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## A Twitter-based survey on marijuana concentrate use

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### Abstract

**Aims**—The purpose of this paper is to analyze characteristics of marijuana concentrate users, describe patterns and reasons of use, and identify factors associated with daily use of concentrates among U.S.-based cannabis users recruited via a Twitter-based online survey.

**Methods**—An anonymous Web-based survey was conducted in June 2017 with 687 U.S.-based cannabis users recruited via Twitter-based ads. The survey included questions about state of residence, socio-demographic characteristics, and cannabis use including marijuana concentrates. Multiple logistic regression analyses were conducted to identify characteristics associated with lifetime and daily use of marijuana concentrates.

**Results**—Almost 60% of respondents were male, 86% were white, and the mean age was 43.0 years. About 48% reported marijuana concentrate use. After adjusting for multiple testing, significant predictors of concentrate use included: living in “recreational” (AOR=2.04; adj. p=0.042) or “medical, less restrictive” (AOR=1.74; adj. p=0.030) states, being younger

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### Conflict of Interest

All authors declare that there are no conflicts of interest.

### Contributors

R. Daniulaityte, A. Sheth, R. Carlson, R. Nahhas, and S. Martins designed the study. M. Zatreh helped conduct statistical analyses. F. Lamy contributed to design, testing and implementation of the web survey. R. Daniulaityte reviewed the literature, conducted statistical analyses and wrote the first draft of the paper. All authors reviewed, commented, and edited the manuscript. All authors contributed to and have approved the final manuscript.

(AOR=0.97, adj. p=0.008), and daily herbal cannabis use (AOR=2.57, adj. p=0.008). Out of 329 marijuana concentrate users, about 13% (n=44) reported daily/near daily use. Significant predictors of daily concentrate use included: living in recreational states (AOR=3.59, adj. p=0.020) and using concentrates for therapeutic purposes (AOR=4.34, adj. p=0.020).

**Conclusions**—Living in states with more liberal marijuana policies is associated with greater likelihood of marijuana concentrate use and with more frequent use. Characteristics of daily users, in particular, patterns of therapeutic use warrant further research with community-recruited samples.

## Keywords

marijuana concentrates; web survey; Twitter; cannabis; social media; cannabis legalization

## 1. Introduction

In the context of profound changes in cannabis legalization policies taking place across the U.S., research suggests a growing trend of marijuana concentrate use in many parts of the country (Carlini et al., 2017; Daniulaityte et al., 2015; Pacula et al., 2016; Zhang et al., 2016). Marijuana concentrates (also referred to as “extracts,” “dabs,” “wax,” “shatter,” etc.) can be produced using various methods, including solvent, water, CO<sub>2</sub>-based processes (Raber et al., 2015) and the rosin technique that uses pressure and heat to extract THC (Lamy et al., 2017). Such products generally have 60-85% THC content (Russo, 2016), which is significantly greater than cannabis plant material, which typically contains 10-12% THC content (ElSohly et al., 2016). Marijuana concentrates are often consumed using various vaporization devices, such as vape-pens or dabs rigs (Raber et al., 2015).

Use of marijuana concentrates may present increased danger of over-intoxication and experience of adverse reactions (Cavazos-Rehg et al., 2016a), including anxiety and psychotic symptomatology (Hall and Degenhardt, 2009; Keller et al., 2016; Kleiman, 2015; Pierre et al., 2016; Stogner and Miller, 2015), increased risk of developing cyclical vomiting syndrome (Monte et al., 2015), and physical dependence symptoms (Loflin and Earleywine, 2014; Meier, 2017). Legalization of recreational and medical use of cannabis along with growing numbers of marijuana dispensaries are expected to stimulate competition and innovation in production and marketing of various types of cannabis products in order to meet needs of medical users and to increase recreational consumer demands (Carlini et al., 2017; Pacula et al., 2015). There is a need of epidemiological data to assess characteristics of marijuana concentrate use among distinct populations of users and across states with different cannabis legalization policies.

A few prior studies used Web-based recruitment to collect information on marijuana concentrate use in the U.S. One Web-based study used [craigslist.com](http://craigslist.com) to recruit a U.S.-based sample of 357 marijuana concentrate users and found that users viewed concentrates as significantly more dangerous than other forms of cannabis (Loflin and Earleywine, 2014). Another study used Web-based data collected from college students from one university and found that, among past year cannabis users (n = 273), about 44% reported marijuana concentrate use; use of concentrates was associated with dependence symptoms (Meier,

2017). In our prior Web-based study conducted in 2016, we used the [Bluelight.org](http://Bluelight.org) Web forum to recruit a U.S.-based sample of 673 cannabis users; 66% reported concentrate use (Daniulaityte et al., 2017a).

Although prior studies demonstrated the utility of Facebook ads to recruit participants for Web-based surveys (Borodovsky et al., 2016; Lee et al., 2016; Lord et al., 2011), Twitter ads have been less commonly used for on-line recruitment (Guillory et al., 2016). To the best of our knowledge, this is the first study to use Twitter ads for a Web-based survey on cannabis use. Prior studies have shown high levels of Twitter based chatter on cannabis-related topics, including marijuana concentrates (Cavazos-Rehg et al., 2015; Cavazos-Rehg et al., 2016b; Daniulaityte et al., 2017b; Daniulaityte et al., 2015). The aims of the study are to: 1) identify regional (state-level cannabis policy-related), socio-demographic, and drug-related characteristics associated with marijuana concentrate use; 2) describe patterns and reasons of marijuana concentrate use; and 3) identify characteristics associated with daily/near daily concentrate use.

## 2. Methods

The web-survey was conducted in June 6-20, 2017. A Twitter ad was created that included a link to the survey, a project logo and the following text: “Share Your Experiences About Cannabis for Research! Only 2-3 minutes of your time (ages 18+).” The cost of running the ad for the survey time period was \$2,100. Twitter allows creation of a targeted campaign enabling better reach to populations of interest. We set the following targeting parameters: 1) U.S.-based accounts only; 2) English language only; and 3) included additional audience features to target accounts whose tweeting content or searches include cannabis-related keywords (e.g., marijuana; #marijuana; weed; #weed; THC; MMJ; #420; #legalizeit, etc.).

The Web-based survey was developed using Qualtrics (Qualtrics, 2016). It was anonymous (no IP addresses were collected), voluntary, and there was no monetary incentive offered. The Institutional Review Boards at the participating institutions approved the study as “exempt” research due to anonymous, Web-based data collection.

Eligibility criteria included: 1) being 18 years of age or older; and 2) reporting use of any form of cannabis at least once in their lifetime. Individuals who clicked on the survey link were first provided with an online informed consent form and had to click “yes” to indicate their consent to participate in the study before being linked to eligibility questions. Only those who indicated eligibility were linked to the survey questions. To keep respondents from taking this survey more than once, the “Prevent Ballot Box Stuffing” function was enabled in Qualtrics.

A total of 802 respondents clicked “yes” to indicate agreement to participate. 61 respondents who did not complete the survey were removed from the database. Of the remaining 741 respondents, 16 were excluded because they did not meet eligibility criteria (5 indicated age under 18, and 11 reported no lifetime cannabis use). Out of 725 individuals, 31 additional respondents were removed because they were identified as potentially inconsistent respondents (e.g., inconsistent reporting of age). Finally, 7 more cases were removed

because of missing data on state of residence or they did not reside in the U.S., resulting in a final sample of 687 respondents.

To assess if individuals from states with more liberal cannabis policies were not overrepresented in our sample, the proportion of survey respondents from each state was compared to 2017 U.S. Census Population estimates (U. S. Census Bureau, 2017). High correlation (Pearson's  $r=0.92$ ,  $p<0.001$ ) suggests that state representation in our sample was fairly consistent with population proportions across states.

The majority completed the survey in about 3 minutes. The questionnaire used in this study is an abbreviated version of a previous Web-based survey of marijuana concentrate use among cannabis users recruited through the Bluelight Web forum (Daniulaityte et al., 2017a). The survey included questions about use of different types of cannabis products, practices of marijuana concentrate use, socio-demographics and state of residence. Use of marijuana concentrates (dabs/wax/shatter) and other types of cannabis products was assessed using the following question: "Have you ever, even once, used the following types of cannabis products?" Frequency of marijuana concentrate use was assessed: "In the past year, how frequently, on average, have you used [cannabis product]?" Response options included: "Did not use in the past year"; "Less than 1 day per month"; "About 1-2 days per month"; "About 1 day per week"; "About 2-3 days per week"; and "Almost every day or every day." Those who responded "almost every day or every day" were classified as "daily/near daily" users of marijuana concentrates. (For more information about the survey questions, see Daniulaityte et al., 2017a).

Statistical analyses were conducted using SPSS (IBM-Corporation, 2016). Multiple logistic regression analyses were conducted to identify: 1) regional (state-level cannabis policy-related), socio-demographic, and drug use characteristics (age of first cannabis and daily herbal cannabis use) associated with marijuana concentrate use; and 2) regional, socio-demographic, and marijuana concentrate use characteristics associated with daily concentrate use in the past year. Marijuana concentrate use characteristics included the following variables: age at first marijuana concentrate use, reasons of use (therapeutic vs. to get high/experiment only), method of administration (vape-pens vs. other), and involvement in production (ever made own concentrates). Selection of variables for the multiple logistic regression analyses was based on our prior study results (Daniulaityte et al., 2017a). Within each regression model, we adjusted for multiple testing using the Hommel method (Hommel, 1988) to preserve a familywise Type I error rate of 0.05. P-values are reported as "adj. p" to reflect the Hommel adjustment and each can be compared to 0.05 to assess statistical significance. This adjustment was carried out in SAS PROC MULTTEST (SAS Institute Inc., 2012).

To assess potential regional influences, states were classified into 4 groups based on cannabis legalization policies implemented as of May 2017 (Table 1). States with medical marijuana programs were grouped into two categories based on their restrictiveness in terms of access to medical marijuana (Chapman et al., 2016; Williams et al., 2016). In our prior study conducted in the spring of 2016, Florida was included in the "illegal" group (Daniulaityte et al., 2017a). In this study, Florida was reclassified into the "medical, more

restrictive” group because its medical marijuana program went into effect at the end of 2016. Although several other states voted for legalization of recreational marijuana or passed medical marijuana laws in 2016 and the beginning of 2017, only Florida implemented policy changes by the time of this survey.

### 3. Results

#### 3.1. Sample characteristics

Among the sample of 687 respondents, almost 60% were male, over 86% white, and about 85% reported at least some college education or more. The average age was 43.0 (SD 15.7; Table 1). Participants had extensive exposure to different types of cannabis products—herbal/flower (weed/bud) was reported by 99% of respondents, about 85% reported ever using marijuana edibles, and 46% used herbal/flower marijuana on a daily or near daily basis in the past year. Nearly half of the total sample (n=329, 48.1%) reported use of marijuana concentrates at least once in their lifetimes (Table 1). Among marijuana concentrate users, about 65% were male, and almost 60% reported using flower/herbal cannabis (weed/bud) daily or near daily in the past year.

#### 3.1. Factors associated with marijuana concentrate use

Multiple logistic regression analysis results (Table 2) indicate that daily/near daily use of marijuana (flower/herbal) was significantly associated with marijuana concentrate use (AOR (Adjusted Odds Ratio) = 2.57; adj. p=0.008). Living in “Recreational” (vs. “Illegal”) states was also significantly associated with lifetime marijuana concentrate use (AOR=2.04; adj. p=0.042). Living in a “Medical, less restrictive” (vs. “Illegal”) state increased the odds of marijuana concentrate use by over 70% (p=0.030). Older age (continuous variable) was associated with lower odds of concentrate use (AOR=0.97, adj. p=0.008).

#### 3.2 Patterns of marijuana concentrate use

Out of all marijuana concentrate users, 44 individuals (13.4%) reported using marijuana concentrates daily or near daily in the past year. Most respondents indicated that they used marijuana concentrates to get high (62%) and/or to experiment (49%). However, many also reported therapeutic reasons, such as to help sleep (38%), control pain (36%), increase appetite (13%), control nausea (13%), get away from problems (9%), or to help get off other drugs (4%). Overall, about 56% of marijuana concentrate users reported ever using concentrates for therapeutic reasons.

About 66% reported ever using vape-pens to administer marijuana concentrates, 51% reported use of “dabs rigs”, and 13% reported use of a self-made smoking device called “gravity bong” (Daniulaityte et al., 2017a). Some individuals also reported smoking concentrates along with herbal/flower cannabis in a joint (32%) or blunt (19%). About 10% (n=34) reported that they had produced marijuana concentrates on their own, most commonly using the butane extraction (n=15) or “rosin tech” (n=10) methods.

### 3.3. Factors associated with daily use of concentrates

Multiple logistic regression analysis shows that living in a state that allows recreational marijuana use (vs. Illegal) was significantly associated with greater odds of daily concentrate use (AOR=3.59, adj. p=0.020). None of the socio-demographic variables showed statistically significant associations. Use of marijuana concentrates for therapeutic purposes (vs. no therapeutic use) multiplied the odds of daily/near daily concentrate use 4.3 times (adj. p=0.020). Use of vape-pens for marijuana concentrate administration was not significantly associated with daily use, although the positive AOR of 1.38 was consistent with our prior study that identified it as a significant correlate of daily use (Daniulaityte et al., 2017a; Table 2).

## 4. Discussion

The use of marijuana concentrates is an emerging public health issue, and our study provides valuable insights through a sample recruited using Twitter ads. The Twitter-based sample was predominantly male and white, but included a greater proportion of females, and was older than the Web-based sample recruited using [Bluelight.org](http://Bluelight.org) (Daniulaityte et al., 2017a). Almost 50% reported lifetime use of marijuana concentrates; in contrast, about 66% of participants recruited through the [Bluelight.org](http://Bluelight.org) had used concentrates (Daniulaityte et al., 2017a). Since younger age was associated with greater likelihood of marijuana concentrate use, the differences in the prevalence of marijuana concentrate use in the two samples of cannabis users could be related to different age compositions of the two samples. In the future, to capture more diverse population of users, Web-based recruitment should combine Web-forum and Twitter-based strategies along with other social media platforms (Guillory et al., 2016).

Our results show that odds of marijuana concentrate use were greater for those living in the states that have more liberal marijuana policies. Odds of daily/near daily concentrate use were also significantly greater for users in recreational cannabis use states. These findings are consistent with other studies that demonstrated greater marijuana concentrate-related Tweeting activity in states that allow recreational and medical cannabis use (Daniulaityte et al., 2015). The findings are also similar to results of an on-line survey that used Facebook to recruit 2,838 cannabis users and found that participants from states with medical marijuana legalization were more likely to report alternative modes of cannabis administration through vaping and edibles, even after accounting for states with recreational cannabis laws (Borodovsky et al., 2016).

Daily/near daily use of herbal cannabis was also a strong predictor of marijuana concentrate use. More research is needed to understand this association. One plausible explanation is that individuals who use marijuana more frequently are more prone to transition to make such products easier to access and more acceptable for experimentation and use.

Almost 60% of respondents reported ever using marijuana concentrates for therapeutic purposes, most commonly for pain and sleep disturbances. Therapeutic use was also strongly linked with greater likelihood of daily/near daily use of concentrates. Prior research has also noted increased frequency of cannabis use among therapeutic users compared to



non-therapeutic users (Lankenau et al., 2017; Walsh et al., 2013). Another study found a relationship between marijuana concentrate use and a history of mental health diagnoses (Chan et al., 2017). The current study did not assess if therapeutic use of concentrates was authorized by medical providers. Future studies should explore how therapeutic marijuana concentrate users who had medical prescriptions differed from those who engaged in self-treatment.

Although the demographics and prevalence of concentrate use among the Twitter-based sample were somewhat different, compared to the Bluelight Web forum sample, the main study results are fairly consistent across recruitment mechanisms (Daniulaityte et al., 2017a). We acknowledge that the sample was self-selected among people recruited through a Twitter-based ad. Due to the cross-sectional nature of the study, causal direction between variables could not be determined. Use of different recruitment mechanisms for Web-based surveys can introduce participant selection biases that are dependent on the outreach of the recruitment platforms. Although more research is needed to assess how Twitter-based recruitment compares to other types of online recruitment strategies, our experiences of recruiting 687 individuals over 2 week period suggest that Twitter ads offer the possibility to collect a large amount of data over a short time period. Several prior studies have demonstrated the utility of Facebook-based ads in recruiting participants for research on substance use (Barratt and Lenton, 2015; Lee et al., 2016; Ramo and Prochaska, 2012). One prior Twitter-based survey conducted with e-cigarette users and smokers also reported high efficiency in participant recruitment (Guillory et al., 2016). Recruiting participants through social media for online surveys is an emerging practice with many unanswered questions. Where possible, it is important to compare social media survey results with data from nationally representative surveys such as the National Survey on Drug Use and Health (Borodovsky et al., 2016). At present, NSDUH does not collect data on marijuana concentrate use. Future research should compare Web-based survey results through samples recruited via multiple social media sources to identify strengths and weaknesses of each recruitment strategy and platform.

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### Highlights

- 48% of cannabis users reported use of marijuana concentrates.
- 13% of marijuana concentrate users reported daily use of concentrates.
- Lifetime and frequent concentrate use were linked with more liberal cannabis laws.
- Marijuana concentrate use was associated with younger age and daily cannabis use.
- Daily use of concentrates was associated with therapeutic reasons of use.

**Table 1**

## Demographic and Drug Use Characteristics

Characteristic	Total Sample N=687 Number (%)	Marijuana Concentrate Users n=329 Number (%)
<b>Gender</b>		
Male	408 (59.4)	209 (63.5)
Female	262 (38.2)	113 (34.0)
Transgender	7 (1.0)	1 (0.3)
<b>Age</b>		
Mean (SD)	43.0 (15.7)	39.1 (15.5)
<b>Ethnicity</b>		
Hispanic	56 (8.1)	35 (10.6)
Non-Hispanic	598 (87.0)	274 (83.3)
<b>Race</b>		
White/Caucasian	592 (86.2)	270 (82.1)
Non-White	63 (9.2)	57 (17.3)
<b>Education</b>		
Less Than College	90 (13.1)	50 (15.2)
Some College or more	587 (85.4)	273 (83.0)
<b>Lifetime use of cannabis product</b>		
Marijuana concentrates/dabs	329 (48.1)	329 (100)
Herbal/flower marijuana (weed/bud)	680 (99.0)	328 (99.7)
Resin/hashish	500 (73.1)	272 (82.7)
Kief/keef	373 (54.8)	260 (79.0)
Marijuana edibles	582 (84.8)	316 (96.0)
Cannabis tinctures	161 (23.7)	105 (31.9)
Ingestible oil (e.g. Rick Simpson oil)	199 (29.2)	133 (40.4)
CBD oil	205 (30.1)	138 (41.9)
<b>Characteristics of cannabis use</b>		
Daily/near daily use of flower/herbal cannabis	316 (46.0)	196 (59.6)
Age of first cannabis use, Mean (SD)	17.8 (6.6)	17.1 (5.1)
<b>States of Residence by Marijuana Legalization</b>		
Recreational <sup>1</sup>	83 (12.1)	48 (14.6)
Medical, Less Restrictive <sup>2</sup>	187 (27.2)	102 (31.0)
Medical, More Restrictive <sup>3</sup>	128 (18.6)	58 (17.6)
Illegal <sup>4</sup>	289 (42.1)	121 (36.8)

<sup>1</sup>Recreational group included 5 states: AK, CO, OR, WA, and DC<sup>2</sup>Medical, less restrictive group includes 11 states: AZ, CA, HI, IL, MA, MI, ME, MT, NM, NV, RI

<sup>3</sup>Medical, more restrictive includes 9 states: CT, DE, FL, MD, MN, NH, NJ, NY, VT

<sup>4</sup>“Illegal” group included 26 states: AL, AR, GA, IA, ID, IN, KS, KY, LA, MO, MS, NC, NE, ND, OH, OK, PA, SC, SD, TN, TX, UT, VA, WV, WI, WY.

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**Table 2**

Multiple Logistic Regression Analyses

<b>A: Adjusted Odds Ratios (AOR) for Predictors of Marijuana Concentrate Use<sup>1</sup></b>			
<b>Variables</b>	<b>AOR</b>	<b>95% CI</b>	<b>Adj. P<sup>3</sup></b>
<b>State Cannabis Laws</b>			
Recreational (vs. Illegal)	2.038	1.212 – 3.427	0.042 *
Medical, less restrictive (vs. Illegal)	1.744	1.187 – 2.565	0.030 *
Medical, more restrictive (vs. Illegal)	1.066	.697 – 1.631	0.822
<b>Socio-demographic characteristics</b>			
Age	0.967	0.956 – 0.979	0.008 *
Gender (Males vs. Female/Transgender)	1.425	1.001 – 2.029	0.196
Race/Ethnicity (White, Non-Hispan. vs. Other)	1.522	0.978 – 2.369	0.252
Education (Some College vs. Less)	0.943	0.563 – 1.577	0.822
<b>Characteristics of Marijuana Use</b>			
Daily/Near Daily Use of Marijuana	2.570	1.817 – 3.634	0.008 *
Age of initiation of marijuana use	0.987	0.960 – 1.015	0.822

<b>B: Adjusted Odds Ratios (AOR) for Predictors of Daily/Near Daily Marijuana Concentrate Use<sup>2</sup></b>			
<b>Variables</b>	<b>AOR</b>	<b>95% CI</b>	<b>Adj. P<sup>3</sup></b>
<b>State Cannabis Laws</b>			
Recreational (vs. Illegal)	3.588	1.570 – 8.203	0.020 *
Medical, less restrictive (vs. Illegal)	1.718	0.789 – 3.742	0.784
Medical, more restrictive (vs. Illegal)	0.863	0.301 – 2.474	0.784
<b>Socio-demographic Information</b>			
Age	1.016	0.950 – 1.086	0.784
Gender (Males vs. Female/Transgender)	1.139	0.521 – 2.490	0.784
Race/Ethnicity (White, Non-Hisp. vs. Other)	1.325	0.569 – 3.087	0.784
Education (Some College vs. Less)	0.393	0.106 – 1.463	0.784
<b>Characteristics of Marijuana Concentrate Use</b>			
Vape Pen Use to Administer Concentrates	1.380	0.598 – 3.181	0.784
Concentrate Use for Therapeutic Purposes	4.336	1.686 – 11.150	0.020 *
Age at First Marijuana Concentrate Use	1.013	0.947 – 1.084	0.784
Ever Produced Marijuana Concentrates	3.317	1.328 – 8.288	0.090

<sup>1</sup>Hosmer and Lemeshow Test: Chi-square=13.2, df (8), p=0.105; out of total sample of 687, 624 were included in the analysis; 63 cases were excluded because of missing values; out of 624 cases, 324 had used marijuana concentrates.

<sup>2</sup>Hosmer and Lemeshow Test: Chi-square=8.5, df (8), p=0.390; out of total sample of 329 marijuana concentrate users, 314 were included in the analysis; 15 were excluded because of missing values; out of 314 included cases, 40 reported daily concentrate use.

<sup>3</sup>P-values are adjusted for multiple testing using the Hommel (1988) method and may each be compared to .05.

\* Indicates statistical significance after adjustment.

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