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"Time for dabs": Analyzing Twitter data on marijuana concentrates across the U.S.

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Abstract

Aims—Media reports suggest increasing popularity of marijuana concentrates ("dabs"; "earwax"; "budder"; "shatter; "butane hash oil") that are typically vaporized and inhaled via a bong, vaporizer or electronic cigarette. However, data on the epidemiology of marijuana concentrate use remain limited. This study aims to explore Twitter data on marijuana concentrate use in the U.S. and identify differences across regions of the country with varying cannabis legalization policies.

Methods—Tweets were collected between October 20 and December 20, 2014, using Twitter's streaming API. Twitter data filtering framework was available through the eDrugTrends platform. Raw and adjusted percentages of dabs-related tweets per state were calculated. A permutation test was used to examine differences in the adjusted percentages of dabs-related tweets among U.S. states with different cannabis legalization policies.

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Conflict of Interest. All authors declare that there are no conflicts of interest.

Results—eDrugTrends collected a total of 125,255 tweets. Almost 22% (n=27,018) of these tweets contained identifiable state-level geolocation information. Dabs-related tweet volume for each state was adjusted using a general sample of tweets to account for different levels of overall tweeting activity for each state. Adjusted percentages of dabs-related tweets were highest in states that allowed recreational and/or medicinal cannabis use and lowest in states that have not passed medical cannabis use laws. The differences were statistically significant.

Conclusions—Twitter data suggest greater popularity of dabs in the states that legalized recreational and/or medical use of cannabis. The study provides new information on the epidemiology of marijuana concentrate use and contributes to the emerging field of social media analysis for drug abuse research.

Keywords

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

1. INTRODUCTION

In the context of the changing legislative landscape of cannabis use (National Conference of State Legislatures; NCSL, 2015), law enforcement and popular media reports suggest a growing trend across the country of manufacture and use of marijuana concentrates (Healy, 2015; Drug Enforcement Administration; DEA, 2014a; Carson, 2013;). Marijuana concentrates are highly potent tetrahydrocannabinol (THC) preparations derived from marijuana plant material. Although marijuana concentrates, or hash oil, have been available for centuries, recent increases in the U.S. are associated with advanced methods to obtain high-level THC extractions (DEA, 2014a,b). Although many methods can be used to convert flower cannabis into concentrates, the solvent-based method that uses butane to extract THC is one of the more commonly used (DEA, 2014a,b). Once converted to concentrates, such products are commonly referred to as “dabs,” “hash oil,” “shatter,” “budder,” or “earwax.” In Colorado and Washington, marijuana concentrates can be obtained legally from licensed retailers and producers. Qualified patients can also obtain marijuana concentrates at some medical marijuana dispensaries. However, in many parts of the country, there has been an increase in explosions and injuries resulting from home-based operations to produce marijuana concentrates using butane gas (DEA 2014a).

Marijuana concentrates produced using solvent-based methods typically contain very high THC levels that can exceed 80% (DEA, 2014b). Most commonly, they are vaporized and inhaled via a bong, oil pipe, vaporizer or electronic cigarette (Loflin and Earleywine, 2014; DEA, 2014b). Because of the increased THC concentration and novel means of administration, use of “dabs” might lead to more severe psychological and physical problems, (Moore et al., 2007; Hall and Degenhardt, 2009; Degenhardt et al., 2013). Prior research has suggested that use of high potency cannabis may increase the risk of cannabis dependence (Hall and Degenhardt, 2015), first-episode psychosis (Di Forti et al., 2014, 2015), and contribute to the cognitive skills impairment (Ramaekers et al., 2006).

Although mainstream media reports about marijuana concentrate use in the U.S. have been increasing (Kim, 2013; Denson, 2014; Wyatt and Johnson, 2015; Healy, 2015; Associated

Press, 2015), research on its use remains very limited. A recent web-based study that recruited 357 participants via craigslist found that users viewed dabs to be more dangerous than flower cannabis and reported an increase in tolerance and withdrawal symptoms as a result of using dabs (Loflin and Earleywine, 2014). Overall, there is a lack of epidemiological data on regional differences in marijuana concentrate use because current surveillance systems do not systematically track use of marijuana concentrates apart from general cannabis consumption (SAMHSA, 2014).

There is a growing recognition that Twitter data can be highly useful for public health surveillance (Bartlett and Wurtz, 2013; Burke-Garcia and Scally, 2014; Jashinsky et al., 2014). Emerging research also suggests its utility in tracking drug abuse trends, including Twitter-based studies that focused on problem drinking (Joshua et al., 2012), and nonmedical use of Adderall among college students (Hanson et al., 2013). Prior research has also used a commercial social media analytics company to examine cannabis-related tweets, and found that the majority of tweets expressed pro-marijuana sentiment, and involved a greater proportion of African Americans and young individuals compared with the Twitter average (Cavazos-Rehg et al., 2014, 2015).

Currently, Twitter reports 302 million monthly active users that generate over 500 million tweets per day (Twitter, 2015). Twitter use is more common among young adults (Kim et al., 2013), an age group that also displays the highest rates of cannabis and other substance use (SAMHSA, 2014). Although tweets are limited to 140 characters and thus contain very brief information, because of the volume of data generated by Twitter users, analysis of tweets can provide valuable population-level metrics. The study aims to explore tweets related to marijuana concentrates (“dabs”) and identify differences across regions with varying cannabis legalization policies.

2. METHODS

Tweets were collected using Twitter's streaming API that provides free access to 1% of all tweets (Twitter, 2014). However, with a limited number of keywords, all or most relevant tweets can be collected since such content will be far less than 1% of overall tweet volume (Morstatter et al., 2013). A Twitter data filtering and aggregation framework was available through the eDrugTrends system (eDrugTrends, 2015), which adapts the social media analysis capabilities of the Twitris platform (Sheth et al., 2013). Data were collected between October 20 and December 20, 2014. Data collection was limited to English language content. The Wright State University IRB reviewed the protocol and determined that it met the criteria for Human Subjects Research exemption 4 because it is limited to publicly available tweets. To protect the anonymity of tweeters, no individual screen names of Twitter users are included in any reports or publications. Global Positioning System (GPS) coordinates were converted into state-level geo-information and analyzed in the aggregate form.

The following keywords were used to collect tweets: “dabs”; “hash oil”; “butane honey oil”; “smoke/smoking shatter”; “smoke/smoking budder”; “smoke/smoking concentrates.” Selected keywords were pre-tested to assure that they collected relevant information.

Several keywords were modified (e.g., adding “smoke/smoking” to “shatter,” “concentrates,” and “budder”) and/or removed (e.g., “BHO”) after determining that they generated irrelevant data. Keywords “earwax marijuana” and “marijuana BHO” generated no tweets.

Geolocation information of tweets was processed by the eDrugTrends/Twitris platform (Sheth et al., 2013). Twitter users may indicate geolocation information in their user profiles, or enable their tweets to contain GPS coordinates via a mobile phone that supports the feature. Tweets that contained geolocation information indicating a state in the U.S. were extracted for further analysis.

To adjust for the different level of tweeting activity in each state, we generated a general sample of tweets. This general sample was collected over an 8-day period and consisted of the default random sample of 1% of all tweets provided by the Twitter Application Programming Interface (API). The general sample was processed using eDrugTrends to extract tweets that contained identifiable state-level geolocation information (N=209,837) (Table 1).

First, raw state-level percentages of dabs-related tweets were computed. Next, adjusted percentages were calculated using general sample rates to account for different levels of tweeting activity in each state. In particular, for each state, we computed the ratio of the proportion of dabs tweets within a particular state to the proportion of general sample of tweets. These ratios were then rescaled by dividing each by the sum of ratios across states and multiplying by 100, resulting in adjusted state-specific percentages of dabs tweets.

A permutation test with 10,000 replications was performed using R (R Core Team, 2014) to examine differences in the adjusted percentages of dabs-related tweets among U.S. states with different cannabis legalization policies. We tested the null hypothesis of no difference between adjusted percentages across legal status, with pairwise comparisons between legal statuses adjusted for multiple comparisons using the Holm-Bonferroni procedure (Holm, 1979).

States’ legal statuses were classified as follows: 1) *“Status 1”* includes 2 states that passed laws legalizing medical and recreational use of cannabis prior to January 2015 (CO, WA); 2) *“Status 2”* includes 21 states and the District of Columbia that have legalized medical but not recreational use of cannabis (AK, AZ, CA, CT, DC, DE, HI, IL, MD, ME, MA, MI, MN, MT, NY, NV, NH, NJ, NM, OR, RI, VT); 3) “Status 3” includes 27 states that had not yet passed medical cannabis laws (AL, AR, FL, GA, ID, IN, IA, KS, KY, LA, MS, MO, NE, NC, ND, OH, OK, PA, SC, SD, TN, TX, UT, VA, WV, WI, WY). Although Alaska, Oregon, and the District of Columbia voted in November 2014 for legalization of recreational cannabis, these laws were not scheduled to become effective until 2015. Thus, they were classified as *Status 2*.

3. RESULTS

Over a two-month period, eDrugTrends collected a total sample of 125,255 tweets. Keyword “dabs” produced 121,061 tweets, which comprised over 99% of the total sample (e.g., “Dabs

on Dabs on Dabs;" "I just need a cute girl to take dabs with me and get stoned together"). "Hash oil" generated 3,671 tweets ("I smoked some hash oil. Im buzzin like crazy"). Other keywords were much less commonly used on Twitter: "Smoke/smoking shatter" produced 488 tweets ("Had some vivid ass dreams last night after smoking almost a full gram of shatter"); "Smoke/smoking budder" produced 50 tweets ("I swear after smoking budder for so long, smoking weed is a foreign concept"); "Smoke/smoking concentrates" ("People that smoke concentrates are whack, flower power") identified 84 tweets; and "butane honey oil" generated 35 tweets ("I like the butane honey oil lol").

Out of a total sample of 125,255 tweets, 22% (n=27,018) contained state-level geolocation information. These 27,018 tweets were posted by 15,897 unique users. Raw counts of dabs-related tweets were the highest in California, Texas, Florida, and New York (Table 1), which are also the most populous states. However, after adjusting for the different levels of Twitter use for each state based on the *general* sample of tweets, Oregon, Colorado, and Washington had the highest proportions of dabs-related tweets, while Mississippi and Alabama had the lowest (Table 1).

We found statistically significant differences in the average adjusted proportion of dabs tweets between states with different legal status. The average adjusted proportion of dabs-related tweets for Status 1 states was 5.1%, for Status 2 states 2.3%, and for Status 3 states 1.4%. After adjusting for multiple comparisons, all three pairwise differences were significantly different from 0 ($p<0.05$). As seen from the map that displays regional differences in the adjusted percentages of dabs-related tweets (Figure 1), rates appear to be greater in the Western part than in the Eastern part of the U.S.

4. DISCUSSION

The analysis of Twitter data demonstrates that the average adjusted percentages of dabs-related tweets were significantly greater in states with recreational and/or medical marijuana laws. Oregon, Colorado, and Washington had the highest rates, compared to other states. Although epidemiological data on marijuana concentrate use are lacking, our Twitter-based findings are consistent with the DEA report suggesting that marijuana concentrate production labs are more common on the West Coast and in the states with more relaxed marijuana laws (DEA, 2014a).

Colorado and Washington were the first states to legalize recreational cannabis use and have established booming commercial markets of cannabis products, including marijuana concentrates (Marijuana Policy Group, 2014; Kleiman, 2015). Interestingly, a web-based survey of cannabis users (N=1,659) that was conducted in Washington state in the year prior to legalization of recreational marijuana use, found that "dabbing" was quite common, with about 47% of surveyed cannabis users reporting past year use of dabs (Beau et al., 2013). Colorado law allows home-based production of concentrates, but due to increased injuries and explosions, is now considering a ban on home-based operations that use butane and other hazardous materials to manufacture marijuana concentrates (Colorado General Assembly, 2015).

Although Oregon has just passed laws allowing recreational cannabis use that are to become operational in 2015, it has one of the oldest medical marijuana programs in the U.S., and a growing medical marijuana dispensary system (Oregon Health Authority, 2015). Oregon also has one of the highest rates of marijuana use in the country, with over 19% of individuals reporting past year marijuana use, compared to average U.S. rate of 12.3% (SAMHSA, 2014). Overall, greater popularity of dabbing in Oregon, and other states that allow medical marijuana use, could be partially related to the emergence of vaporizer use being perceived as a safer and more therapeutically beneficial alternative to smoking among medical marijuana patients (Abrams et al., 2007; Earleywine and Barnwell, 2007). Furthermore, prior research suggested that the emerging trend of “dabbing” is linked to recent increases in the availability of marijuana concentrates at medical marijuana dispensaries (Loflin and Earleywine, 2014).

Regional differences in dabs-related tweets could be partially related to greater acceptance of cannabis use in states that allow medical and/or recreational use. In addition, production of marijuana concentrates requires access to large amounts of plant material. Although the ratio may vary from producer to producer, an ounce of plant material can generally yield only a few grams of dabs (Colorado Pot Guide, 2015). Easier access to the quantities of raw material needed to produce marijuana concentrates might be one of the reasons for potentially greater popularity of dabs in the states that allow medical and/or recreational cannabis use compared to states where marijuana use is illegal.

Our results also show greater dabs-related tweeting activity in the Western part of the country (Figure 1). Potentially, these differences might be at least partially related to the fact that medical marijuana laws in the western states were passed in the late 90s-early 2000s, while in most of the medical marijuana states on the East Coast, such laws came into effect in 2010-2014 (NCSL, 2015).

Interpretation of the study findings should take into account several limitations. First, our results are limited to English language content. Second, lack of demographic information presents another limitation, which is inherent to most social media studies. Third, the findings from the study should be interpreted with caution given known and not yet fully understood characteristics and behaviors of Twitter users. For example, it is known that Twitter users are more likely to be young adults, and thus our findings may be more reflective of drug use behaviors among younger than older age groups. Also, it is not known if there are clear differences between those who choose to identify their geolocation and those who do not, which might contribute to additional limitations when comparing regional differences. In addition, we do not know the characteristics of people who tweeted in terms of medical versus recreational use. It is also likely that regional differences in dabs-related tweets might be partially related to the fact that users living in states with more liberal cannabis policies might feel less restricted to publically acknowledge their use than individuals in states where cannabis use is illegal. Finally, selection of keywords and information extraction techniques might have contributed to additional limitations. Some relevant keywords (wax, BHO) had to be excluded because they generated high numbers of irrelevant tweets. Improvement of information extraction techniques and disambiguation will help address such limitations in the future research.

The study contributes new information on the emerging trend of "dabbing," a form of marijuana concentrate, which may carry significant health consequences and risks. In the context of shifting cannabis legalization policies, active monitoring is needed to identify emerging issues and trends, and to inform timely prevention and policy measures. Our present study demonstrates that Twitter can be of particular value in detection of emerging drug use practices that are difficult to capture using traditional epidemiological surveillance methods. Twitter data collection and processing can be much more rapid, compared to traditional survey methods. Further development of information extraction methods will help conduct more powerful, in-depth analyses of Twitter data for drug abuse epidemiology research. Additional studies using community-recruited samples and web-based surveys are also needed to corroborate Twitter findings and to better understand this emerging trend. Considering the potential adverse effects inherent in these concentrated forms of cannabis use (Hall and Degenhardt, 2015; Kleiman, 2015), gaining new insights on this emerging trend would help to better inform users, practitioners and policy makers.

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Highlights

- This study is among the first to focus on the emerging trend of “dabbing” in the U.S.
- The paper reports results of our innovative, interdisciplinary research collaboration to develop eDrugTrends platform for the analysis of Twitter data for drug abuse epidemiology research.
- The study found statistically significant differences in the adjusted percentages of dabs-related tweets across states with different cannabis legalization policies. Average adjusted percentages were the highest in the states that allow recreational cannabis use, and the lowest in the states where any cannabis use is illegal.
- The study is significant because it contributes to the emerging field of social media research and highlights the utility of Twitter data in tracking emerging drug use practices and trends.

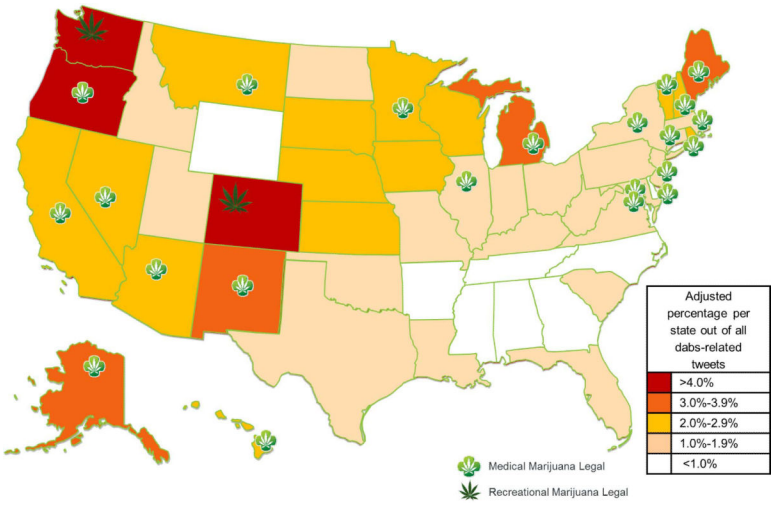

Figure 1.

U.S. Map of Regional Differences in Adjusted Percentages of Dabs-Related Tweets per State

Table 1

Ranking of States by Percentage of Tweets in General and Dabs-Related Samples.

Rank Order	General Sample of Tweets (N=209,837)		Dabs-Related Sample of Tweets (N=27,018)			
	Percentage of General Sample of Tweets per State		Raw Percentage of Dabs-Related Tweets per State		Adjusted Percentage of Dabs-Related Tweets per State	
1	CA	13.6	CA	20.6	OR	6.4
2	NY	10.2	TX	8.4	CO	6.2
3	TX	10.0	FL	6.3	WA	4.0
4	FL	6.6	NY	6.0	MI	3.5
5	IL	4.2	MI	5.2	AK	3.4
6	GA	3.9	CO	5.0	NM	3.2
7	PA	3.5	WA	4.1	ME	3.1
8	OH	3.1	OR	3.4	NV	2.9
9	MI	2.8	IL	3.1	CA	2.9
10	NC	2.7	PA	2.8	SD	2.8
11	NJ	2.3	OH	2.8	AZ	2.7
12	MA	2.3	AZ	2.6	MN	2.6
13	MO	2.0	NV	2.3	HI	2.5
14	VA	2.0	MA	2.1	KS	2.4
15	TN	2.0	NJ	1.8	NE	2.3
16	LA	1.9	MN	1.7	IA	2.3
17	WA	1.9	GA	1.6	RI	2.1
18	AZ	1.8	LA	1.5	MT	2.1
19	MD	1.8	MD	1.5	VT	2.0
20	DC	1.5	MO	1.3	WI	2.0
21	CO	1.5	NC	1.2	NH	2.0
22	KY	1.5	WI	1.2	FL	1.8
23	NV	1.5	VA	1.2	ND	1.8
24	AL	1.4	IN	0.9	UT	1.7
25	IN	1.3	KS	0.9	OH	1.7
26	MN	1.2	KY	0.8	MA	1.7
27	WI	1.1	DC	0.8	TX	1.6
28	OR	1.0	TN	0.8	MD	1.5
29	SC	1.0	SC	0.7	PA	1.5
30	CT	0.8	IA	0.7	CT	1.4
31	OK	0.8	CT	0.6	NJ	1.4
32	KS	0.7	NE	0.6	LA	1.4
33	WV	0.6	NM	0.6	IL	1.4
34	AR	0.5	UT	0.5	SC	1.4
35	UT	0.5	ME	0.5	IN	1.3

Rank Order	General Sample of Tweets (N=209,837)		Dabs-Related Sample of Tweets (N=27,018)			
	Percentage of General Sample of Tweets per State		Raw Percentage of Dabs-Related Tweets per State		Adjusted Percentage of Dabs-Related Tweets per State	
36	IA	0.5	OK	0.5	WV	1.3
37	NE	0.5	AK	0.4	MO	1.2
38	RI	0.4	RI	0.4	ID	1.1
39	MS	0.3	AL	0.4	VA	1.1
40	NM	0.3	WV	0.4	OK	1.1
41	ME	0.3	HI	0.4	NY	1.1
42	HI	0.3	AR	0.2	KY	1.1
43	WY	0.3	NH	0.2	DC	1.0
44	AK	0.2	MT	0.2	WY	0.9
45	ID	0.2	SD	0.2	NC	0.8
46	DE	0.2	ID	0.1	AR	0.8
47	NH	0.2	VT	0.1	GA	0.8
48	MT	0.2	WY	0.1	TN	0.7
49	VT	0.1	ND	0.1	DE	0.7
50	ND	0.1	MS	0.1	AL	0.6
51	SD	0.1	DE	0.1	MS	0.5