



Full length article

## Illicit drug use and prescription drug misuse among young adult medical cannabis patients and non-patient users in Los Angeles



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### ABSTRACT

**Introduction:** Young adults have the highest rates of cannabis and other drug use, as compared to other age groups, and contribute a significant proportion to the total population of medical cannabis patients (MCP). However, little is known about the relationships between various cannabis practices and illicit drug use/prescription drug misuse among young adult cannabis users with and without legal access to medical cannabis.

**Methods:** 210 MCP and 156 non-patient cannabis users (NPU) aged 18–26 were recruited in Los Angeles in 2014–15 for a longitudinal study assessing the impact of medical cannabis on health and substance use among emerging adults. For the present analysis, only quantitative baseline survey data were used. Logistic regression was used to examine the associations between past 90-day cannabis practices and other drug use, including illicit drug use and prescription drug misuse.

**Results:** Illicit drug use was associated with being non-Hispanic white (AOR = 3.0, 95% CI 1.8–5.1), use of cannabis concentrates (AOR = 2.8, 95% CI 1.6–4.9), while self-reported medical cannabis use was associated with lower probability of illicit drug use (AOR = 0.5, 95% CI 0.3–0.9). The odds of prescription drug misuse were increased for participants who reported use of cannabis edibles (AOR = 2.0, 95% CI 1.1–3.5), and decreased with age (AOR = 0.9, 95% CI 0.8–1.0) and for those who used cannabis alone (AOR = 0.5, 95% CI 0.3–0.9).

**Conclusion:** Use of alternative cannabis forms, but not cannabis use frequency, were associated with greater odds of other drug use. Self-reported medical cannabis use, but not MCP status, decreased probability of illicit drug use.

### 1. Introduction

Young adults have the highest prevalence of cannabis use, other drug use, and mental illness comorbidity as compared to older adults or adolescents (Center for Behavioral Health Statistics and Quality, 2017; Johnston et al., 2008). In 2016, prevalence of past month cannabis use among 18–25-year-old adults was 20.8% while prevalence of illicit drug use, including cannabis and nonmedical use of prescription medications, was 23.2%, which represented increases since 2002. Prevalence

of any mental illness in the past year among young adults was 22.1% in 2016, 46.9% of whom had a co-occurring substance use disorder associated with illicit drug use (Center for Behavioral Health Statistics and Quality, 2015, 2017).

While cannabis remains a Schedule I Controlled Substance, denoting high potential for abuse and no recognized medical value, as of January 1st, 2019, medical cannabis is legal in 33 states and the District of Columbia, and recreational cannabis is legal in 10 states and the District of Columbia. California, the first state to legalize medical cannabis in

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1996, legalized recreational cannabis use in 2016 (California Secretary of State, 2016; California Department of Public Health, 2018). Young adults contribute about 17.9–19% to the total population of medical cannabis patients (MCP) in California (Mikuriya et al., 2007; Reinerman et al., 2011).

### 1.1. Patterns of cannabis use and illicit drug use/prescription drug misuse

While cannabis flower is the most popular form among both medical and recreational cannabis users (Grella et al., 2014; Johnson et al., 2016; Lankenau et al., 2017; Schauer et al., 2016), use of alternative cannabis forms, such as cannabis concentrates and edibles, has been increasing among both groups of users (Benjamin and Fossler, 2016; Zhang et al., 2016). Use of alternative cannabis forms is a growing public health concern, and has been linked to increased risk of psychosis, cannabis dependence (Hall and Degenhardt, 2015), overdose (Benjamin and Fossler, 2016; Cavazos-Rehg et al., 2016), and may also have important implications for risk of other drug use.

Attention to use of cannabis for medical purposes has increased in recent years though studies have not defined this practice consistently. For instance, Lin et al. (2016) defined medical cannabis use based upon whether any cannabis use in the past 12 months was recommended by a doctor, which is essentially a proxy for MCP status. Similarly, Boyd et al. (2015) defined medical cannabis users as those who obtained cannabis from a medical cannabis dispensary as a result of their own medical cannabis recommendation. In contrast, other studies defined medical cannabis use as any self-reported medical cannabis use within the assessment period (Choi et al., 2017; Roy-Byrne et al., 2015) while some studies attempted to quantify self-reported medical cannabis use by separating mixed (recreational and medical), medical only and recreational only cannabis users (Pacula et al., 2016; Schauer et al., 2016). Notably, these studies articulated the possibility that individuals could be using cannabis both medically and recreationally. Additionally, MCP status and self-reported medical cannabis use have been assessed within the same study but without examining the relationship between MCP status and other variables (Choi et al., 2017; Roy-Byrne et al., 2015).

In the recreational cannabis literature, higher frequency of cannabis use was found to be a risk factor for illicit drug use (Degenhardt et al., 2010; Keith et al., 2015; Swift et al., 2012) and prescription drug misuse (Arterberry et al., 2016; Novak et al., 2016). Conversely, in studies on medical cannabis among U.S. adults, MCP status and self-reported medical cannabis use were associated with higher frequency of cannabis use whereas MCP had lower odds of illicit drug use and prescription drug misuse (Compton et al., 2017; Lin et al., 2016; Richmond et al., 2015), while any self-reported medical cannabis use was either protective against (Roy-Byrne et al., 2015), or not associated (Choi et al., 2017) with the severity of other drug use. Lower rates of substance use among MCP could be due to a possible substitution effect in which cannabis is used in place of other substances as a safer alternative with less negative consequences (Grella et al., 2014; Lucas et al., 2016; Reiman, 2009). In contrast to the research conducted among adult population, in a study among 12<sup>th</sup> graders, MCP, while using cannabis more frequently, were more likely to report any past year illicit drug use or prescription drug misuse (Boyd et al., 2015). Similarly, conflicting findings have been reported on the role of solitary cannabis use on the severity of other drug use with solitary cannabis use being a risk factor in recreational cannabis literature (Creswell et al., 2015) and being protective in medical cannabis literature (Roy-Byrne et al., 2015).

Overall, the evidence is conflicting and limited on how specific cannabis practices, including use of alternative cannabis forms, frequency of use, MCP status, self-reported medical cannabis use, solitary use and substitution with cannabis for other drugs, relate to illicit drug use and prescription drug misuse among young adult cannabis users.

### 1.2. Cannabis use and mental health

The association between cannabis (Kedzior and Laeber, 2014; Moore et al., 2007) or other drug use (Compton et al., 2005; Stone et al., 2012) and symptoms of anxiety and depression has been well established in the literature. A number of longitudinal studies indicate that anxiety and depression predict cannabis use which might suggest self-medication with cannabis for these conditions (Agosti et al., 2002; Arendt et al., 2007; Crippa et al., 2009; Feingold et al., 2015; Wittchen et al., 2007). Use of cannabis for management of depression and anxiety has been reported in both medical (Nunberg et al., 2011; Reinerman et al., 2011; Walsh et al., 2013) and recreational (Boys et al., 2001; Gurley et al., 1998; Pedersen et al., 2015; Regelson et al., 1976) cannabis literature.

To summarize, previous research provides ample evidence on the association between cannabis use, other drug use and anxiety or depressive symptoms. However, it is unknown whether cannabis use as self-medication for anxiety or depression is associated with recent illicit drug use or prescription drug misuse among young adult MCP and non-patient cannabis users (NPU).

### 1.3. Present study

We examine the relationships between other drug use, including illicit drug use and prescription drug misuse (outcomes), cannabis use and mental health among young adult MCP and NPU. Towards this end, this study has two research questions: 1) What is the relationship between patterns of cannabis use and other drug use? 2) What are the relationships between using cannabis to cope with depression or anxiety and other drug use?

## 2. Methods

### 2.1. Data source

Data came from Cannabis, Health & Young Adults (CHAYA) project, a longitudinal study assessing the impact of medical cannabis and medical cannabis dispensaries on physical and psychological health and substance use among emerging adults. For the present analysis, only quantitative baseline survey data were used which included survey questions pertaining to cannabis practices, mental health, illicit drug use and prescription drug misuse.

### 2.2. Study sample

Participants were recruited and interviewed (n = 366) in Los Angeles in 2014–2015 through targeted and chain referral sampling strategies. Eligibility criteria was as following: aged 18–26 years old; used cannabis at least 4 times within the last 30 days; spoke/read English; and lived in the Los Angeles metro area. The sample was divided into MCP (n = 210), who had a current medical cannabis recommendation issued by a California-based physician, and NPU (n = 156) who had never had a medical cannabis recommendation.

Among those who met eligibility criteria, 82% of screened MCP and 86.7% of screened NPU were enrolled. There were no statistically significant differences across demographic variables (e.g., age, gender, race/ethnicity) between enrolled and non-enrolled individuals (Lankenau et al., 2017).

### 2.3. Data collection

The study instrument was developed by the research team (including author) and programmed into Research Electronic Data Capture (REDCap), a web-based survey platform. All interviews were conducted in private (e.g., office) or semi-private (e.g., coffee shops, parks) settings. Most of the questions were interviewer-administered while

**Table 1**  
Prescription drug misuse and illicit drug use in the past 90 days among young adult cannabis users in Los Angeles (n = 366).

Variable	Lifetime n = 366 n(%)	90 days n = 366 n(%)
Rx drug misuse		
Any Rx drug misuse	216(59.0)	83(22.7)
Stimulants	105(28.7)	34(9.3)
Opioids	138(37.7)	32(8.7)
Tranquilizers	110(30.1)	29(7.9)
Sleeping pills	75(20.5)	15(4.1)
Muscle relaxants	80(21.9)	11(3.0)
Anti-depressants	10(2.7)	0(0.0)
Illicit drug use		
Any Illicit Drug	269(73.5)	115(31.4)
Cocaine	147(40.2)	45(12.3)
Ecstasy	178(48.6)	38(10.4)
Mushrooms	158(43.2)	32(8.7)
LSD	112(30.6)	29(7.9)
Synthetic Cannabis	117(32.0)	11(3.0)
Salvia Divinorum	121(33.1)	7(1.9)
Methamphetamine	50(13.7)	5(1.4)
Ketamine	29(7.9)	4(1.1)
GHB	9(2.5)	2(0.5)
Heroin	16(4.4)	1(0.3)
Crack	16(4.4)	1(0.3)
Synthetic Cathinone (Bath Salts)	6(1.6)	0(0.0)

standardized scales/measures and sections containing especially sensitive questions were self-administered. All study procedures were approved by the Institutional Review Boards at Children's Hospital Los Angeles and Drexel University.

#### 2.4. Measures

Demographic characteristics included age, race/ethnicity (non-Hispanic white versus other race/ethnicity categories), gender (male as a reference category) and sexual identity (heterosexual versus gay/lesbian and bisexual) (Lankenau et al., 2018). Illicit drug use and prescription drug misuse (see Table 1 for complete list) were assessed through the following question: *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 to "to get high" or to self-medicate)?* Responses were dichotomized into binary variables representing use or absence of use of any illicit/prescription drug listed in the survey instrument within 90 days prior to the baseline interview. Cannabis practices in the past 90 days were assessed through questions derived from medical and non-medical cannabis literature which included cannabis forms, solitary use, frequency of use, and ever substituting cannabis for illicit or prescription drugs (Chapkis and Webb, 2008; Gieringer, 2001; Sifaneck et al., 2003). Use of various cannabis forms was assessed by asking participants to indicate all of the cannabis forms they used in the past 90 days including edibles and concentrates (wax, shatter, dab, oil). Self-reported medical cannabis use was measured through item: *How would you characterize your use of cannabis over the past 90 days?* Response options for this question were dichotomized into self-reported medical cannabis use, which included exclusively and primarily medical or equally medical and recreational uses, versus predominantly self-reported recreational cannabis use, which included primarily or exclusively recreational uses. This item was preceded by definitions for recreational (*"to socialize with others, to increase creativity, or to make experiences more pleasurable, interesting, or exciting"*) versus medical (*"to treat or help cope with any physical ailments, such as pain or discomfort, or psychological conditions, such as feeling anxious or sad, insomnia"*) cannabis use. Medical cannabis patient status was assessed by providing a current valid doctor's recommendation at enrollment. Reasons for cannabis use in the past 90 days, such as *"to relieve feeling*

*uptight and anxious"* and *"to cope with feeling depressed,"* were used as indicators of current mental health status and were based on studies of recreational cannabis use, e.g., Comprehensive Marijuana Motives Questionnaire (Lee et al., 2009), and medical cannabis use (Mikuriya et al., 2007; Nunberg et al., 2011). History of prescribed medications for treatment of mental health conditions was assessed by asking participants whether they ever been prescribed tranquilizers or anti-depressants. Problematic cannabis use was assessed with the Severity of Dependence Scale (SDS), which is a five-item measure of concerns about not being able to control one's cannabis use (Martin et al., 2006).

#### 2.5. Data analysis

Data were analyzed using SPSS, version 24.0 (SPSS Inc., Chicago, IL, USA). Bivariate and multiple regression analyses were conducted separately for illicit drug use and prescription drug misuse as outcomes. We first examined bivariate associations between independent and dependent variables by calculating unadjusted odds ratios using logistic regression. Potential multicollinearity problems in adjusted models were assessed by creating a correlation matrix with tetrachoric or Pearson correlation coefficients between all independent variables. None of the variables had a correlation coefficient value greater than 0.5. Independent variables associated with each of the outcomes at  $p < 0.05$  level were retained in the multiple logistic regression models. Binary independent variables with categories containing a very small number of observations (< 10% of the total sample) or a very large number of observations (> 90% of the total sample) were excluded from multiple regression analyses to avoid occurrence of cells with zero frequencies. Model fit was assessed with Hosmer and Lemeshow tests.

### 3. Results

Prescription drug misuse in the past 90 days was reported by 22.7% of the participants (Table 1). The most commonly misused prescription drugs were stimulants (9.3%), opioids (8.7%) and tranquilizers (7.9%). Nearly, one third (31.4%) of the sample used illicit drugs in the past 90 days. Cocaine (12.3%), ecstasy (10.4%) and mushrooms (8.7%) were the top three illicit drugs while prevalence of such drugs as heroin, crack and methamphetamine was in a range of 0.3–1.4%.

Unadjusted bivariate associations with prescription drug misuse as an outcome are shown in Table 2, while unadjusted bivariate association with illicit drug use as an outcome are reported in Table 3. Table 4 displays the results of multiple regression analyses for both outcomes of interest: prescription drug misuse and illicit drug use. When adjusted for other variables, the odds of prescription drug misuse were increased for participants who reported use of cannabis edibles (AOR = 2.0, 95% CI 1.1–3.5), and decreased with age (AOR = 0.9, 95% CI 0.8–1.0) and for those who used cannabis alone (AOR = 0.5, 95% CI 0.3–0.9). When adjusted for other variables, illicit drug use was associated with being non-Hispanic white (AOR = 3.0, 95% CI 1.8–5.1), and the use of cannabis concentrates (AOR = 2.8, 95% CI 1.6–4.9), while it was negatively associated with self-reported medical cannabis use (AOR = 0.5, 95% CI 0.3–0.9).

### 4. Discussion

While several studies have examined the association between medical cannabis use and other drug use, this is the first study describing the relationships between various cannabis use practices, including access to medical cannabis and self-reported medical cannabis use, specifically within a population of young adult cannabis users. Approximately one quarter of the sample reported recent misuse of prescription drugs, whereas, similar to an earlier study, stimulants, opioids and tranquilizers were the top three prescription drug classes reported (Kelly et al., 2013). One third of the sample reported recent illicit drug use where the most commonly used substances were cocaine

**Table 2**  
Unadjusted bivariate associations with prescription drug misuse in the past 90 days as an outcome among young adult cannabis users in Los Angeles (n = 366).

Variable	Rx drug	No Rx drug	Unadjusted OR 95%CI
	misuse n = 83 n(%)	misuse n = 283 n(%)	
<b>Demographics</b>			
Non-Hispanic White	23(28.4)	69(24.7)	1.2(0.7–2.1)
Age, mean (SD)	20.7(2.5)	21.4(2.5)	0.9(0.8–1.0)*
Heterosexual	62(76.5)	227(82.8)	0.7(0.4–1.2)
Female	33(39.8)	91(32.2)	1.4(0.8–2.3)
<b>Cannabis forms</b>			
Bud/flower	83(100.0)	279(98.6)	–
Edibles	61(73.5)	155(54.8)	2.3(1.3–3.9)**
Concentrates (wax, shatter, dab, oil)	58(69.9)	157(55.5)	1.9(1.1–3.2)*
<b>Other cannabis practices</b>			
Medical Cannabis Patient	44(53.0)	166(58.7)	0.8(0.5–1.3)
Self-reported medical cannabis use	49(59.0)	174(61.5)	0.9(0.6–1.5)
Typically used cannabis alone	14(16.9)	92(32.5)	0.4(0.2–0.8)**
Days of cannabis use, mean(SD)	74.4(24.6)	67.5(27.1)	1.01(1.00–1.02)*
Ever substituted cannabis for Rx drugs	10(12.0)	18(6.4)	2.0(0.9–4.6)†
<b>Mental health indicators</b>			
Ever been prescribed tranquilizers	15(18.1)	33(11.7)	1.7(0.9–3.3)
Ever been prescribed anti-depressants	21(25.3)	45(15.9)	1.8(1.0–3.2)†
Used cannabis to relieve feeling uptight and anxious	58(69.9)	172(60.8)	1.5(0.9–2.5)
Used cannabis to cope with feeling depressed	40(48.2)	111(39.2)	1.4(0.9–2.4)
SDS, mean(SD)	2.9(2.6)	2.3(2.7)	1.1(1.0–1.2)†

Note. †p < 0.1, \*p < 0.05, \*\*p < 0.01.

**Table 3**  
Unadjusted bivariate associations with illicit drug use in the past 90 days as an outcome among young adult cannabis users in Los Angeles (n = 366).

Variable	Illicit	No illicit	Unadjusted OR 95%CI
	drug use n = 115 n(%)	drug use n = 251 n(%)	
<b>Demographics</b>			
Non-Hispanic White	45(39.8)	47(19.0)	2.8(1.7–4.6)***
Age, mean (SD)	21.2(2.6)	21.2(2.4)	1.0(0.9–1.1)
Heterosexual	90(80.4)	199(81.9)	0.9(0.5–1.6)
Female	35(30.4)	89(35.5)	0.8(0.5–1.3)
<b>Cannabis forms</b>			
Bud/flower	115(100.0)	247(98.4)	–
Edibles	76(66.1)	140(55.8)	1.6(1.0–2.5)†
Concentrates (wax, shatter, dab, oil)	87(75.7)	128(51.0)	3.0(1.8–4.9)***
<b>Other cannabis practices</b>			
Medical Cannabis Patient	72(62.6)	138(55.0)	1.4(0.9–2.2)
Self-reported medical cannabis use	61(53.0)	162(64.5)	0.6(0.4–1.0)*
Typically used cannabis alone	28(24.3)	78(31.1)	0.7(0.4–1.2)
Days of cannabis use, mean(SD)	75.2(20.8)	66.3(28.5)	1.01(1.01–1.02)**
Ever substituted cannabis for illicit drugs	15(13.0)	14(5.6)	2.5(1.2–5.5)*
<b>Mental health indicators</b>			
Ever been prescribed tranquilizers	16(13.9)	32(12.7)	1.1(0.6–2.1)
Ever been prescribed anti-depressants	20(17.4)	46(18.3)	0.9(0.5–1.7)
Used cannabis to relieve feeling uptight and anxious	76(66.1)	154(61.4)	1.2(0.8–2.0)
Used cannabis to cope with feeling depressed	51(44.3)	100(39.8)	1.2(0.8–1.9)
SDS, mean(SD)	2.8(3.0)	2.3(2.5)	1.1(1.0–1.2)

Note. †p < 0.1, \*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001.

**Table 4**  
Multiple regression models with prescription drug misuse and illicit drug use in the past 90 days as outcomes among young adult cannabis users in Los Angeles (n = 366).

Variable	AOR 95%CI	
	Prescription drug misuse	Illicit drug use
<b>Demographics</b>		
Non-Hispanic White	–	3.0(1.8–5.1)***
Age	0.9(0.8–1.0)*	–
<b>Cannabis forms</b>		
Edibles	2.0(1.1–3.5)*	–
Concentrates (wax, shatter, dab, oil)	1.2(0.7–2.2)	2.8(1.6–4.9)***
<b>Other cannabis practices</b>		
Self-reported medical cannabis use	–	0.5(0.3–0.9)*
Typically used cannabis alone	0.5(0.3–0.9)*	–
Days of cannabis use, mean(SD)	1.0(1.0–1.0)	1.01(1.00–1.02)†

Note. †p < 0.1, \*p < 0.05, \*\*\*p < 0.001.

and drugs with hallucinogenic properties (e.g., ecstasy, mushrooms, LSD). Interestingly, there was no overlap in the correlates in the multiple regression models for these two types of drug use, which indicates distinct profiles of recent prescription drug misusers and recent users of illicit drugs in this sample. Prescription drug misusers were significantly more likely to be younger (Kelly et al., 2013), use edibles and use cannabis with others. A greater proportion of prescription drug misusers were females (though not significant). In contrast, illicit drug users were significantly more likely to be non-Hispanic white, use cannabis concentrates, and less likely to be among self-reported medical cannabis users. A greater proportion of illicit drug users were males (though not significant). These findings have important implications for future research among young adult cannabis users highlighting the importance of distinguishing between prescription drug misuse and illicit drug use.

A primary question concerned whether MCP status or self-reported medical cannabis use were associated with other recent drug use. Self-reported medical cannabis use was negatively associated with recent illicit drug use, but not prescription drug misuse. Similarly, in a study among adults within primary care settings, medical cannabis use was associated with lower drug problem severity (Roy-Byrne et al., 2015). However, we did not find significant differences in 90-day use of either prescription or illicit drugs between MCP and NPU. Though, in another analysis, we found MCP reporting lower rates (not significant) of prescription sedatives and opioids misuse (Lankenau et al., 2017). Previous general population studies found MCP status to be associated with lower risk of other drug use (Compton et al., 2017; Lin et al., 2016; Richmond et al., 2015), with the exception of one study among 12<sup>th</sup> graders demonstrating a higher probability of illicit drug use and prescription drug misuse among MCP when compared to NPU (Boyd et al., 2015). A possible explanation for the lack of the association between MCP status and either illicit drug use or prescription drug misuse in our study is that MCP is a mixed group consisting of both medical and recreational cannabis users, while NPU group also has some medical cannabis users. Additionally, as it was shown in another study, younger MCP had more recreational and less medical motives for cannabis use when compared to older MCP (Haug et al., 2017). Therefore, within a population of young adults self-reported medical cannabis use may be a better indicator of medical use than MCP status since some MCP may use cannabis recreationally.

Frequency of cannabis use was significant in the bivariate analyses (while small in magnitude) for both types of drug use, but it was not significant in the adjusted regression models. Our results are in contrast with the recreational cannabis literature that commonly reported that more frequent cannabis use increased the risk of other drug use (Degenhardt et al., 2010; Novak et al., 2016; Swift et al., 2012). This might be explained by the possible moderating effect of medical

motivations for cannabis use where self-reported medical cannabis use was associated with more frequent cannabis use but it was also associated with lower odds of other drug use (Pacula et al., 2016). Similarly, problematic cannabis use, measured by the SDS scale, was not associated with either illicit drug use or prescription drug misuse. Moreover, solitary cannabis use was negatively associated with prescription drug misuse in contrast to findings from the recreational cannabis literature whereby solitary cannabis use predicted more problematic drug use (Tucker et al., 2006). Our findings among young adults might suggest that solitary cannabis use potentially served as a proxy indicator of self-reported medical cannabis use since both self-reported medical cannabis use and solitary cannabis use were protective against illicit drug use and prescription drug misuse respectively. Moreover, in another study, medical cannabis use was found to be associated with solitary cannabis use (Roy-Byrne et al., 2015).

A sizable proportion of the overall sample used cannabis to cope with anxiety or depression. However, no significant relationships were found between cannabis use as a means of coping with negative mental health states and other drug use, which suggests that other drugs were not used to self-medicate for mental health problems. While coping motives predicted more problematic substance use in previous research (Hides et al., 2008; Lee et al., 2007), our study revealed that coping motives for cannabis use were not associated with increased probability of drug use other than cannabis.

Ever substituting with cannabis either for prescription or illicit drugs was significant in the bivariate analyses but was not included in the multiple regression model due to a very small number of observations. Overall, we found a relatively low prevalence of substitution unlike other studies conducted within a population of older medical cannabis patients (Nunberg et al., 2011; Reiman, 2009; Reinerman et al., 2011). Interestingly, we found that ever substituting with cannabis was positively associated with other drug use in the bivariate analyses. This finding requires further investigation as to whether substitution with cannabis resulted in the reduction of frequency/amounts of illicit or prescription drugs consumed.

Finally, alternative cannabis forms, e.g., edibles and concentrates, were associated with increased odds of other drug use but in different ways. Illicit drug use was associated with the use of cannabis concentrates, while prescription drug misuse was associated with the use of cannabis edibles. It is a notable finding since no studies have examined these relationships. Given that use of concentrates and edibles can result in higher levels of euphoria or sedation (predictable immediate heightened effect after concentrates use and potentially heightened but postponed effect after edibles use), the association between use of these alternative cannabis forms and other drug use might be explained by possible sensation seeking motivations for use, including novelty and intensity components (Arnett, 1994). Additionally, using cannabis edibles for pain relief (Mikuriya et al., 2007) offers an alternative explanation for the association between cannabis edibles use and prescription drug misuse since this includes misusing prescription pain relievers. Future research should explore the mechanism of the associations between the use of alternative cannabis forms and illicit/prescription drug use, and whether there are any particular differences in those mechanisms between the concentrates and edibles users.

Our findings have important implications for the research community, policy makers and public health practitioners, especially given recent legalization of recreational cannabis in California and the growing number of states where medical and/or recreational cannabis is legal (California Secretary of State, 2016). First, this study contributes to the body of literature on medical and recreational cannabis by focusing on a sample of young adult MCP and NPU and simultaneously examining the role of self-reported medical cannabis use and MCP status on the rates of other drug use. Second, our study revealed associations between the use of cannabis concentrates and edibles and other drug use which adds to already known risks for the use of these alternative cannabis forms reported in the academic literature

(Benjamin and Fossler, 2016; Hall and Degenhardt, 2015) and popular media as well (Cavazos-Rehg et al., 2016). Third, our data indicates that prescription drug misuse and illicit drug use were driven by different sets of factors highlighting distinct profiles of use. Finally, despite reports of much higher substitution rates with cannabis for other substances among older MCP (Grella et al., 2014; Lucas et al., 2016; Reiman, 2009), our results showed much lower substitution rates and its positive association with current other drug use. Therefore, more research is needed to understand how substitution works specifically among young adult MCP and NPU.

This study has several limitations. First, we did not examine a randomly selected sample, therefore, the results might not be generalizable to all young adult cannabis users residing in Los Angeles. Second, given a cross-sectional nature of the data, we were not able to assess causality. Third, data used within this study was based on self-report, and therefore, might be a subject to recall bias. Fourth, sensitive questions assessing illicit drug use and prescription drug misuse could have introduced social desirability bias. However, interviewers made concerted efforts to establish a good rapport with study participants to minimize this type of bias.

## 5. Conclusions

In this sample of cannabis-using young adults, self-reported medical cannabis use (but not MCP status) was associated with lower rates of illicit drug use. Therefore, future studies, especially those focusing on young adults, should consider inclusion of self-reported medical cannabis use as a measure to capture medical use rather than MCP status alone. Additionally, future research should develop standardized measure of self-reported medical cannabis use to ensure comparability between different studies. Finally, alternative cannabis forms, such as cannabis concentrates and edibles (but not frequency of cannabis use) were associated with illicit drug use and prescription drug misuse. Exploratory research is needed to understand the mechanism of these associations by examining similarities and distinct features in the profiles of users of cannabis edibles and concentrates.

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## Contributors

Authors Schragger, Wong, Iverson and Lankenau developed the study design and protocol. Author Fedorova conducted literature review, statistical analysis and wrote the first draft of the manuscript. Authors Schragger and Robinson contributed to statistical analysis and author Cepeda contributed to development of the discussion section. All authors contributed to revisions of the draft and have approved the final manuscript.

## Conflict of interest

No conflict declared.

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