetings, 99% CI: 2.0, 13.3), but there were no significant differences in the proportion of any lifetime (CAN v. ALC: $p = 0.047$; CAN v. OTH: $p = 0.015$).

With regards to criminal justice involvement, there were no significant differences observed in the proportion of arrests between groups (CAN v. ALC: $p = 0.265$; CAN v. OTH: $p = 0.305$). The average number of lifetime arrests ($M = 4.46$, 99% CI: 3.39, 5.54) as well as number of arrests since recovery ($M = 1.35$, 99% CI: 1.18, 1.51) was not significantly different between groups. CAN was more likely than ALC participants to have been involved in drug court (CAN: OR = 3.75, 99% CI: 1.12, 12.51).

Recovery indices (Table 2)

Forty-five percent of participants overall considered themselves to be currently “in recovery”. The proportion of participants currently in recovery did not significantly differ between groups (CAN v. ALC: $p = 0.128$; CAN v. OTH: $p = 0.065$). The most commonly endorsed definition of recovery was abstinence from all drugs and alcohol (56.32%), followed by abstinence from problem drugs and/or alcohol (24.97%). Non-problematic or moderate use of drugs and/or alcohol was the least common definition of recovery endorsed by participants (18.70%). CAN was significantly more likely to endorse the definition of recovery as abstinence from problem drugs and/or alcohol relative to ALC (OR = 2.13, 99% CI: 1.07, 4.24).

Psychosocial wellbeing of participants was similar between groups. On average, participants reported low psychological distress (Score: 4.9 out of 24), moderate-high quality of life (3.7 out of 5), happiness (3.8 out of 5) and self-esteem (3.5 out of 5), and high recovery capital (Score: 46.7 out of 60). These indicators did not differ as a function of primary problem substance ($p > 0.01$).

Subsidiary analyses

Overall, we found that CAN showed a general pattern of less formal treatment/service use. We wondered whether, given the increased access to, and potency of, cannabis in more recent years as well as increased insurance coverage for AOD disorder (e.g., through the essential benefits provision in the Affordable Care Act) whether individuals in the CAN group who had resolved their cannabis problem more recently were more likely to use formal treatment than individuals resolving their problem in the more distant past. To evaluate this, we constructed post-hoc linear regression models examining the relationship between utilization of formal treatment services and time since problem resolution. Our hypothesis was that CAN participants with more recent problem resolution may be more likely to report utilization of formal services. We found that when looking at outpatient and inpatient treatment, specifically, statistically significant differences emerged. Specifically, any utilization of outpatient treatment among CAN group participants was associated with 5.15 fewer years since problem resolution, on average, relative to CAN participants that did not utilize outpatient treatment (controlling for inpatient treatment [$p = 0.014$]). Furthermore, each additional outpatient treatment episode was associated with more recent problem resolution (4.87 fewer years per episode, $p < 0.001$, controlling for number of inpatient treatment episodes). In contrast, utilization of inpatient treatment in the CAN group was associated with 8.31 *additional* years since problem resolution, on average, relative to CAN participants that did not utilize inpatient treatment, controlling for outpatient treatment ($p = 0.014$). Furthermore, each additional inpatient treatment episode was associated with

more time since problem resolution (5.68 more years per episode, $p = 0.002$), controlling for number of outpatient treatment episodes.

Discussion

Using a national probability-based sample of the US non-institutionalized adult population, findings from the current study suggest that of all Americans who report resolving a significant AOD problem (22.35 million), 10.97% report resolving a cannabis problem. Furthermore, compared to both ALC or OTH individuals, CAN individuals, overall, are younger, and also younger when they began regular, weekly, use of their primary substance and when they resolved their drug problem. They also were more likely, in general, to resolve their cannabis problem without using addiction treatment or recovery support services, compared to ALC and OTH, but this trend appears to have changed recently, with CAN who resolved their problem in more recent years being more likely to have used outpatient treatment. Finally, compared to ALC and OTH, CAN individuals appear similar on measures of psychological distress and quality of life.

Findings suggest that close to two and a half million (2.40 million) Americans have resolved a cannabis problem and these individuals are largely similar in gender composition, education, income, ethnicity, and sexual orientation compared to other primary problem drug use groups. One notable exception was that compared to OTH, CAN appear slightly higher in religiosity. While anecdotally cannabis use may be used by some people to obtain religious or spiritual transcendence (Gray, 2016), and plays a role in the Rastafarian religion (Gray, 2016), it is unclear from these cross-sectional data whether this difference emerges before or during active use, or after problem resolution.

Also in terms of demographics, of note was that CAN began regular weekly use of their primary substance at a significantly younger age and resolved their problem at a younger age compared to ALC and OTH. Consequently, among all individuals resolving an AOD problem, those resolving a CAN problem began regular use the earliest and resolved their problem the earliest. While there are many critical lingering research questions related to cannabis use among youth, existing data points to the deleterious effects of cannabis problems that begin in youth and continue through young adulthood on intellectual functioning (Meier et al., 2012); negative effects are similarly observed with early alcohol exposure (e.g., Bava, Jacobus, Thayer, & Tapert, 2013; Cservenka & Brumback, 2017; Nguyen-Louie et al., 2017). In parallel, a recent quasi-experiment limiting college student-age youth access to cannabis showed that reduced access results in significantly improved academic performance, with an even stronger effect of reduced access for initially low-achieving students (Marie & Zöhlitz, 2017). Taken together with data on reduced perception of harm related to cannabis use among youth (e.g., in just the past 10 years there has been a 30% reduction in the perception that regular cannabis use is harmful among US 10th graders; Johnston, O'Malley, Miech, Bachman, & Schulenberg, 2017), our findings on the earlier onset of regular cannabis use among those who have resolved a problem may highlight the need for policies that help implement evidence-based prevention in youth using cannabis regularly during early adolescence (Substance Abuse and Mental Health Administration, 2014).

Also, compared to alcohol, but not other drugs, the CAN group had significantly shorter substance use careers. It may be that, given recreational cannabis and other drug use was still illegal for many in the CAN group during the time of active use and at the time of problem resolution (i.e., 10.73 years ago, on average), ongoing use of cannabis (or other illicit substances) becomes less acceptable and more stigmatized as individuals need to meet the developmental milestones as they progress through the life-course (e.g., relationship, child, work responsibilities). Given cannabis also typically is smoked and smoking substances generally are associated with greater perceived health risks (including affecting others in close proximity), there may be increased pressure to stop cannabis use. Alcohol, in contrast, being legal, socially sanctioned, culturally reinforced and promoted, and widely available and accessible may mean it takes longer for those with primary alcohol problems to resolve a related problem on average. Further research is needed to understand whether individuals with cannabis problems who began to use cannabis more recently – given more lenient cannabis laws and associated reductions in perceived harm among youth described above – also have shorter substance use careers (i.e., whether this is a cohort-specific effect). In terms of abstinent problem resolution, about one third of CAN reported continuing to use at least some cannabis despite resolving their cannabis problem. This was similar to the proportion in the ALC group who continued to use alcohol, but was lower than the OTH group, of whom roughly four fifths reported abstinent primary substance problem resolution. Thus, while the majority of CAN perhaps need to abstain completely from their primary substance to resolve their AOD problem, a substantial minority elect to continue to use at least some without problems.

Perhaps most intriguing was that CAN were least likely to use formal (inpatient/outpatient treatment) or informal (e.g., mutual-help organizations like NA, AA etc.) intervention and support services. They were also less likely to report suffering from chronic health conditions compared to ALC. As anticipated, given the comparatively less dramatic impact on the brain and central nervous system, compared to ALC, for example (Squeglia, Jacobus, & Tapert, 2009), it may be that CAN are more able to stop or cut down on their use without the use of medical detoxification or other external stabilization and treatment services and appear more likely to be able to continue to maintain problem resolution without the use of ongoing supports. Of note is that those CAN who resolved their problem in more recent years, appear to be using more outpatient treatment, and less likely to be using inpatient treatment. This greater use of outpatient treatment may be due to the increasingly higher potency of cannabis that has been available in more recent years (National Institute on Drug Abuse, 2017). One could speculate, for example, that this higher potency cannabis exacts a greater neurobiological toll than the lower potency cannabis, resulting in more dramatic brain changes and impaired inhibitory control and decision-making, making it increasingly less likely that they can stop on their own. Future research should examine this trend given increased availability of cannabis with increasingly high potency as well as newer, more powerful formulations (e.g., edibles, butane hash oil, or “wax dabs”). It is worth noting that the lower rates of inpatient versus outpatient treatment use among those who resolved their problem more recently may be due to general shifts in accessibility and insurance coverage for outpatient relative to inpatient/residential care beginning in the mid-1990s (White, 2001, 2014).

CAN had similar and quite high levels of happiness, self-esteem, recovery capital and overall quality of life compared to ALC and OTH. Thus, regardless of type of substance used and for how long or when one started using regularly, these aspects of quality of life appeared to be similar across groups. Given the earlier onset of regular use among CAN, one might anticipate lower scores on indices of quality of life because some studies have found long-lasting effects on memory and intellectual functioning even following full remission (Meier et al., 2012), which conceivably could affect behavior and quality of life. On the other hand, the earlier age of problem offset in the CAN group in their late twenties, could ameliorate the negative impact of this risk by reducing overall exposure across later developmental life-stages. Of note, in the sample overall, QOL scores appear similar to non-depressed individuals in the general population (Da Rocha, Power, Bushnell, & Fleck, 2012).

Limitations

Findings from this study should be considered in light of some important limitations. The purpose of this study was to characterize problem resolution across the broad heterogeneous array of self-defined cannabis problems and the initial screening question was open to interpretation, where “a drug or alcohol problem” was participant-defined and did not necessarily signify the presence of a diagnosable AOD disorder. It should be kept in mind, therefore, that the term “resolution of a cannabis problem” we use in this paper may certainly overlap with, but not necessarily signify, diagnostic remission. Also, we sought to provide unbiased prevalence estimates. It is important to note that in an effort to reduce bias by imposing sampling weights to make these data nationally representative, there is a consequential increase in the variance of the estimates due to the design effect. Thus, the statistical inferences may be conservative. The cross-sectional nature of the data also precludes making strong inferences to causal or longitudinal relationships, although our data may uncover the existence of such relationships. Future, prospective studies therefore should confirm or refute observations here made cross-sectionally.

Conclusions

With legal, social, and political changes in the drug policy landscape regarding cannabis use, preliminary information on how individuals resolve a broad array of cannabis problems can inform the national debate and also the potential future need for different types of services that may be required to address problems secondary to increased access and exposure in the general population. This study is the first nationally representative investigation on cannabis problem resolution suggesting approximately 2.4 million American adults have resolved a significant cannabis problem and that, compared to other primary problem substance use groups, such as alcohol and other drugs, they are younger overall, younger when they begin regular use, and younger when they resolve their problem. Given the documented acute and potentially enduring effects of early cannabis exposure on neurocognitive functioning (Gruber & Sagar, 2017; Jacobus & Tapert, 2014; Lisdahl, Gilbert, Wright, & Shollenbarger, 2013; Meier et al, 2012), regulatory standards governing legalization that attempt to mitigate the potential harms of cannabis use should ensure that cannabis exposure among youth is minimized. Individuals with cannabis problems are also significantly less likely to use either

formal or informal recovery support services to help them initially resolve or maintain resolution of their primary drug problem, but this trend appears to be changing in more recent years with individuals suffering from a primary cannabis problem being more likely to seek outpatient treatment. Finally, despite earlier onset of regular use, and less use of external treatment and recovery support services, they appear as high functioning and enjoy as high a quality of life as individuals with histories of alcohol or other drug problems. With a rapidly changing policy landscape regarding cannabis in the US and around the world, more research is needed to understand how increases in population exposure and potency may affect the nature and magnitude of differences in problem resolution characteristics and pathways observed in this current preliminary study.

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Table 1a

Demographic characteristics

	Primary Problem Substance ^d			OR/d CAN vs. ALC ^b	OR/d CAN vs. OTH ^c
	Cannabis (12.6%, n = 217)	Alcohol (58.5%, n = 1013)	Other Drugs (28.9%, n = 500)		
Age [in years; M(SE)]	39.41 (1.46)	49.79 (0.68)	43.80 (0.84)	-0.73 *	-0.36 *
Sex (Male, %)	60.53	63.72	50.33	0.87	1.51
Education					
<i>Less than high school</i> , %	14.23	9.87	11.37	1.52	1.29
<i>High school</i> , %	40.22	33.63	40.51	1.33	0.99
<i>Some college</i> , %	28.37	34.38	36.75	0.76	0.68
<i>Bachelor's degree or higher</i> , %	17.18	22.12	11.37	0.73	1.62
Household Income					
<25,000 USD, %	31.24	25.24	33.34	1.35	0.91
25,000–49,999 USD, %	22.98	22.42	23.88	1.03	0.95
50,000–74,999 USD, %	18.04	19.02	15.61	0.94	1.19
75,000–99,999 USD, %	15.95	16.46	13.25	0.96	1.24
>100,000 USD, %	11.78	16.86	13.92	0.66	0.83
Marital Status					
<i>Married</i> %	48.82	48.09	32.92	1.03	1.94
<i>Widowed/Divorced/Separated</i> %	9.7	23.46	25.69	0.35 *	0.31 *
<i>Never Married</i> %	33.3	23.77	29.13	1.60	1.21
<i>Cohabiting</i> %	8.18	4.68	12.25	1.82	0.64
Urbanicity Metro, %	84.97	83.42	85.74	1.12	0.94
Employment (Employed; %)	60.56	53.64	56.13	1.33	1.20
Race/Ethnicity					
<i>White, Non-Hispanic</i> , %	55.74	66.29	62.32	0.64	0.76
<i>Black, Non-Hispanic</i> , %	15.82	9.73	15.08	1.74	1.06
<i>Other Non-Hispanic</i> , %	10.36	6.85	7.9	1.57	1.35
<i>Hispanic</i> , %	18.09	17.14	14.7	1.07	1.28
Sexuality					
<i>Heterosexual</i> , %	91.73	89.66	82.15	1.28	2.41

	Primary Problem Substance ^a			OR/d CAN vs. ALC ^b	OR/d CAN vs. OTH ^c
	Cannabis (12.6%, n = 217)	Alcohol (58.5%, n = 1013)	Other Drugs (28.9%, n = 500)		
<i>Gay/Lesbian, %</i>	5.31	5.27	9.97	1.01	0.51
<i>Other, %</i>	2.96	5.08	7.88	0.57	0.36
Religion					
<i>Christianity, %</i>	73.47	68.43	67.34	1.28	1.34
<i>Judaism, %</i>	1.08	0.62	1.1	1.75	0.98
<i>Other Religion, %</i>	21.43	27.25	25.1	1.09	0.61
<i>Atheist/Agnostic, %</i>	4.02	3.7	6.46	0.73	0.81
Religiosity, M(SE)	1.54 (0.10)	1.36 (0.04)	1.23 (0.06)	0.19	0.35 *
Spirituality, M(SE)	1.81 (0.11)	1.69 (0.05)	1.75 (0.06)	0.12	0.07

^aDisplaying weighted counts by primary problem substance.

^bOdds ratio displayed for categorical variables; Cohen's d displayed for continuous variables.

^cOdds ratio displayed for categorical variables; Cohen's d displayed for continuous variables.

* p < 0.01.

Table 1b

Physical, Mental health, and substance use.

	Primary Problem Substance			OR/d CAN vs. ALC	OR/d CAN vs. OTH
	Cannabis (12.6%, n = 217)	Alcohol (58.5%, n = 1013)	Other Drugs (28.9%, n = 500)		
Number of Self-Reported Chronic Physical Diseases, M(SE)	1.06 (0.02)	1.14 (0.02)	1.17 (0.04)	-0.21 *	-0.24
Substance Use Problems					
<i>History of Alcohol Use Problems, %</i>	48.44	100.00	34.26	-	1.80
<i>History of Cannabis Use Problems, %</i>	100.00	14.07	16.18	-	-
<i>History of Other Drug Use Problems, %</i>	33.34	18.68	100.00	2.18 *	-
<i>Current Alcohol Use, %</i>	42.99	34.21	45.87	1.45	0.89
<i>Current Cannabis Use, %</i>	29.54	23.31	40.38	1.38	0.62
<i>Current Other Drug Use, %</i>	6.78	5.48	17.1	1.05	0.35
Number of Substances Used 10+ Times, M(SE)	3.47 (0.22)	2.75 (0.10)	5.06 (0.19)	0.33 *	-0.69 *
Number of Substances Used (Categorical, %)				0.18 *	1.36
1	9.81	37.12	7.39		
2	39.62	26.81	8.68		
3+	50.57	36.07	83.93		
Age of Onset (first use of primary substance), M(SE)	15.26 (0.39)	14.90 (0.17)	21.70 (0.42)	0.09	-1.17 *
Age of Weekly Use (primary substance), M(SE)	16.89 (0.52)	19.02 (0.24)	23.29 (0.44)	-0.40 *	-1.08 *
Quit Attempts, M(SE)	4.62 (0.92)	5.38 (0.54)	5.39 (1.10)	-0.07	-0.08
Years since resolved substance use problem, M(SE)	10.73 (1.05)	12.31 (0.41)	11.60 (0.53)	-0.15	-0.10
Age when substance use problem resolved (in years), M(SE)	28.87 (0.94)	37.86 (0.53)	33.06 (0.64)	-0.80 *	-0.45 *
Duration of substance use career – primary substance (in years), M(SE)	11.74 (0.94)	18.39 (0.52)	9.37 (0.52)	-0.61 *	0.29
Current Abstinence					
<i>From all substances, %</i>	43.01	59.02	39.34	0.52 *	1.16
<i>From problem substance, %</i>	63.12	65.62	79.37	0.90	0.44 *

*
p < 0.05.

Table 1c

Treatment and recovery support services.

	Primary Problem Substance			OR/d CAN vs. ALC	OR/d CAN vs. OTH
	Cannabis (12.6%, n = 217)	Alcohol (58.5%, n = 1013)	Other Drugs (28.9%, n = 500)		
Medication					
Alcohol (lifetime), %	7.04	7.31	2.8	0.96	2.63
Alcohol (current), %	4.68	1.01	1.25	4.80	3.89
Opioid (lifetime), %	5.92	3.25	7.78	1.88	0.75
Opioid (current), %	2.95	2.28	3.03	1.30	0.97
Psychotropic (lifetime), %	38.78	28.94	39.33	1.56	0.98
Treatment and Recovery Support Services (Lifetime, unless otherwise specified)					
Sober Living, %	3.63	6.82	1.51	0.52	0.21
Recovery High School, %	0.00	1.22	0.10	–	–
College Recovery Program, %	2.84	1.87	0.47	1.53	6.26
Recovery Community Center, %	3.08	4.94	9.79	0.61	0.29
Faith-Based Program, %	7.91	8.84	11.95	0.89	0.63
State or Local Recovery Community Organization, %	3.37	2.3	4.74	1.48	0.70
Outpatient Treatment, %	12.35	13.13	29.22	0.93	0.34*
Number of Outpatient Treatment Episodes	1.21 (0.12)	2.34 (0.30)	2.77 (0.44)	–0.31*	–0.58*
Detoxification, %	1.72	9.5	13.02	0.17	0.12
Number of Detox Episodes	1 (N/A)	2.66 (0.38)	4.67 (1.18)	–	–
Inpatient Treatment, %	4.95	13.61	27.21	0.33*	0.14*
Number of Inpatient Treatment Episodes	1.34 (0.19)	1.87 (0.14)	2.82 (0.28)	–0.44	–0.78*
Mutual Help Organization Attendance (Lifetime), %	35.35	47.39	51.44	0.61	0.52
Any Past 3-Month MHO Attendance (among lifetime attendees), %	42.86	26.91	25.53	2.04	2.19
Any Past 3-Month MHO Attendance (full sample), %	15.15	12.70	13.12	1.23	1.18
Past 3-Month MHO Attendance, M(SE)	1.66 (0.42)	7.70 (1.74)	7.65 (2.21)	–0.29*	–0.49*
Marijuana Anonymous, %	2.66	0.62	1.12	4.39	2.41
Any Community-Based Service, %	15.18	17.23	26.6	0.86	0.49
Any Formal Treatment, %	18.14	25.7	41.62	0.64	0.31*

	Primary Problem Substance			OR/d CAN vs. ALC	OR/d CAN vs. OTH
	Cannabis (12.6%, n = 217)	Alcohol (58.5%, n = 1013)	Other Drugs (28.9%, n = 500)		
No Services, %	65.97	62.72	50.34	1.15	1.91
Criminal Justice Involvement					
Ever Arrested, %	53.88	47.29	60.35	1.30	0.77
Number of Arrests (Lifetime), M(SE)	5.33 (2.06)	4.48 (0.61)	4.85 (0.74)	0.10	0.06
Number of Arrests Since Recovery, M(SE)	1.49 (0.30)	1.43 (0.12)	1.34 (0.09)	0.04	0.14
Drug Court, %	24.19	7.84	21.43	3.75*	1.17

* p < 0.05.

Table 2

Recovery indices.

	Primary Problem Substance			OR/d CAN vs. ALC	OR/d CAN vs. OTH
	Cannabis (12.6%, n =217)	Alcohol (58.5%, n =1013)	Other Drugs (28.9%, n = 500)		
Definition of Recovery, %					
<i>Abstinence from all drugs/alcohol</i>	43.69	58.46	52.39	0.82	1.05
<i>Abstinence from problem drugs/alcohol</i>	32.39	18.35	38.09	2.13*	0.78
<i>Non-problematic/moderate use of drugs/alcohol</i>	13.92	23.19	9.52	0.54	1.54
Currently self-defined as "in recovery", %	37.95	47.27	50.18	0.68	0.61
Psychiatric Symptoms, M(SE)	5.53 (0.62)	4.58 (0.23)	5.69 (0.37)	0.18	-0.03
Happiness, M(SE)	3.74 (0.10)	3.74 (0.04)	3.66 (0.06)	0.00	-0.04
Self-Esteem, M(SE)	3.35 (0.14)	3.52 (0.05)	3.39 (0.08)	-0.15	-0.04
Quality of Life (Item mean), M(SE)	3.65 (0.10)	3.67 (0.04)	3.56 (0.05)	-0.03	0.12
Recovery Capital, M(SE)	47.70 (1.04)	46.43 (0.43)	46.92 (0.61)	0.14	0.09

*
p < 0.05.