Marijuana practices and patterns of use among young adult medical marijuana patients and non-patient marijuana users

Stephen E. Lankenau[a,*], **Ekaterina V. Fedorova**[a], **Megan Reed**[a], **Sheree M. Schrager**[e], **Ellen Iverson**[b,c], and **Carolyn F. Wong**[b,c,d]

[a]Department of Community Health and Prevention, Drexel University, Dornsife School of Public Health, 3215 Market Street, Philadelphia, PA 19104, United States

[b]Department of Pediatrics, University of Southern California, Keck School of Medicine, Los Angeles, CA, United States

[c]Children's Hospital Los Angeles, Division of Adolescent Medicine, 4650 Sunset Blvd., MS #2, Los Angeles, CA 90027, United States

[d]Children's Hospital Los Angeles, Division of Research on Children, Youth, & Families, 4650 Sunset Blvd., MS #2, Los Angeles, CA, United States

[e]Children's Hospital Los Angeles, Division of Hospital Medicine, 4650 Sunset Blvd., MS #94, Los Angeles, CA 90027, United States

Abstract

Background: Little is known about young adult medical marijuana patients (MMP) and their marijuana using patterns and practices, which includes frequency of use, sourcing of marijuana products, forms/modes of administration, and patterns of illicit/prescription drug misuse, compared to non-patient marijuana users (NPU).

Methods: Young adults (N = 366) aged 18–26 years old were sampled in Los Angeles in 2014–15 and segmented into NPU (n= 156), marijuana users who never had a medical marijuana (MM) recommendation, and MMP (n = 210), marijuana users with a current, verified MM recommendation. Differences regarding self-reported marijuana and other drug use during the past 90 days are expressed as unadjusted risk ratios or differences in means.

Results: MMP reported significantly greater mean days of use (76.4 vs. 59.2, p < 0.001) and mean dollars spent on marijuana products (564.5 vs. 266.9, p<0.001) than NPU. Approximately one-quarter (22.6%) of both MMP and NPU report selling marijuana obtained from a dispensary to someone else in the past 90 days. MMP were more likely to report vaporization modalities for

*Corresponding author at: Drexel University, 3215 Market Street, Philadelphia, PA 19104, United States. sel59@drexel.edu (S.E. Lankenau), evf26@drexel.edu (E.V. Fedorova), mr925@drexel.edu (M. Reed), sschrager@chla.usc.edu (S.M. Schrager), Eiverson@chla.usc.edu (E. Iverson), CaWong@chla.usc.edu (C.F. Wong).

concentrates (URR =1.5,95% C.I. = 1.2, 2.0) and for marijuana (URR = 1.5,95% C.I. = 1.1,2.1) than NPU. Though not significant, trends toward lower misuse of prescription drugs in the past 90 days were observed among MMP compared to NPU.

Conclusion: MMP reported greater access to marijuana via dispensaries, more frequent and intensive use of marijuana, and greater use of non-combustible forms of marijuana compared to NPU. MMP reported less recent misuse of prescription drugs compared to NPU.

Keywords

Medical marijuana; Young adults; Drug use

1. Introduction

Young adults, who have the highest rate of marijuana use among all age groups in the U.S. (Center for Behavioral Health Statistics and Quality, 2015), are an important population to study as drug policies evolve towards legalizing marijuana for medical and recreational use. In 21 states where marijuana has been legalized for medical use only (excluding Alaska, Colorado, Oregon, Washington, and the District of Columbia), two groups of young adult marijuana users now exist: medical marijuana patients (MMP) - persons possessing a doctor's recommendation which enables legal access to medical marijuana at dispensaries; and non-patient users (NPU) - persons who use marijuana without possessing a doctor's recommendation or legal access, i.e., illicit users. While studies of older MMP and NPU consistently indicate more frequent marijuana use among MMP (Richmond et al., 2015; Woodruff and Shillington, 2016), no studies have compared specific patterns and practices of marijuana use among young adult MMP and NPU, which have important implications for assessing legalization policies and health among young adults.

1.1. Medical and non-medical marijuana use in California

California, which was the first state to legalize the use of marijuana for medical purposes in 1996 following the passage of Proposition 215, has one of the broadest definitions of health conditions for which a physician can recommend medical marijuana (Wilkinson et al., 2016). Among Californians, 9.2% of young adults (aged 18 to 24 years old) report having "ever used medical marijuana" in 2012, which is the highest rate among any age group and nearly double the state average of 5.2% (Ryan-Ibarra et al., 2014).Including non-medical use, 21.5% of young adults in California reported any marijuana use in the past month in 2014, which is the highest rate of any age group and more than twice the state average of 9.2% (CBHSQ, 2015). Apart from lifetime medical marijuana use (Ryan-Ibarra et al., 2014), data are limited regarding frequency and quantity of marijuana use among young adult MMP. Studies of older samples of MMP recruited from California dispensaries indicate that most are daily marijuana users (Bonn-Miller et al., 2014; Grellaet al., 2014) and 6 to 12g was the average weekly consumption (Bonn-Miller et al., 2014). Given this history, California offers an important setting to examine differences between frequencies of marijuana use among young adult MMP and NPU.

1.2. Forms and modes of administering marijuana

The common understanding of forms and modes of administering marijuana has traditionally been based upon reports by NPU or illicit users but is increasingly informed by MMP and other legal users. Conventionally, NPU smoked dried marijuana leaves/buds using some kind of pipe (including a water pipe or bong) or rolled marijuana with paper or a cigar wrapper to form a joint or blunt (Kelly, 2005; Sifaneck et al., 2005). Vaporization, which heats marijuana leaves (Gieringer, 2001) or marijuana "concentrates" (Raber et al., 2015) to the point where cannabinoids are released without combustion, has become increasingly common in states where marijuana is legal for recreational or medical use (Daniulaityte et al., 2015; Pacula et al., 2016). Examples of concentrates include "dabs" and "oil," which are high potency forms created through an extraction process (Raber et al., 2015). Dabs (solid form) can be vaporized using an "oil rig," which is similar to a bong for smoking marijuana leaves (Black, 2013), whereas oil (liquid form) is commonly vaporized using a battery-powered device similar to an e-cigarette (Budney et al., 2015). Forms of marijuana consumed orally, such as food products, tinctures (alcohol and marijuana), and beverages, are also commonly reported among both NPU (Murphy et al., 2015) and MMP (Grella et al., 2014; Murphy et al., 2015). Among adults, conventional modes of administering marijuana, i.e., smoking, however, remain more typical than alternative modes, i.e., vaporization, oral (Pacula et al., 2016; Schauer et al., 2016). Overall, little is known as to how marijuana practices differ between young or older MMP and NPU (Richmond et al., 2015; Woodruff and Shillington, 2016).

1.3. Sources of marijuana

Epidemiological surveys provide limited information on where young adult NPU obtain marijuana (Harrison et al., 2007) or the types/forms of marijuana consumed for personal use. In contrast, qualitative research has shown that high potency "designer" strains, such as Jack Herer, were sold to NPU via delivery services in New York (Sifaneck et al., 2007), and from medical marijuana dispensaries in Los Angeles and elsewhere (Murphy et al., 2015). No research has examined the issue of marijuana sources among young adult or older MMP and NPU, or which sources each group may prefer (Murphy et al., 2015; Richmond et al., 2015; Woodruff and Shillington, 2016).

1.4. Other drug use among young adults

Apart from marijuana, young adults also have the highest rates of recent other drug use among any age group, including opioids, hallucinogens, stimulants, and sedatives (CBHSQ, 2015). While other studies of older MMP and NPU report mixed findings on other recent drug use among MMP, i.e., lower (Richmond et al., 2015), or higher (Woodruff and Shillington, 2016), no studies have examined rates of other drug use among young adult MMP in comparison to NPU, which may provide insights into potential substitution effects offered by medical marijuana (Mikuriya, 2004; Murphy et al., 2015; Reiman, 2009).

1.5. Present study

Given generally high rates of non-medical marijuana and other drug use among young adults and a lack of research specifically examining use among young adult MMP, a descriptive

analysis was undertaken to characterize and compare young adult MMP and NPU in Los Angeles, California in the following domains: frequencies and quantity of marijuana use; forms/modes of administering marijuana; sources of marijuana; and rates of other drug use. An overarching hypothesis is that young adult MMP, who have legal access to marijuana via dispensaries, will use more marijuana (including greater diversity of forms and modes) and fewer other drugs than NPU.

2. Methods

2.1. Sample

Sampling and interviewing of participants (n = 366) occurred in Los Angeles between February 2014 and April 2015. Targeted sampling (Watters and Biernacki, 1989) - a non-random, purposive sampling methodology - and chain referral sampling (Biernacki and Waldorf, 1981) were employed to recruit participants from socioeconomic and geographically diverse areas of Los Angeles, including medical marijuana dispensaries, and natural settings, such as parks, streets, and college campuses. Also, recruitment flyers were posted in public locations across the Los Angeles area and on Craigslist, a classified advertisements website. Persons screened for eligibility received a $3 gift card while those who both qualified and were interviewed received a $25 cash incentive.

To be eligible for enrollment, participants were: aged between 18 and 26 years old; used marijuana at least four times in the last 30 days; lived in the Los Angeles metro area; and spoke/read English. Additionally, young adults in the sample were stratified based upon whether they had a current medical marijuana recommendation issued by a California-based physician and legal access to medical marijuana, i.e., medical marijuana patients (MMP = 210), or not, i.e., non-patient users (NPU =156). Enrolled MMP were required to provide a valid doctor's recommendation. Persons reporting ever having an expired recommendation, i.e., former MMP, were excluded during screening. Separating participants into mutually exclusive groups based upon legal access to medical marijuana (e.g., Richmond et al., 2015) is distinct from groupings based upon self-reported behaviors like "medicinal" or "medical" marijuana use (e.g., Pacula et al., 2016; Roy-Byrne et al., 2015), which may include both NPU and former MMP who use medicinally but without legal access.

A total of 710 individuals were screened and 436 (61.4%) conformed to study eligibility requirements. Among NPU, 180 met eligibility requirements and 156 (86.7%) were enrolled in the study. Among MMP, 256 met eligibility requirements and 210 (82.0%) were enrolled in the study. No significant differences in sociodemographic variables, i.e., age, gender, and race/ethnicity, were found between enrolled and non-enrolled individuals.

2.2. Data collection

Research Electronic Data Capture (REDCap) was used to program the study instrument. Participants were interviewed in semiprivate locations in the neighborhoods where they were recruited or lived. Interviewers rescheduled an interview if a participant was determined to be intoxicated. Questions used in this analysis were administered face-to-face. Study

procedures were approved by the Institutional Review Boards at Children's Hospital Los Angeles and Drexel University.

2.3. Measures

The full quantitative instrument, which covered topics pertaining to demographics, marijuana and other drug use, health, and risk behaviors, took approximately 60 to 90 min to administer. Sociodemographic data were captured using structured questions about age, gender, sexual identity, race/ethnicity, education, employment, and insurance coverage (Lankenau et al., 2012). Questions measuring frequency and amount of marijuana use in the past 90 days captured units of marijuana use generally understood by marijuana users (Sifaneck et al., 2003, 2005, 2007) (see questions and response options in Table 1). Questions assessing sources of marijuana and experiences acquiring/selling marijuana from medical marijuana dispensaries in the past 90 days were guided by the literature on medical marijuana collectives/dispensaries (Chapkis and Webb, 2008; Reiman, 2008) and black market selling of marijuana (Sifaneck et al., 2007). "Medical marijuana dispensary/ collective" is a storefront location where medical marijuana can be purchased whereas "medical marijuana delivery service" is a service accessed via phone, email, or text that delivers medical marijuana to a residence (see questions and response options in Table 2). Questions assessing forms and modes of administering marijuana in the past 90 days were derived from the existing literature on marijuana practices among medical and non-medical users of marijuana (Chapkis and Webb, 2008; Gieringer, 2001; Sifaneck et al., 2003) (see questions and response options in Table 3). To assess licit and illicit use/misuse of drugs, participants were asked: *Have you ever used any of the following drugs when they were not prescribed to you or that you took only for the experience or feeling it caused (including or to self-medicate)?* (Harris et al., 2009; Lankenau et al., 2012; Patrick et al., 2015) (see drugs listed in Table 4). Face validity of outcomes examined in this analysis was achieved through pre-testing (n=10) of the quantitative instrument with MMP and NPU and having the instrument reviewed by the study's community advisory board.

2.4. Data analysis

Descriptive analyses characterized the study sample, and comparisons between MMP and NPU were made using Pearson's χ^2-tests for categorical outcomes and independent sample *t*-tests for continuous outcomes. Cochran's Qtest was used to assess within group differences among MMP and NPU. Unadjusted risk ratios (URR) and 95% confidence intervals (C.I.) were derived from contingency table analyses for binary outcomes. Results were not adjusted for demographic variables, e.g., age, gender, race/ethnicity, across all analyses given the lack of significant findings based on preliminary investigations. Given the large number of comparisons, correction for multiple testing was used to control for false discovery rate at a=0.05 (Benjamini and Hochberg, 1995), which resulted in reducing the number of comparisons previously significant at $a < 0.05$ by four. P-values corrected for multiple testing are reported in Tables 1–4. All analyses were performed using SPSS, version 23.0 (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Sample demographics

Participants in the sample were typically in their early 20s (21.2 years old mean age), male (66.1%), heterosexual (81.9%), currently insured (77.6%), had some college education or higher (71.2%), and employed (52.7%). Ethnicity demographics were: Hispanic (45.6%); non-Hispanic race demographics were: white (25.6%), black (18.9%), multiracial (6.1%), and Asian/Pacific Islander (3.9%). No statistically significant differences between MMP and NPU were found among these demographic characteristics.

3.2. Frequency and amount of marijuana use

Overall, both MMP and NPU were frequent users of marijuana, e.g., typically 20 to 25 hits per day. Across two indicators of marijuana use in the past 90 days, MMP reported significantly greater use than NPU on average: days of marijuana use and dollars spent on marijuana (see Table 1). MMP were significantly less likely to report using smaller than one-eighth of an ounce of marijuana compared to NPU. MMP were significantly more likely to report as acceptable the use of marijuana multiple times per day than once a day or less compared to NPU.

3.3. Marijuana sources

Among recent sources of marijuana, purchasing marijuana directly from a dispensary (98.6%) was the top source among MMP and significantly so relative to other sources (see Table 2), which was followed by a friend obtaining from a dispensary (27.6%). Purchasing directly from a delivery service (14.8%) was also somewhat common among MMP. Among NPU, having a friend purchase from a dispensary (80.1%) was the top source and also significantly so relative to other sources, followed by a source other than a dispensary/delivery service (30.1%), which signals more traditional black market sourcing of marijuana. Among NPU, 91.9% reported having a primary member of their marijuana user group with a current medical marijuana recommendation (data not shown), which may explain the high frequency of friends purchasing from a dispensary. Purchasing directly from a dispensary (15.4%) or delivery service (5.8%), which is prohibited by law, was somewhat common among NPU. A small portion of both MMP and NPU grew their own marijuana. MMP had nearly one and a half times the risk of reporting that 100% or all of the marijuana used/purchased in the past 90 days came from a dispensary than NPU.

Notably, 53.6% of NPU reported that 100% of their marijuana came from a dispensary/delivery service while 2.6% (data not shown) reported that none came from a dispensary/delivery service. Approximately the same proportion (about one-quarter) of both MMP and NPU reported selling some of the marijuana obtained from a dispensary to someone else in the past 90 days. MMP were significantly more likely to report having a primary dispensary where they obtained marijuana compared to NPU. Despite the fact that 90.9% of MMP reported having a primary dispensary, MMP reported buying marijuana from an average of 6.6 dispensaries in the past 90 days.

A high proportion of both MMP and NPU reported ever obtaining marijuana from a dispensary that has since closed, but this was significantly more common among MMP compared to NPU. Additionally, among the 69.9% of MMP who reported buying marijuana from a dispensary that has closed, 4.4 dispensaries was the average number of closings.

3.4. Forms and modes of administering marijuana

Overall, both MMP and NPU commonly reported using multiple forms and modes of administration of marijuana. Across both groups, top forms of marijuana consumed were buds/flowers, edibles, and concentrates (see Table 3). MMP were significantly more likely to report consuming edibles, concentrates, drinks, and sprays/drops - all forms more commonly purchased at dispensaries - than NPU. The most common modes of administration across both groups were those involving smoking/burning marijuana, such as pipe/bowl, joint, blunt, and bong. No significant differences were found among these modes. However, MMP were significantly more likely to report vaporization modalities, such as portable electronic vaporizers for concentrates and vaporizers for marijuana as well as oral modes, e.g., edibles, beverage, than NPU. Approximately one quarter reported using oil rigs to vaporize concentrates, such as "dabs," "waxes," or "shatter," and no differences were found between groups. While indicas were the most commonly reported strain across both groups, MMP were significantly more likely to report any primary strain, i.e., indica, stativa, hybrid, than not having a primary strain, compared to NPU. Top strains reported by participants included Blue Dream (hybrid), Skywalker (indica), and Girl Scout Cookies (hybrid).

3.5. Other drug use

Alcohol and nicotine were the most commonly reported substances ever used across both groups followed by hallucinogens, stimulants, sedatives, opioids, and synthetic cannabinoids (Table 4). MMP were significantly more likely than NPU to report lifetime use/misuse of one broad drug category - hallucinogens - that includes specific drugs such as MDMA, mushrooms, LSD, salvia divinorum, and ketamine. The overall trend was higher lifetime prevalence across all broad categories of substances among MMP compared to NPU. Among 90 day users, there were no statistically significant differences between MMP and NPU in any drug category. However, a trend indicated that MMP reported less frequent misuse of sedatives and opioids than NPU. Moreover, there was lower misuse among MMP in all subcategories, e.g., prescription tranquilizers, prescription opioids, with the exception of heroin. Overall, there was a trend toward lower recent misuse of any prescription drugs among MMP compared to NPU.

4. Discussion

Our results indicated several distinct differences between young adult MMP and NPU regarding frequency/quantity of marijuana use, marijuana using practices, sources of marijuana, and other drug use. First, while both MMP and NPU were frequent current users of marijuana, MMP reported significantly greater use of marijuana than NPU across most measures of marijuana use in the past 90 days - days of use, dollars spent, and quantity purchased. While this analysis does not distinguish reasons for current marijuana use, findings of greater use among MMP are consistent with prior studies comparing older

samples of MMP and NPU (Richmond et al., 2015; Woodruff and Shillington, 2016) and could be explained by one or more factors: greater direct and consistent access to quantities of marijuana through medical marijuana dispensaries; greater motivations and practices associated with recreational or problematic use; or greater health problems, e.g., pain, anxiety, depression, nausea, etc., applicable for treatment with medical marijuana.

Results on use of dispensaries and sources of marijuana in the past 90 days revealed several important findings for MMP and NPU. Among MMP, while a majority had a primary dispensary/delivery service that they purchased marijuana from, MMP commonly bought from multiple dispensaries. The use of a variety of dispensaries may be a reflection of the hundreds of dispensaries that exist in Los Angeles (Thomas and Freisthler, 2015). At the same time, the common experience of ever obtaining marijuana from a dispensary service that later closed, which may be somewhat unique to Los Angeles due to its historically unregulated dispensary system (Thomas and Freisthler, 2015), could be a factor in visiting multiple dispensaries. Among NPU, a significant proportion reported gaining access to dispensaries without an approved medical marijuana recommendation while others were accessing marijuana diverted from a dispensary through friends or family (Nussbaum et al., 2014) or other black market sources. Overall, the abundance of dispensaries in Los Angeles appears to provide ample access to marijuana among MMP, but also are sources of diverted marijuana for NPU.

Results indicate that both MMP and NPU report using a range of new forms and modes of administration of marijuana. The greater likelihood of MMP reporting use of edibles and concentrates is potentially a function of access to these products via dispensaries. At the same time, the fact that nearly half of NPU reported use of edibles or concentrates in the past 90 days is another potential indicator of diversion of products from dispensaries. It is notable that the top forms of administration - pipe, joint, blunt, and bong - all involved burning marijuana (Schauer et al., 2016) and that there were no significant differences between MMP and NPU. Non-combustible modes, such as vaporizing and oral ingestion, are linked to form of marijuana (concentrates and edibles, respectively), and as such, MMP reported greater likelihood of both vaporizing and oral modes (Pacula et al., 2016). Compared to combustible modes, these non-combustible modes are generally regarded to be healthier methods of consumption since they release less or no carbon monoxide, tar, and other toxins related to smoked marijuana (Abrams et al., 2007; Gieringer, 2002; Lanz et al., 2016). Notably, about one-quarter of both MMP and NPU reported the use of oil rigs or "dabbing," a method of vaporizing high-THC concentrated forms. Dabs, which can be purchased from dispensaries, are of some public health concern due to the high amounts of THC consumed and high heat involved in vaporizing the concentrate (Raber and Kaplan, 2015; Stogner and Miller, 2015. While both MMP and NPU reported using indicas, sativas, and hybrids, MMP were more likely to have a preferred strain compared to NPU. Information learned at dispensaries about the benefits of particular strains or general knowledge about strains, e.g., indica for pain, sleep, may be acquired through the course of being MMP (Mikuriya et al., 2007; Pearce et al., 2014).

MMP reported a greater likelihood of lifetime use of hallucinogens and greater lifetime use/ misuse of most other drugs than NPU. Overall, the pattern of greater history of substance

use among MMP may be attributed to a general pattern of self-medication (McCabe et al., 2009; Moonzwe et al., 2011) or sensation-seeking (McCabe et al., 2015) among some young adults, who were then inclined to seek a recommendation for medical marijuana. However, 90-day substance use comparisons between MMP and NPU were different than lifetime comparisons. In particular, lower recent sedative/opioid misuse among MMP compared to NPU provides some support for the "stepping off" phenomena (Dreher, 2002; Mikuriya, 2004; Reiman, 2009; Sifaneck and Kaplan, 1995), whereby medical marijuana may serve as a substitute or replacement for other substances (Lucas et al., 2016; Richmond et al., 2015). Other studies comparing older MMP and NPU report varying results on other recent drug use among MMP, i.e., lower (Richmond et al., 2015), higher (Woodruff and Shillington, 2016). Given these different results across studies, future projects should strive to longitudinally assess other drug use (opioids and sedatives in particular) among MMP to better understand substitution practices (Lucas et al., 2016) and the potential to reduce opioid dependence and overdose with medical marijuana (Lau et al., 2015).

Results from this study point to several broader implications for public health. First, young adult MMP, all of whom had direct access to medical marijuana dispensaries, reported greater use of marijuana in general and greater use of newer forms of marijuana, which may relate to current health conditions and/or stem from patterns of use prior to becoming MMP. At the same time, the common sourcing of marijuana from dispensaries among NPU - both directly and indirectly - suggests a need for closer oversight of the quantity sold to MMP and/or how dispensaries check the credentials of patrons before allowing access to buy and sell marijuana (Thurston et al., 2011). Second, a greater variety of forms of marijuana, e.g., edibles, concentrates, made available via medical marijuana dispensaries may result in new challenges assessing risk associated with use. For instance, it is unknown whether the emergence of vaping as a mode of administration is a promising public health development or not since vaping may be associated with both positive (Gartner, 2015) and negative outcomes (Budney et al., 2015; Taskin, 2015). Third, while lifetime rates of drug use, e.g., cocaine, methamphetamine, heroin, were higher in the sample than in the broader population (CBHSQ, 2015), it is notable that below 1% of participants reported using heroin in the past 90 days. Declining rates of illicit and prescription drug misuse among MMP, possibly due to substituting marijuana for these other substances, is an important potential trend and worthy of future research given the association between prescription drug misuse/heroin and overdose (Compton et al., 2016). Lastly, high rates of current use of nicotine products - both cigarettes/cigars and newer forms, e.g., hookah, e-cigarette - among both MMP and NPU suggest the need to more closely examine practices common to both substances, e.g., vaping, or ones that combine tobacco and marijuana, e.g., blunts, spliffs.

There are several limitations to this study. First, the current cross-sectional design precludes determining causal relationships. Second, results may not be representative of all young adult MMP and NPU in Los Angeles, e.g., a majority had some college education or higher, frequent daily marijuana use, since the sample was not randomly selected. Third, self-reported responses to particular interview questions, such as those assessing frequency of marijuana use and amount purchased, are subject to recall bias and social desirability bias. Despite these limitations, results are based upon a diverse sample of young adults recruited from across the Los Angeles metro area whose self-reported marijuana and other drug use

offered consistencies in key areas of inquiry, e.g., frequency of marijuana use, forms/modes of administration, other drug use, within MMP and NPU subgroups.

MMP reported greater access to marijuana via medical marijuana dispensaries, more frequent and intensive use of marijuana, and greater use of novel, non-combustible forms of marijuana, e.g., dab, oil, edibles, compared to NPU. MMP also reported less recent misuse of prescription drugs compared to NPU, which suggests that marijuana may be used in place of or as a substitute for some prescription drugs. Results suggest the need for drug surveillance systems to include questions assessing both medical use and status as MMP as well as use of emerging forms and modes of administration of marijuana to more accurately characterize both younger and older populations of marijuana users.

Acknowledgements

References

Abrams DI, Vizoso HP, Shade SB, Jay C, Kelly ME, Benowitz NL, 2007 Vaporization as a smokeless cannabis delivery system: a pilot study. Clin. Pharmacol. Ther. 82,572–578, 10.1038/sj.clpt. 6100200. [PubMed: 17429350]

Benjamini Y, Hochberg Y, 1995 Controlling the false discovery rate: a practical and powerful approach to multiple testing. J. R. Stat. Soc. 57, 289–300.

Biernacki P, Waldorf D, 1981 Snowball sampling: problems, techniques and chain-referral sampling. Sociol. Method Res. 10,141–163.

Black B, 2013 The Official Dab Dictionary. High Times, http://www.hightimes.com/read/official-dab-dictionary (retrieved 06.23.16).

Bonn-Miller MO, Boden MT, Bucossi MM, Babson KA, 2014 Self-reported cannabis use characteristics, patterns and helpfulness among medical cannabis users. Am. J. Drug Alcohol Abuse 40, 23–30, 10.3109/00952990.2013.821477. [PubMed: 24205805]

Budney AJ, Sargent JD, Lee DC, 2015 Confirmation of the trials and tribulations of vaping. Addiction 110,1699–1704. [PubMed: 26264448]

Center for Behavioral Health Statistics and Quality, 2015 Behavioral Health Trends In The United States: Results From The 2014 National Survey On Drug Use And Health. HHS Publication No. SMA 15–4927, NSDUH Series H-50 2015.

Chapkis W, Webb RJ, 2008 Dying to Get High: Marijuana as Medicine. New York University, New York.

Compton WM, Jones CM, Baldwin GT, 2016 Relationship between nonmedical prescription-opioid use and heroin use. N. Engl. J. Med. 374,154–163, 10.1056/NEJMra1508490. [PubMed: 26760086]

Daniulaityte R, Nahhas RW, Wijeratne S, Carlson RG, Lamy FR, Martins SS, Boyer EW, Smith GA, Sheth A, 2015 Time for dabs: analyzing Twitter data on marijuana concentrates across the U.S. Drug Alcohol Depend. 155, 307–311, 10.1016/j.drugalcdep.2015.07.1199. [PubMed: 26338481]

Dreher M, 2002 Crack heads and roots daughters: the therapeutic use of cannabis in Jamaica. J. Cannabis Ther. 2,121–133, 10.1300/J175v02n03_08.

Gartner C, 2015 Mull it over: cannabis vaporizers and harm reduction. Addiction 110,1709–1710, 10.1186/s12916-014-0264-5.1709. [PubMed: 26471154]

Gieringer DH, 2001 Cannabis vaporization: a promising strategy for smoke harm reduction. J. Cannabis Ther. 1,153–170.

Gieringer DH, 2002 Medical use of cannabis: experience in California In: Grotenhermen F, Russo E (Eds.), Cannabis and Cannabinoids: Pharmacology, Toxicology, and Therapeutic Potential. Haworth Integrative Healing Press, New York, pp. 143–151.

Grella CE, Rodriguez L, Kim T, 2014 Patterns of medical marijuana use among individuals sampled from medical marijuanadispensaries in LosAngeles.J. Psychoact. Drugs 46, 263–272, 10.1080/02791072.2014.944960.

Harris KM, Halpern CT, Whitsel E, Hussey J, Tabor J, Entzel P, Udry JR, 2009 The National Longitudinal Study of Adolescent to Adult Health: Research Design, URL: http://www.cpc.unc.edu/projects/addhealth/design(WWW document).

Harrison LD, Erickson PG, Korf DJ, Brochu S, Benschop A, 2007 How much for a dime bag? An exploration of youth drug markets. Drug Alcohol Depend. 90 (Suppl. 1), S27–S39, http://dx.doi.org/10.1016Zj.drugalcdep.2006.09.009. [PubMed: 17088025]

Kelly BC, 2005 Bongs and blunts: notes from a suburban marijuana subculture. J. Ethn. Subst. Abuse 4, 81–97, 10.1300/J233v04n03. [PubMed: 16537329]

Lankenau SE, Schrager SM, Silva K, Kecojevic A, Bloom JJ, Wong C, Iverson E, 2012 Misuse of prescription and illicit drugs among high-riskyoung adults in Los Angeles and New York. J. Public Health Res. 1, 22–30. [PubMed: 22798990]

Lanz C, Mattsson J, Soydaner U, Brenneisen R, 2016 Medicinal cannabis: invitro validation ofvaporizers forthe smoke-free inhalation of cannabis. PLoS One 11, e0147286, 10.1371/journal.pone.0147286.

Lau N, Sales P, Averill S, Murphy F, Sato SO, Murphy S, 2015 A safer alternative: cannabis substitution as harm reduction. Drug Alcohol Rev. 34, 654–659, 10.1111/dar.12275. [PubMed: 25919477]

Lucas P, Walsh Z, Crosby K, Callaway R, Belle-Isle L, Kay R, Capler R, Holtzman S, 2016 Substituting cannabis for prescription drugs, alcohol and other substances among medical cannabis patients: the impact of contextual factors. Drug Alcohol Rev. 35, 326–333, 10.1111/dar.12323. [PubMed: 26364922]

McCabe SE, Boyd CJ, Teter CJ, 2009 Subtypes ofnonmedical prescription drug misuse. Drug Alcohol Depend. 102, 63–70. [PubMed: 19278795]

McCabe CJ, Louie KA, King KM, 2015 Premeditation moderates the relation between sensation seeking and risky substance use among young adults. Psychol. Addict. Behav. 29, 753–765. [PubMed: 26415063]

Mikuriya TH, Hergenrather J, Denney P, et al., 2007 Medical marijuana in california, 1996–2006.J. Cannabis Clin. Pract. Winter/Spr, 1–4.

Mikuriya TH, 2004 Cannabis as a substitute for alcohol: a harm-reduction approach.J.CannabisTher. 4, 79–93, 10.1300/J175v04n0K04.

Moonzwe LS, Schensul JJ, Kostick KM, 2011 The role of MDMA(ecstasy) in coping with negativ life event situations among urban young adults. J. Psychoact. Drugs 43,199–210, 10.1038/nature13314A

Murphy F, Sales P, Murphy S, Averill S, Lau N, Sato S-O, 2015 Baby boomers and cannabis delivery systems. J. Drug Issues 45, 292–313, 10.1108/17506200710779521.

Nussbaum AM, Thurstone C, McGarry L, Walker B, Sabel AL, 2014 Use and diversion of medical marijuana among adults admitted to inpatient psychiatry. Am.J. Drug Alcohol Abuse 42, 166–172, 10.3109/00952990.2014.949727.

Pacula RL,Jacobson M, Maksabedian EJ, 2016 Inthe weeds: a baseline view of cannabis use among legalizing states and their neighbours. Addiction 111, 973–980, 10.1111/add.13282. [PubMed: 26687431]

Patrick ME, O'Malley PM, Kloska DD, Schulenberg JE,Johnston LD, Miech RA, Bachman JG, 2015 Novel psychoactive substance use by US adolescents: characteristics associated with use of

synthetic cannabinoids and synthetic cathinones. Drug Alcohol Rev. 35, 586–590. [PubMed: 26711540]

Pearce DD, Mitsouras K, Irizarry KJ, 2014 Discriminatingthe effects ofcannabis sativa and cannabis indica: a web survey of medical cannabis users.J. Altern. Complement. Med. 20, 787–791, 10.1089/acm.2013.0190. [PubMed: 25191852]

Raber JC, Elzinga S, Kaplan C, 2015 Understanding dabs: contamination concerns of cannabis concentrates and cannabinoid transfer during the act of dabbing. J. Toxicol. Sci. 40, 797–803, 10.2131/jts.40.797. [PubMed: 26558460]

Reiman AE, 2008 Self-efficacy, social support and service integration at medical cannabis facilities in the San Francisco Bay area of California. Health Soc. Care Community 16, 31–41, 10.1111/j. 1365-2524.2007.00722.x. [PubMed: 18181813]

Reiman A, 2009 Cannabis as a substitute for alcohol and other drugs. Harm Reduct. J. 6, 35, 10.1186/1477-7517-6-35. [PubMed: 19958538]

Richmond MK, Pampel FC, Rivera LS, Broderick KB, Reimann B, Fischer L, 2015 Frequency and risk ofmarijuana use among substance-using health care patients in Colorado with and without access to state legalized medical marijuana. J. Psychoact. Drugs 47, 1–9, 10.1080/02791072.2014.991008.

Roy-Byrne P, Maynard C, Bumgardner K, Krupski A, Dunn C, West II, Donovan D, Atkins DC, Ries R, 2015 Are medical marijuana users different from recreational users? The view from primary care. Am. J. Addict. 24, 599–606, 10.1111/ajad.12270. [PubMed: 26337603]

Ryan-Ibarra S, Induni M, Ewing D, 2014 Prevalence of medical marijuana use in California, 2012. Drug Alcohol Rev, 10.1111/dar.12207.

Schauer GL, King BA, Bunnell RE, Promoff G, McAfee TA, 2016 Toking, vaping, and eating for health or fun. Am.J. Prev. Med. 50,1–8, 10.1016/j.amepre.2015.05.027. [PubMed: 26277652]

Sifaneck SJ, Kaplan CD, 1995 Keeping off, stepping on and stepping off: the steppingstone theory reevaluated in the context of the Dutch cannabis experience. Contemp. Drug Probl. 22, 483–513.

Sifaneck SJ, Kaplan CD, Dunlap E,Johnson BD, 2003 Blunts and blowtjes: cannabis use practices in two cultural settings and their implications for secondary prevention. Free Inq. Creat. Sociol. 31,3–14.

Sifaneck SJ,Johnson BD, Dunlap E, 2005 Cigars-for-blunts: choice oftobacco products by blunt smokers.J. Ethn. Subst. Abuse 4, 23–42, 10.1300/J233v04n03.

Sifaneck SJ, Ream GL,Johnson BD, Dunlap E, 2007 Retail marijuana purchases in designer and commercial markets in New York City: sales units, weights, and prices pergram. Drug Alcohol Depend. 90,40–51, 10.1016/j.drugalcdep.2006.09.013.

Stogner JM, Miller BL, 2015 Assessing the dangers of dabbing: mere marijuana or harmful newtrend? Pediatrics 136,1–3, 10.1542/peds.2015-0454. [PubMed: 26077476]

Taskin DP, 2015 How beneficial is vaping cannabis to respiratory health comparedtosmoking? Addiction 110,1706–1707, 10.1093/pubmed/fdv005. [PubMed: 26471152]

Thomas C, Freisthler B, 2015 Examiningthe locations of medical marijuana dispensaries in Los Angeles. Drug Alcohol Rev, 10.1111/dar.12325.

Thurston C, Lieberman SA, Schmiege SJ, 2011 Medical marijuana diversion and associated problems in adolescent substance treatment. J. Am. Acad. Child Adolesc. Psychiatry 51, 694–702.

Watters JK, Biernacki P, 1989 Targeted sampling: options for the study of hidden populations. Soc. Prob. 36, 416–430.

Wilkinson ST, Yarnell S, Radhakrishnan R, Ball SA, D'souza DC, 2016 Marijuana legalization: impact on physicians and public health. Annu. Rev. Med. 67, 453–466. [PubMed: 26515984]

Woodruff SI, Shillington AM, 2016 Sociodemographic and drug use severity differences between medical marijuana users and non-medical users visiting the emergency department. Am.J. Addict. 1–7, 10.1111/ajad.12401.

Table 1

Frequency and Amount of Marijuana Use in Past 90 Days among Medical Marijuana Patients (MMP) and Non-Patient Users (NPU) (N = 366).

Variable	MMP n=210 m (sd)	NPU n=156 m(sd)	Total N=366 m (sd)	t-test
How many days have you used marijuana in the past 90days?				
Range: 4 to 90	76.4(21.7)	59.2(29.5)	69.1(26.6)	6.41 ***
How many hits (pulls off of a pipe,joint, bong, et.) per day did you typically do in the past 90days?				
Range: 1 to 101	25.9(28.0)	20.0(24.4)	23.4(26.7)	2.08 †
How much money did you typically spend on marijuana products inthe past 90days? [dollars]				
Range: 0to 7000	564.5(737.1)	266.9(538.8)	437.8(675.4)	4.25 ***
	%(n)	%(n)	%(n)	Unadjusted Risk Ratios (95% CI)
How much marijuana did you typically use per week in the past 90 days?				0.7(0.5–0.9) **1
Less than 1/8 of an ounce (3.5 g)	33.7(70)	49.0(76)	40.2(146)	
Between 1/8 and 1/2 of an ounce (3.5 to 14g)	56.3(117)	43.2(67)	50.7(184)	
Between 1/2 and 1 ounce(14to 28g)	8.2(17)	4.5(7)	6.6(24)	
More than 1 ounce (28 g)	1.9(4)	3.2(5)	2.5(9)	
What do you think is an acceptable level of marijuana use for you?				1.7(1.3–2.1) ***2
Use multiple times a day everyday	56.7(119)	34.0(53)	47.0(172)	
Use once a day, everyday	25.2(53)	22.4(35)	24.0(88)	
Use once every few days	14.3(30)	34.6(54)	23.0(84)	
Use once a week	1.9(4)	5.8(9)	3.6(13)	
Use once a month or less	1.9(4)	3.2(5)	2.5(9)	

†
p < 0.1,

**
p < 0.01,

***
p < 0.001.

1 URR was computed based on comparing differences between MMP and NPU on using less than 1/8 of an ounce vs 1/8 of an ounce or more.

[2]URR was computed based on comparing differences between MMP and NPU on perceived acceptable level of use from using multiple times a day everydayvs. using once a day, everyday or less.

Table 2

Use of Dispensaries/Delivery Services in Past 90 days among Medical Marijuana Patients (MMP) and Non-Patient Users (NPU) (N = 366).

Variable	MMP n = 210 % (n)	NPU n = 156 % (n)	Total N = 366 % (n)	Unadjusted Risk Ratios (95% CI)
Which of the following persons or places have you bought or received marijuana from in the past 90 days [1,2]?				
I bought from a medical marijuana dispensary/collective storefront	98.6(207)	15.4(24)	63.1(231)	
I bought from a medical marijuana delivery service	14.8(31)	5.8(9)	10.9(40)	
Drug dealer bought it for me from a medical marijuana dispensary/delivery service	4.3(9)	17.3(27)	9.8(36)	
Friend obtained it for me from a medical marijuana dispensary/delivery service	27.6(58)	80.1(125)	50.0(183)	
Family member obtained it for me from a medical marijuana dispensary/delivery service	5.7(12)	18.6(29)	11.2(41)	
A drug dealer, friend, family member, or someone else obtained marijuana from a source other than a medical marijuana dispensary/delivery service	11.0(23)	30.1(47)	19.1(70)	
I have grown my own marijuana plants	7.1(15)	3.2(5)	5.5(20)	
	%(n)	%(n)	%(n)	
What proportion of the marijuana you've used or purchased came from a medical marijuana dispensary/delivery service in the past 90 days?				
100%	76.2(160)	53.6(82)	66.7(242)	1.4(1.2–1.7)***
Have you sold any of the marijuana you bought to someone else in the past 90 days?				
Yes	22.2(46)	23.0(35)	22.6(81)	1.0(0.7–1.4)
Do you have a primary dispensary or delivery service where you've typically gotten marijuana in the past 90 days?				

Drug Alcohol Depend. Author manuscript; available in PMC 2019 May 29.

Variable	MMP n = 210 % (n)	NPU n = 156 % (n)	Total N = 366 % (n)
Yes	90.9(189)	64.0 (87)	80.2(276) 1.4(1.2–1.6) ***
Has a dispensary that you've gotten marijuana from ever closed? (n = 341)			
Yes	69.9(144)	51.9(70)	62.8(214) 1.4(1.1–1.6) **

1 Persons and places to buy/receive marijuana were not mutually exclusive.

2 Cochran's Q test statistic for MMP = 754.6, df = 6, p < 0.001; for NPU = 331.0, df = 6, p < 0.001.

**
p < 0.01,

***
p < 0.001.

Table 3

Forms and Modes of Administering Marijuana in Past 90 days among Medical Marijuana Patients (MMP) and Non-Patient Users (NPU) (N = 366).

Variable	MMP n=210%(n)	NPU n = 156%(n)	Total N=366 %(n)	Unadjusted Risk Ratios (95%CI)
What are the different forms of marijuana you used in the past 90 days?[1]				
Buds/flowers	99.0(208)	98.7(154)	98.9(362)	1.0(1.0–1.0)
Edibles	67.1(141)	48.1(75)	59.0(216)	1.4(1.2–1.7)**
Concentrates (e.g., oil, dab)	66.7(140)	48.1(75)	58.7(215)	1.4(1.2–1.7)**
Drinks	15.2(32)	6.4(10)	11.5(42)	2.4(1.2–4.7)*
Spray/drops	6.7(14)	1.3(2)	4.4(16)	5.2(1.2–22.6)*
What are the different ways that you used marijuana in the past 90days?[1]				
Smoking				
Pipe/Bowl	85.7(180)	87.2(136)	86.3(316)	1.0(0.9–1.1)
Joint	85.7(180)	78.8(123)	82.8(303)	1.1(1.0–1.2)
Blunt	81.0(170)	78.8(123)	80.1(293)	1.0(1.0–1.1)
Bong	78.6(165)	73.7(115)	76.5(280)	1.1(1.0–1.2)
Skiff or spliff (e.g., marijuana and tobacco mixed together)	18.1(38)	19.9(31)	18.9(69)	0.9(0.6–1.4)
Vaporization				
Electronic vaporizer device, e.g., e-joint, vape pen	51.9(109)	34.0(53)	44.3(162)	1.5(1.2–2.0)**
Vaporizer, e.g., volcano	38.6(81)	25.6(40)	33.1(121)	1.5(1.1–2.1)*
Oil rig (for concentrates)	30.0(63)	22.4(35)	26.8(98)	1.3(1.0–1.9)
Oral (swallowing)				
Edible form	66.2(139)	46.8(73)	57.9(212)	1.4(1.2–1.7)***
Beverage form	15.7(33)	7.1(11)	12.0(44)	2.2(1.2–43)*
What is the primary type or strain of marijuana that you used in the past 90 days [1,2]				1.2(1.0–1.3)*[3]
Indica	49(103)	34.6(54)	42.9(157)	
Sativa	21.4(45)	19.9(31)	20.8(76)	
Hybrid	11.9(25)	11.5(18)	11.7(43)	

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Variable	MMP n=210%(n)	NPU n = 156%(n)	Total N=366 %(n)	Unadjusted Risk Ratios (95%CI)
No primary strain	16.7(35)	25.6(40)	20.5(75)	

*
p <0.05,

**
p < 0.01,

***
p < 0.001.

[1]Other was excluded from analysis due to low occurrence (1.1% to 2.2%).

[2]Top 5 strains named by participants were Blue Dream (hybrid), Skywalker (indica), Girl Scout Cookies (hybrid), Jack Herer (hybrid), and Green Crack (sativa).

[3]URR was computed based on comparison between MMP and NPU on 'Indica or Sativa or Hybrid' as a primary strain vs 'No primary strain'.

Table 4

Lifetime and 90 day Use/Misuse of Licit and Illicit Drugs among Medical Marijuana Patients (MMP) and Non-Patient Users (NPU) (N = 366).

Variable	Lifetime			90 day[1]		
	MMP n=210 %(n)	*NPU n= 156 % (n)*	*Unadjusted Risk Ratios (95% CI)*	*MMP N=210 % (n)*	*NPU n = 156%(n)*	*Unadjusted Risk Ratios (95% CI)*
Alcohol	**97.1(204)**	**96.2(150)**	**1.0(1.0–1.1)**	**85.3(174)**	**82.7(124)**	**1.0(0.9,1.1)**
Nicotine	**97.1(204)**	**94.9(148)**	**1.0(1.0–1.1)**	**67.6(138)**	**66.2(98)**	**1.0(0.9,1.2)**
Cigarette	84.3(177)	82.1(128)		54.3(96)	58.6(75)	
Hookah	88.1(185)	82.7(129)		30.3(56)	41.9(54)	
E-cigarette	65.2(137)	54.5(85)		48.2(66)	49.4(42)	
Cigars	58.6(123)	48.1(75)		28.4(35)	38.7(29)	
Hallucinogens	**72.4(152)**	**57.1(89)**	**1.3(1.1–1.5)** **	**37.5(57)**	**30.3(27)**	**1.2(0.9,1.8)**
MDMA(Ecstasy)	56.7(119)	37.8(59)		22.7(27)	18.6(11)	
Mushrooms	48.6(102)	35.9(56)		22.5(23)	16.1(9)	
LSD	37.1(78)	21.8(34)		28.2(22)	20.6(7)	
Salvia divinorum	40.0(84)	23.7(37)		4.8(4)	<2.0 (s)	
Ketamine	8.6(18)	7.1(11)		<2.0 (s)	<2.0 (s)	
Stimulants	**56.2(118)**	**46.2(72)**	**1.2(1.0–1.5)**	**35.6(42)**	**38.9(28)**	**0.9(0.6,1.3)**
Cocaine	43.3(91)	35.9(56)		28.6(26)	33.9(19)	
Prescription stimulants	31.0(65)	25.6(40)		30.8(20)	35.0(14)	
Methamphetamine	15.7(33)	10.9(17)		12.1(4)	<2.0 (s)	
Crack	6.2(13)	<2.0 (s)		<2.0 (s)	0.0(0)	
Synthetic cathinone	2.4(5)	<2.0 (s)		0.0(0)	0.0(0)	
Sedatives/Hypnotics	**47.1(99)**	**38.5(60)**	**1.2(1.0–1.6)**	**22.2(22)**	**38.3(23)**	**0.6(0.4–1.0)** [†]
Prescription tranquilizers	34.3(72)	24.4(38)		22.2(16)	35.1(13)	
Sleeping pills	22.9(48)	17.3(27)		12.5(6)	33.3(9)	
Muscle relaxant	26.2(55)	16.0(25)		12.7(7)	16.0(4)	
Anti-depressants	4.3(9)	<2.0 (s)		0.0(0)	0.0(0)	
GHB	2.9(6)	<2.0 (s)		<2.0 (s)	<2.0 (s)	
Opioids	**41.4(87)**	**34.6(54)**	**1.2(1.0–1.6)**	**17.2(15)**	**31.5(17)**	**0.6(0.3–1.0)** [†]

Variable	Lifetime			90 day[1]		
	MMP n=210 %(n)	NPU n = 156 % (n)	Unadjusted Risk Ratios (95% CI)	MMP N=210 % (n)	NPU n = 156 %(n)	Unadjusted Risk Ratios (95% CI)
Prescription opioids	40.5(85)	34.0(53)		17.6(15)	32.1(17)	
Heroin	5.7(12)	2.6(4)		<2.0 (s)	0.0(0)	
Synthetic cannabinoids	35.2(74)	27.6(43)	1.3(1.0–1.8)	12.2(9)	<2.0 (s)	2.6(0.6–11.6)

†
p < 0.1,

**
p < 0.01.

[1]Percentages reflect the number of 90 day users divided by lifetime users for each drug or category.

s = cells containing between 1 and 3 respondents were suppressed to minimize the risk of identification