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A content analysis of tweets about high-potency marijuana

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Abstract

Introduction—“Dabbing” involves heating extremely concentrated forms of marijuana to high temperatures and inhaling the resulting vapor. We studied themes describing the consequences of using highly concentrated marijuana by examining the dabbing-related content on Twitter.

Methods—Tweets containing dabbing-related keywords were collected from 1/1 – 1/31/2015 (n = 206,854). A random sample of 5,000 tweets was coded for content according to predetermined categories about dabbing-related behaviors and effects experienced using a crowdsourcing service. An examination of tweets from the full sample about respiratory effects and passing out was then conducted by selecting tweets with relevant keywords.

Results—Among the 5,000 randomly sampled tweets, 3,540 (71%) were related to dabbing marijuana concentrates. The most common themes included mentioning current use of concentrates (n= 849; 24%), the intense high and/or extreme effects from dabbing (n = 763; 22%) and excessive/heavy dabbing (n = 517; 15%). Extreme effects included both physiological (n = 124/333; 37%) and psychological effects (n = 55/333; 17%). The most common physiologic effects, passing out (n=46/333; 14%) and respiratory effects (n=30/333; 9%), were then further studied in the full sample of tweets. Coughing was the most common respiratory effect mentioned (n=807/1179; 68%), and tweeters commonly expressed dabbing with intentions to pass out (416/915; 45%).

Conclusions—This study adds to the limited understanding of marijuana concentrates and highlights self-reported physical and psychological effects from this type of marijuana use. Future

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Contributors

Dr. Cavazos-Rehg led the acquisition of the data, analyses, interpretation of results and manuscript writing, as well as provided mentoring on all aspects of the project. Ms. Sowles participated in data analysis, interpretation of results, and drafting of the manuscript. Ms. Krauss led the data analysis and interpretation of results, as well as assisted in drafting the manuscript. Ms. Agbonavbare participated in data analysis and drafting of the manuscript. Drs. Bierut and Grucza contributed to interpretation of results and critical revisions to the manuscript.

Conflict of Interest

One of the authors, Dr. Bierut, is listed as an inventor on Issued U.S. Patent 8, 080, 371, “Markers for Addiction,” covering the use of certain SNPs in determining the diagnosis, prognosis, and treatment of addiction. All other authors declare they have no conflicts of interest.

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research should further examine these effects and the potential severity of health consequences associated with concentrates.

Keywords

social media; Twitter; marijuana smoking; cannabis; marijuana concentrates

1. INTRODUCTION

Marijuana concentrates (i.e., herein referred to as “concentrates”) contain “extraordinarily high” levels of *delta-9-tetrahydrocannabinol* (THC; the main psychoactive ingredient in marijuana) reaching up to 80% (Mehmedic et al., 2010; Stogner and Miller, 2015). This is extremely high in comparison to plant-based forms of marijuana which average around 12% THC (Mehmedic et al., 2010). Consequently, the “high” experienced from use of concentrates is quicker and more intense. As the emergence of legal, regulated markets continues in the U.S., it is likely that accessibility and use of concentrates will gain traction. Furthermore, given states’ power to regulate commercial availability of this method of marijuana ingestion, research on concentrates is timely.

The consequences of using highly concentrated forms of marijuana are relatively unknown. In the only self-report study to investigate perceptions of concentrate users, Loflin and Earleywine (2014) used a web-based survey and found the use of concentrates was associated with perceived higher tolerance and withdrawal symptoms, which has potential implications for addiction. It has been suggested that use of concentrates has many acute side effects, such as rapid heartbeat, blackouts, paranoia and hallucinations, but further research is needed to confirm these “extreme” effects (John, 2015; Stogner and Miller, 2015). One method of consuming concentrates is by dabbing, which involves heating the concentrate to high temperatures and inhaling the resulting vapor (Stogner and Miller, 2015). In their commentary, Stogner and Miller (2015) encourage health care professionals to educate their marijuana-using patients about the potential harms related to the use of a stronger substance, and that concentrates may not be as safe as traditional plant-based marijuana use.

Previous studies have demonstrated that Twitter is a popular venue where substance use behaviors are openly discussed, and researchers have accordingly used Twitter data for substance use epidemiology research (Alvaro et al., 2015; Cavazos-Rehg et al., 2015a; Cole-Lewis et al., 2015; Hanson et al., 2013; Jo et al., 2015; Lamy et al., 2016; Myslin et al., 2013; Thompson et al., 2015; van der Tempel et al., 2016). Additionally, Daniulaityte et al., (2015) identified a greater prevalence of dabbing-related tweets among states that allowed recreational and/or medicinal marijuana use versus states where use is still illegal; this study is informative for potential surveillance of dabbing. Still, the content of such tweets was not examined but such a study could help increase knowledge about what individuals are discussing when socially networking with others about dabbing.

In consideration of the limited scope of research about dabbing, the present study examines the content of tweets about dabbing. Our study has two components. First, we broadly study the range of tweets about dabbing to identify the most prevalent topics about dabbing that

are discussed on this platform. Then, we hone in on investigating the content of tweets that are specific to the intense high and/or extreme effects of dabbing to delineate the key themes discussed on Twitter regarding the details of having such an experience from dabbing. We believe that surveillance of this type can be helpful for garnering novel insight into the perspectives of and experiences with high-potency marijuana, which is increasing in popularity but remains a largely understudied behavior that appears to be qualitatively different from ingesting plant-based forms of marijuana.

2. METHOD

A schematic depicting the overall process used to collect and code tweets related to dabbing concentrates is found in Figure 1.

2.1. Collecting dabbing-related tweets

In order to collect tweets relevant to our subject of interest, a list of dabbing-related keywords was developed. First, we examined the existing scientific literature and popular marijuana-centric media outlets (i.e., HighTimes Magazine) on dabbing (Loflin and Earleywine, 2014; Schneberk et al., 2014; Stogner and Miller, 2015). Then, we verified the popularity of keywords on Topsy.com, an online analytics tool that provides the number of tweets with specific keywords up to the past 30 days and a sample of tweets containing each term, which we reviewed to determine our inclusion or exclusion criteria.

We collected all tweets in the English language with the keywords in Table 1 from January 1 to January 31, 2015 using GNIP, a social media company that provides complete access to the Twitter “firehose”, or 100% of the tweets sent via one application program interface (<https://gnip.com/>). Once collected, a random sample of tweets was reviewed for additional cleaning. For example, we found that the term “dab” was often used as a slang adverb to describe extreme or intense feelings (e.g., “getting annoyed dab”, “I’m bored dab”). We then used the index function in SAS version 9.4 (SAS Institute, Inc., Cary, NC) to search for tweets with specific terms (e.g., “annoyed dab”, “bored dab”, “cold dab”, “hungry dab”) to remove from the volume of tweets. This resulted in full sample of 206,854 total tweets.

2.2. Content analysis of tweets

In order to examine the content of tweets with our keywords of interest, we first took a random sample of 5,000 tweets from the 206,854 tweets using SAS proc surveyselect (SAS Institute, Inc, Cary, NC). Relevant and recurrent themes were then identified and coded as described below.

2.2.1. Identifying themes—A subset of tweets was examined to inductively identify common themes in the tweets (Neuendorf, 2002). Two members of the research team (PCR and MK) independently reviewed and subsequently discussed batches of 25–50 tweets (total = 300 tweets) in order to identify common, recurrent themes that would then be coded on the full sample of 5,000 tweets. Based on this a codebook was developed, and a content analysis was conducted on the full sample of tweets using the pre-determined categories. Because dabbing terminology could be used in reference to things other than marijuana (e.g., dabbing

makeup, a pop culture dance), it must first be determined whether the tweet is actually about dabbing concentrates. Tweets about dabbing were then coded for these themes: 1) currently dabbing concentrates, wanting/planning to dab, or having dabbled in the recent past, 2) describing a first experience with dabbing concentrates, 3) mentioning that dabbing concentrates aids in relaxation, sleep, or solving problems, 4) heavy or excessive dabbing, which was interpreted from the individual's "subjective" description of the dab (i.e., "*fat*" *dab*) or via a numerical value provided within the tweet (i.e., *ingesting 1 gram of concentrate or more in one dabbing session*), 5) describing the intense or extreme effects following dabbing, 6) mentioning other forms of marijuana and other substances (e.g., alcohol, other drugs) (tweets about concomitant use of substances were later coded by research team members PCR and MK), and 7) an advertisement or promotion of dabbing products. Some tweets contained one or more themes, and coders were instructed to tabulate every theme that was observed within a tweet, even those that were overlapping.

2.2.2. Coding the tweets—As in our prior twitter studies (Cavazos-Rehg et al., 2015a; Cavazos-Rehg et al., 2015b; Krauss et al., 2015a), we used CrowdFlower as the platform for accessing an online crowdsourcing workforce (www.crowdfLOWER.com) for the bulk of coding. The cost for completion of the current study was \$653.47 plus a monthly subscription cost of \$850.00 to access Crowdflower's services for multiple projects including the present study. The sample of tweets along with instructions for coding the themes, including example tweets, was uploaded to the CrowdFlower platform. A chosen set of 200 tweets was coded by research team members (MK, SS, KZ); each tweet was first coded by one team member and then the assigned codes were reviewed another team member. Any discrepancies were discussed and resolved using the third research team member when needed. These tweets were used as test items for CrowdFlower workers. Prior to commencing their coding, each Crowdflower coder was provided with a set of instructions, a detailed description of dabbing, synonyms of dabbing (i.e., wax, shatter, oil, concentrates), and popular key words associated with dabbing (i.e., rig nail, dome, wand/dabber, e-nail). Upon reading these instructions, coders were next provided with a series of 10 test tweets for which they must first score at least 80% before beginning to code the rest of the tweets. Additional test items were hidden and interspersed throughout the job in order to track the worker's coding quality. If a worker's score on test items fell below 80%, they were removed from the job, their assigned codes were cleared, and they were replaced by a new coder. Of 422 workers who attempted to work on the job, 122 (30%) maintained a score of 80% on test items throughout the job. The average score on test items among those who remained in the job was 89%.

At least three CrowdFlower workers coded each tweet (93.5% of tweets were coded by three workers, 6.5% were coded by four workers). The final response used for the presence/absence of each theme in each tweet was the response with the highest confidence score. The confidence score is the level of agreement between coders, is weighted by the worker's score on test items, and indicates "confidence" in the validity of the response (<https://success.crowdfLOWER.com/hc/en-us/articles/201855939-Get-Results-How-to-Calculate-a-Confidence-Score>). In order to further test the reliability of results from CrowdFlower workers, we compared responses coded by a member of the research team on a total of 350

randomly sampled tweets that were not used as test items versus final responses on these tweets from CrowdFlower contributors. Originally beginning with a sample of 200 tweets coded for reliability, this random sample was increased to 350 tweets so that informational adequacy could be achieved for the least commonly coded theme, based on an acceptable Krippendorff's alpha of 0.667 and level of significance of $p=0.05$ (Krippendorff, 2011). Inter-rater reliability results are presented in section A of Table 2.

2.2.3. Coding specific extreme effects from dabbing—We also examined the content of tweets that described the intense or extreme effects from dabbing to code the specific effects that were mentioned. For this sub-analysis, we excluded any tweets that used humorous images/videos given the difficulty to discern the specific effects being portrayed (other than an extreme high). Among the remaining tweets, two members of the research team separately coded each tweet for the presence of these themes: 1) physiological effects; specific effects included: passing out/losing consciousness, loss of body control or inability to move, respiratory effects (e.g., coughing, pain in lungs), perspiring, crying/tearing up, nausea/vomiting; 2) cognitive or psychological effects; specific effects included: memory loss/forgetfulness, confusion/distorted or altered reality. All discrepancies were discussed and a consensus was reached. Results of inter-rater reliability for all tweets included in this sub-analysis ($n=333$) were good and are presented in section B of Table 2.

We further examined tweets about the two most common physiological effects from dabbing, respiratory effects and passing out/losing consciousness. We identified common terms in our random sample of coded tweets that were likely to garner tweets with the effects of interest using the word frequency query in NVivo 10 for Windows (QSR International, Burlington, MA). We then used the *index* function in SAS version 9.4 (SAS Institute, Inc, Cary, NC) to search the total volume of tweets collected during January of 2015 ($n=206,854$) for tweets with the text “lung”, “cough”, or “breath” to identify respiratory effects tweets, and with the text “coma”, “pass” and “out” in the same tweet, or “knock” and “out”/“ass”/“off” in the same tweet to identify tweets about passing out/losing consciousness.

All tweets with the respiratory effects terms of interest ($n=1,623$) and the passing out terms of interest ($n=1,043$) were then coded for the themes described below in teams of two research team members, with each tweet coded separately by each coder. Tweets were coded in sets of 100 and codes for each set were compared and discussed before moving on to code the next set. For respiratory tweets, themes included whether the tweet mentioned a) coughing after dabbing; excessive coughing was also coded separately, b) dabbing is hard on the lungs, and c) difficulties with breathing after dabbing, d) disliking the respiratory effects from dabbing. For passing out tweets, themes included: a) Tweeter uses dabs in order to pass out/plans to pass out/desires to pass out; b) the tweeter actually experienced passing out after dabbing, c) someone else (besides the tweeter) experienced passing out after dabbing, d) Tweeter explicitly dislikes the effects of passing out after dabbing. Again, results of inter-rater reliability for all tweets included in this in-depth examination were good and are presented in sections C and D of Table 2.

2.3 Demographic characteristics of the tweeters

Using the services of DemographicsPro, a social media analytics company that we have utilized in our past studies (Cavazos-Rehg et al., 2014, 2015a), demographic characteristics of the Twitter users who tweeted about dabbing marijuana were inferred based on Twitter behavior. Demographic characteristics were inferred for the 3,159 unique Twitter users who tweeted about dabbing marijuana as determined by our coding of the random sample of tweets described above. Twitter users in the random sample who tweeted advertisements/promotions of dabbing products were excluded in order to focus our analysis on Twitter users who tweeted about use, experiences, or attitudes/knowledge about dabbing. Thus, all Twitter users who posted tweets in our random sample with codes related to dabbing, other than advertisements/promotions, were included in this analysis.

DemographicsPro predicts demographic characteristics using proprietary algorithms that consider the strength and nature of ties within Twitter networks, consumption of information on Twitter determined by accounts followed and Twitter usage, as well as the language used in individual tweets and account bios. All of these signals are filtered and amplified using large proprietary knowledge bases of established correlations between data points and demographic characteristics. Series of algorithms are used to combine the multiple amplified signals in order to infer likely demographic characteristics, using big data analytics, natural language processing, entity identification, image analyses, and network theory. Over 300 million Twitter users have been profiled by DemographicsPro. The methods are tested iteratively on large established samples of Twitter users with verified demographics, with sample sizes ranging from 10,000 to 200,000 Twitter users depending on the demographic characteristic of interest. A confidence interval of 95% or above is required to make an estimate for a single demographic characteristic (DemographicsPro, n.d.). Geographic location of tweeters was also inferred using these methods, going beyond the use of geo-tagged data which was only available for a very small proportion of the tweets.

3. RESULTS

From the full sample of 206,854 tweets, 63% (130,625) of these were original tweets and 37% (76,229) were retweets. The median number of followers was 408 (inter-quartile range 193 to 847). Among the 5,000 tweets randomly sampled from the 206,854 tweets, 3,540 (71%) were about dabbing concentrates and were manually coded for the presence of themes; 1,126 tweets (23%) were not about dabbing concentrates and 334 tweets (7%) could not be discerned.

3.1. Themes of tweets about dabbing (Table 4)

Of the 3,540 tweets manually coded, the most common theme identified in the tweets (n= 849; 24%) was in reference to the tweeter's current use of concentrates (i.e., having just used concentrates or planning to use concentrates). Intense high or the extreme effects following dabbing was portrayed in 763 tweets (22%) and 517 tweets (15%) mentioned heavy/frequent dabbing. Some tweets (n=293; 8%) also mentioned specific benefits of dabbing including that doing so improved sleep, enhanced relaxation, and/or relieved stress/anxiety; 7% of tweets (n=251) were about people describing their first experience with/reaction to dabbing.

Tweeters also mentioned concentrates along with other forms of marijuana including joints/buds, edibles, and/or other substances (i.e., alcoholic beverages and/or other drugs such as Xanax or LSD) (n=356; 10%); of these tweets, concomitant use of concentrates along with other forms of marijuana (n=71/137; 52%), alcohol and/or other substances (n=55/137; 40%), and all substances combined (n=11/137; 8%) were also observed in 137 of the 356 tweets. Finally, we found dabbing-related advertisements or promotions for dabbing products in 192 (5%) of the tweets.

3.2. Sub-analysis: Extreme effects from dabbing (Table 5)

There is limited scientific information about dabbing, despite its apparent increasing popularity to ingest marijuana in order to obtain an intense and quick high; therefore, we more closely scrutinized the 763 tweets about extreme effects from dabbing. Tweets that were humorous images/videos (many popular retweets) were excluded (n=430) because they were potentially retweeted to entertain/amuse others versus reflecting true life experiences. Of the remaining 333 tweets, 37% (124/333) tweets described physiological effects due to dabbing. Among these, passing out or loss of consciousness was the most common (46/333; 14%), followed by respiratory effects including coughing, experiencing loss of breath, and/or feeling pain in one's lungs following dabbing were described in 30 tweets (30/333, 9%). A loss of body control or an inability to move was described in 12 tweets (12/333, 4%), and feeling nauseous/vomiting was described in 10 tweets (10/333, 3%). Other physiological effects due to dabbing that were observed to a lesser degree included the tweeter disclosing that they had begun perspiring (6/333, 2%), and crying/tearing up due to dabbing (5/333, 2%).

Cognitive/psychological consequences following dabbing were expressed in 17% (55/333) of the tweets. Among these, confusion or experiencing a form of altered reality was described in 37 tweets (37/333, 11%). In addition, memory loss or forgetfulness was depicted in 5 tweets (5/333, 2%). Approximately 47% of the tweets (157/333) described neither physiological nor cognitive/psychological consequences following dabbing, but instead described the extreme effects from dabbing in a non-specific way. It should be noted that when considering the entire random sample of tweets that were found to be about dabbing marijuana (n=3,540), specific physiological effects and cognitive effects comprised a small proportion of the sample: 4% of the 3,540 tweets described specific physiological effects and 2% described specific cognitive effects.

3.3. In-depth examination of tweets about respiratory effects and “passing out”

From the full set of 206,854 tweets collected, we identified 1,623 tweets with the terms “lung”, “cough”, or “breath”. Among these, 1,179 were about respiratory effects from dabbing concentrates. We estimate that this reflects approximately 0.8% (1,179/147,000) of the full set of tweets about dabbing marijuana (when approximating that about 71% -- or 147,000 -- of the full set of 206,854 tweets are likely about dabbing marijuana based on our coding of the random sample of 5,000 tweets). This is similar to the prevalence of respiratory effects tweets found in the coding of our random sample of tweets (see Table 5). Over 2/3 of the 1,179 respiratory effects tweets (807/1,179; 68%) referenced coughing after dabbing, with 47% (376/807) of these describing excessive coughing (e.g., “Dabs got me

coughing organs up). The popular retweet “RT @HighStruggles: #TheStruggleofAHighNigga ft Wiz Khalifa... Dabs even a Pro coughs <https://t.co/yH4sotRhXF>” accounted for 195 (24%) of those that mentioned coughing. Approximately 21% (244/1,179) referenced dabbing being hard on the lungs (e.g., “*dabbin so hard my lungs hurt*”) and 7% (84/1,179) referenced difficulty breathing after dabbing (e.g., “*You know it’s a good dab if you have trouble breathing afterwards*”). Only 2% (27/1,179) explicitly expressed disliking the respiratory effects following dabbing (e.g., “*Dabs ain’t right, I almost coughed up a damn lung my first time*”).

From the full set of tweets we also identified 1,043 tweets with the terms “coma”, “pass” and “out” or “knock” and “out”/“ass”/“off”. Among these, 915 were about passing out or losing consciousness from dabbing concentrates. Using the same estimation methods described in the prior paragraph, we estimate that this reflects approximately 0.6% (915/147,000) of the full set of tweets about dabbing marijuana. This is slightly lower than the prevalence of passing out-related tweets found in the coding of our random sample of tweets (1.3%, see Table 5) but this is expected as it was more difficult to determine a comprehensive list of relevant keywords to pull these tweets. Nearly half (416/915; 45%) of the 915 tweets about passing out expressed that the tweeter used concentrates with intentions/plans to pass out or lose consciousness (e.g. “*I’m trying to dab to the point where I pass out tonight*”, “*Gonna dab myself into a coma*”). In addition, 28% (259/915) indicated the tweeter had experienced passing out after dabbing (e.g., “*I was in the fattest dab coma last night*”) and 17% (151/915) indicated someone else had passed out after dabbing (e.g., “*my sister just passed out with her 1st dab*”). Only 2% (14/915) explicitly indicated that the tweeter did not like the effect of passing out after dabbing (e.g., “*yeah I did a dab once but that shit will have u passed out so I wouldn’t do it again. Too many risks*”).

3.4. Demographic characteristics of Twitter handles

In respect to the demographic characteristics of unique tweeters (n=3,159) from our random sample who tweeted about dabbing (but not advertisements – refer to Table 4), approximately 59% were male, versus 46% male in the Twitter Median Average (TMA). Over three quarters (80%) were single (TMA: 50%). Nearly half (45%) were age 17 to 19 years, and another 48% were age 20 to 24 years (TMA: 31% and 34%, respectively). In addition, a larger proportion of Twitter users tweeting about dabbing were African American (44%) and Hispanic (19%) (TMA: 16% and 7%, respectively). States with disproportionately greater tweets about dabs are listed in Table 3; 20 of the 24 states inferred by Demographics Pro to be tweeting about dabs excessively were also included as top states tweeting about dabs in Daniulailyte et al. (2015) and the correlation between our ratio of dabbing-related tweets to the Twitter average and Daniulailyte et al.’s adjusted percentage of dabs-related tweets per state was moderate (Spearman’s $r = 0.57$, $p < 0.001$). In addition, the ratio of dabbing-related tweets to the Twitter average tended to be higher for states where medical or recreational use was legal by January 2015 (time of data collection) (median 1.8, range 0.3 to 5.0) than states where use was not legal (median 1.1, range 0.5 to 3.0), but this did not reach statistical significance (Wilcoxon Mann-Whitney $p = 0.113$). These results suggest somewhat similar findings between our two studies in terms of the geo-location of dabbing-related tweets; differences in results could be due to differences in methodologies

as we relied on inferred geographic location determined by a social media analytics company and Daniulailyte et al. used geographic data indicated in Twitter user profiles or GPS-enabled devices).

4. DISCUSSION

We investigated Twitter content about dabbing to gain new understanding and key insights into this behavior that is increasingly popular but remains understudied. About one out of five of the dabbing-related tweets that we examined were about one's own dabbing behaviors. In addition, 15% of the examined tweets were about dabbing an excessive amount (e.g., using "fat" dabs, dabs 1 gram) and/or engaging in successive dabbing sessions, which potentially have implications for addiction and misuse. This sort of heavy use has also been seen in YouTube videos, where individuals take extremely large or multiple dabs in a row seemingly as a competition or challenge (Krauss et al., 2015b). Consequently, consuming one-gram dabs (or more) appear to be for entertainment purposes (i.e., boasting about one's tolerance), rather than consuming what is necessary to achieve a desired effect. While there is still much to learn about what can be considered "normal dabbing behaviors", such tweets about heavy and successive dabbing sessions signal tendencies that could align with symptoms of misuse and tolerance.

We also observed tweets about experiencing effects of dabbing that help to illustrate the relatively numerous physical and mental reactions that one could experience following dabbing. While some tweeters mentioned that they were dabbing in order to induce relaxation/reduce sleep difficulties, others described outcomes from dabbing that appeared to be rather intense including passing out, feeling a loss of body control, and/or vomiting. These experiences may contrast with the seemingly milder effects experienced after ingesting traditional forms of marijuana (i.e., relaxation/tension reduction and/or perceptual/cognitive enhancement; Green et al., 2003; Zeiger et al., 2010). Related, Loflin and Earleywine (2014) found that concentrates users often prefer dabs because of the stronger effects and different type of "high" as compared to flower cannabis. Furthermore, it is worth noting that only 2% of tweets about respiratory effects and losing consciousness/passing out tweets explicitly described disliking these experiences, which corroborates the findings of Loflin and Earleywine (2014) who found that users, in general, did not perceive dabs as being dangerous. Our findings nevertheless signal a need for continued study regarding users' outcomes to dabbing.

We additionally viewed tweets that mentioned use of other forms of marijuana and/or other substance use within the dabbing-related tweets, some of which explicitly mentioned concomitant use of concentrates plus other substances. While consequences associated with concomitant use of concentrates plus other substances remain unknown, existing research does signal a greater likelihood for marijuana use disorders and difficulties with quitting marijuana among individuals who are poly-substance users (Chen and Kandel, 1998; Lynskey et al., 2003; Stinson et al., 2006). Thus, tweets about dabbing and concomitant use of other substances are concerning and stress the need for surveillance and a better understanding of their associated consequences.

Public health education and prevention efforts about this highly concentrated form of marijuana may be important for minority teens and young adults on social media who were inferred to be the bulk of tweeters in this study and have also been found to drive social media discussions about marijuana in our related research (Cavazos-Rehg et al., 2014, 2015a). Although the prevalence of African Americans tweeting about dabbing marijuana concentrates in our study (44%) conflicts with results from Loflin and Earleywine (5% African American in a survey of concentrates users) this could be due to differences in study design; Loflin and Earleywine (2014) recruited participants for a survey via Craigslist while we examined tweets about dabbing, and Twitter is known to be a very popular social media platform among African American youth (Smith, 2014). Furthermore, surveillance may be crucial in states where recreational and/or medical use are/become legal, as tweets about dabbing were found to be significantly higher in these states in the study by Daniulaityte et al. (2015) and trended higher in such states in our own study.

A number of limitations are worth noting. An extended time frame of tweets beyond one month would have allowed us to track the frequency of these discussions, possibly providing further support for its increasing popularity. The current study only examined tweets that were dabbing-related; comparing our findings with a control set of tweets about traditional (herbal/resin) cannabis was beyond the scope of the current study but could potentially validate our conclusions. Also, a more comprehensive list of keywords to collect tweets may have impacted the results. We are also unable to determine the extent to which the tweets reflect accurate dabbing use behaviors and effects from dabbing. Furthermore, nearly half of the extreme effects tweets were missing descriptive details about whether one was experiencing physiological or cognitive/psychological outcomes from dabbing. Brevity was expected given that tweets have a 140 character limit restriction; nevertheless, more descriptive content within tweets could help to validate our findings. In addition, the use of inferred demographic characteristics for social media users is still an experimental domain of research and prior studies in this field have shown varying levels of accuracy (Chen et al., 2015; Culotta et al., 2015; Fink et al., 2012; Kosinski et al., 2013). Finally, examining a greater number of tweets could lead to more accurate and comprehensive findings.

Nevertheless, our study is the first of its kind to identify the most common themes of dabbing-related tweets in order to add to the limited understanding of this form of marijuana ingestion that might be a different experience (i.e., more intense effects) than use of plant-based forms of marijuana. By investigating the content of tweets about dabbing, we gained insight into potential reactions to, experiences with, and motives for dabbing as depicted in individuals' tweets. Moreover, our in-depth analysis of tweets regarding the extreme effects of dabbing additionally revealed potential and intense physical and psychological outcomes that may be associated with dabbing. As it stands, there is very little known about dabbing concentrates, and our surveillance of tweets is one approach for generating new knowledge about this behavior that may be useful for guiding future research questions and informing prevention efforts.

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Highlights

- Use of high-potency marijuana (i.e., dabbing) produces a quick and intense high.
- Surveillance of tweets can be helpful for garnering novel insight about dabbing.
- Tweeters often discussed reactions to, experiences with, and motives for dabbing.
- Tweets mentioned extreme psychological and physical effects felt after dabbing.
- Tweets about dabbing may help guide future studies and inform prevention efforts.

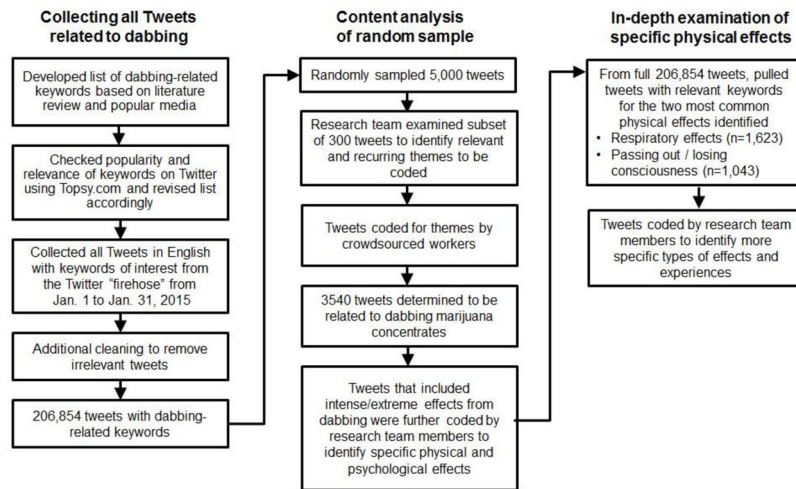


Figure 1.
Process for data collection and content analysis

Table 1

Dabbing-related keywords

dab^a or #dab^b
dabs or #dabs
dabbing or #dabbing
dabbin^c or #dabbin
dabber^d or #dabber or dabbers^e or #dabbers
“dab life” or #dablif
oil^f
“honey oil” or #honeyoil
“hash oil” or #hashoil
“THC oil”
#710^g
shatter^h or #shatter
waxⁱ
concentrates^j or #concentrates
shatterday or #shatterday
e-nail or #enail

^aExcluded tweets with “radio”, “smack dab”, “wireless”, “FM”, “Bluetooth”, “music”, or “dab of”

^bExcluded tweets with “radio”, “wireless”, “FM”, “Bluetooth”, or “music”

^cExcluded tweets with “havin and dabbin”

^dExcluded tweets with “bingo”, “perfume”, “Dan Dabber”, or “Dabber Dan”

^eExcluded tweets with “bingo”

^fOnly in combination with “marijuana”, “weed”, “kush”, or “dank”

^gRefers to oil (710 upside down spells OIL)

^hOnly in combination with “marijuana”, “weed”, “high”, “hash”, “kush”, “cannabis”, “THC”, or “dank”

ⁱOnly in combination with “marijuana”, “weed”, “hash”, “kush”, “cannabis”, “loud”, “THC”, or “dank”

^jOnly in combination with “marijuana”, “weed”, “pot”, “high”, “hash”, “kush”, “cannabis”, “THC”, or “dank”

Table 2

Inter-rater reliability results for all coded themes

| Theme | Percent agreement | Krippendorff's alpha(95% CI) |
|--|-------------------|------------------------------|
| A. Overall themes: Crowdsourced final response vs research team member (subsample n=350) | | |
| Tweet is about dabbing marijuana concentrates | 91% | 0.79 (0.66 – 0.91) |
| Currently dabbing, recently dabbed, or wanting/planning to dab ^a | 85% | 0.62 (0.43 – 0.77) |
| Describes first experience with dabbing | 100% | 1.00 (1.00 – 1.00) |
| Mentions that dabbing aids in relaxation, sleep, or solving problems | 96% | 0.69 (0.40 – 0.93) |
| Heavy or excessive dabbing | 94% | 0.77 (0.57 – 0.93) |
| Describes intense or extreme effects from dabbing | 95% | 0.82 (0.65 – 0.96) |
| Mentions other forms of marijuana, alcohol, or other substances | 94% | 0.74 (0.52 – 0.91) |
| Advertisement or promotion of dabbing products | 98% | 0.75 (0.35 – 1.00) |
| B Specific extreme effects from dabbing: All tweets with “intense or extreme effects” theme further coded by two research team members | | |
| Physiological effects | 92% | 0.83 (0.71 – 0.93) |
| Passing out/losing consciousness | 99% | 0.98 (0.94 – 1.00) |
| Loss of body control or inability to move | 97% | 0.78 (0.50 – 1.00) |
| Respiratory effects | 100% | 1.00 (1.00 – 1.00) |
| Perspiring | 100% | 1.00 (1.00 – 1.00) |
| Crying/tearing up | 100% | 1.00 (1.00 – 1.00) |
| Nausea/vomiting | 99% | 0.94 (0.81 – 1.00) |
| Cognitive or psychological effects | 93% | 0.73 (0.51 – 0.92) |
| Memory loss/forgetfulness | 97% | 0.89 (0.68 – 1.00) |
| Confusion/distorted reality | 91% | 0.79 (0.57 – 1.00) |
| C. In-depth examination of respiratory effects: All tweets with specific respiratory-related keywords of interest coded by two research team members | | |
| Tweet is about respiratory effects from dabbing | 94% | 0.82 (0.67 – 0.94) |
| Tweet mentioned coughing after dabbing | 98% | 0.96 (0.90 – 1.00) |
| Describes excessive coughing | 91% | 0.83 (0.74 – 0.90) |
| Dabbing is hard on the lungs | 99% | 0.96 (0.87 – 1.00) |
| Difficulties with breathing after dabbing | 99% | 0.94 (0.77 – 1.00) |
| Tweeter explicitly dislikes respiratory effects from dabbing | 98% | 0.55 (0.00 – 1.00) |
| D. In-depth examination of “passing out”: All tweets with specific passing out-related keywords of interest coded by two research team members | | |
| Tweet is about passing out/losing consciousness from dabbing | 97% | 0.81 (0.57 – 1.00) |
| Tweeter uses dabs in order to pass out, or plans/desires to pass out | 93% | 0.86 (0.76 – 0.96) |
| Tweeter actually experienced passing out after dabbing | 93% | 0.83 (0.71 – 0.95) |
| Someone else (besides tweeter) experienced passing out after dabbing | 96% | 0.85 (0.70 – 0.96) |
| Tweeter explicitly dislikes the effects of passing out after dabbing | 99% | 0.62 (0.00 – 1.00) |

^aPercent agreement and Krippendorff's alpha for the theme concerning currently/wanting/planning to dab was relatively low in comparison to the other themes (77% and Krippendorff's alpha 0.49). However, when we restricted use of this code to only tweets with no other theme present, reliability was better (reported in table above). Thus, this theme is reported only in the absence of the other themes.

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Table 3

States with disproportionately greater tweets about dabs

| State ^a | ----- Our study ----- | | ----- Daniualaityte et al. ----- | |
|--------------------|--|--|---|------|
| | Ratio of percent of dabs-related tweets from each state to the Twitter average | | Adjusted % of dabs-related tweets per state | Rank |
| NM | 5.0 | | 3.22 | 6 |
| OR | 4.0 | | 6.38 | 1 |
| AK | 3.0 | | 3.39 | 5 |
| SD | 3.0 | | 2.80 | 10 |
| IA | 3.0 | | 2.31 | 16 |
| WV | 3.0 | | 1.27 | 36 |
| MI | 2.6 | | 3.46 | 4 |
| WA | 2.5 | | 4.04 | 3 |
| NE | 2.3 | | 2.34 | 15 |
| CO | 2.2 | | 6.17 | 2 |
| KS | 2.0 | | 2.44 | 14 |
| ND | 2.0 | | 1.76 | 23 |
| KY | 2.0 | | 1.06 | 42 |
| MN | 1.9 | | 2.64 | 12 |
| OH | 1.9 | | 1.69 | 25 |
| CT | 1.9 | | 1.45 | 30 |
| NV | 1.8 | | 2.89 | 8 |
| AZ | 1.8 | | 2.68 | 11 |
| LA | 1.7 | | 1.43 | 32 |
| PA | 1.6 | | 1.48 | 29 |
| MD | 1.5 | | 1.50 | 28 |
| TX | 1.5 | | 1.59 | 27 |
| RI | 1.5 | | 2.14 | 17 |
| IL | 1.3 | | 1.41 | 33 |

^aStates not listed in this table did not tweet about dabs to a disproportionately greater degree than the Twitter average as inferred by Demographics Pro

Table 4

Themes from dabbing-related tweets (N=3,540)

| Themes | n (%) | Example tweets |
|--|-----------|---|
| Tweeter is currently dabbing, wants/plans to dab, or dabbled in the recent past. | 849 (24%) | <ul style="list-style-type: none"> Dabbing myself to unconsciousness tonight Need some more dabs in my life I wanna try dab so fucking badly |
| ----- Specific reactions to/experiences with dabbing and/or patterns of dabbing ----- | | |
| The intense high and/or extreme effects from dabbing | 763 (22%) | <ul style="list-style-type: none"> That dab hit just melted my entire face Too many dabs and my head kills the day after Smoke weed, ide, but dabs kill your brain tho so like dont do too many if any at all, thanks. |
| Excessive or heavy dabbing (e.g., "fat" dabs, dabs 1 gram or more) or dabbing multiple times | 517 (15%) | <ul style="list-style-type: none"> can't wait to go home + take a fat ass dab + die It's 9:30 and I already took like 6 dabs lol levels dabbing all night this shit got me faded |
| Dabbing helps you to relax, go to sleep, or solves problems | 293 (8%) | <ul style="list-style-type: none"> Can't sleep. Having a dab competition with myself to go to bed, In need of a dab ... I think all my problems would go away for like a couple hours Up and time to dab my face off and forget my failures |
| First experience dabbing | 51 (7%) | <ul style="list-style-type: none"> I remember the first time I ever took a dab I was so high lol but I didn't cough Hit dabs for the first time coughed so much I thought I was gonna puke Dabs really somethin serious my first time i think a piece of my lung came out lol |
| ----- Contexts associated with dabbing ----- | | |
| Mentions dabbing plus other forms of marijuana, alcohol and/or other substances ^a | 356 (10%) | <ul style="list-style-type: none"> You know it's a goodnight when my dad hits the blunt and my mom takes a dab for new years My life consists of blunts, bong, bowls & dabs. #HigherLvng Starting to like dabs more than bud |
| Tweet is an advertisement or promotion for dabbing products. | 192 (5%) | <ul style="list-style-type: none"> Tomorrow is SHATTERDAY!\$10 off Full grams or \$5 off half grams of BHO or Clear. Also 15% off all Co2 or Buy 3 get 1 free u2026 We got the fire \$30 cap on OG dank OZ prices starting at \$150!! Shatter \$20 Goldcoastextracts today Oh wow! @IoffappareLlfe is the shit!!! Custom bowls, dabbers, rigs, etc. all hand blown! |

^aConcomitant use was further coded from the 356 tweets that discussed dabbing plus other forms of marijuana, alcohol, and/or other substances (n = 37)

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| Themes | n (%) | Example tweets |
|---|--------------|---|
| Dabbing plus other forms of marijuana | 71/137 (51%) | <ul style="list-style-type: none"> • Dabs n blunts that's how you dooo itttt • Settle for a bowl or take dab?! Okay both it is, sold • A bowl with dabs surrounded by tree, packed with kief on the top. Smoker's Heaven. |
| Dabbing plus alcohol and/or other substances | 55/137 (40%) | <ul style="list-style-type: none"> • I drown my sorrows in dabs and bush light. • Bars n dabs n percs. Long day working. • Wine and dabs! My kinda night |
| Dabbing plus other forms of marijuana, alcohol and other substances | 11/137 (8%) | <ul style="list-style-type: none"> • pop a oxy or two kick back roll up a blunt & to finish it off take a fat dab. • Drinking and dabbing then bowls and bed. punctuated by pizza. This is my heaven aka Saturday night • Dab hits, keef, hash?! I think I'm dying tonight. and a Captain Morgan |

Table 5

Sub-analysis of specific extreme effects from dabbing described in tweets

| Themes | Number of tweets | Percent among 333 tweets coded for extreme effects ^a | Percent among the 3,540 tweets coded as related to dabbing marijuana | Example tweets |
|--|------------------|---|--|--|
| Physiological effects | | | | |
| | 124 | 37% | 3.5% | |
| - Passed out or loss of consciousness | 46 | 14% | 1.3% | <ul style="list-style-type: none"> I was in a dab coma yesterday another person to pass out off the dabs |
| - Respiratory effects | 30 | 9% | 0.8% | <ul style="list-style-type: none"> Dabs so hard my lungs hurt Last night I took a fat ass fucking shatter dab that I felt like I tore a lung or something cause of the massive cough attack I had |
| - Loss of body control/inability to move | 12 | 4% | 0.3% | <ul style="list-style-type: none"> When I first tried dabs I was stuck like I couldn't fucking move That night I smoked dabs and got drunk I was saying that I couldn't get off the ground because my feet were too heavy. Lmfáio! |
| - Nauseous/Vomiting | 10 | 3% | 0.3% | <ul style="list-style-type: none"> I just took a dab and almost vomited everywhere. Gross dabs fucked my stomach up |
| - Perspiring | 6 | 2% | 0.2% | <ul style="list-style-type: none"> Dunked a dab and im sweatin whoooo That dab during my lunch break had ya girl sweatin |
| - Crying/tearing up | 5 | 2% | 0.1% | <ul style="list-style-type: none"> dab hit was so hit i started tearing Let her hit the dab once and she was crying tears of dabs |
| Cognitive/Psychological effects | | | | |
| | 55 | 17% | 1.6% | |
| - Confusion or distorted reality | 37 | 11% | 1.0% | <ul style="list-style-type: none"> Canna caps and dabs. Body is entering the promised land and my brain is saying what's up to mars. First time I smoked ever I got a huge dab and I was crawling around a basement asking furniture to take me to the hospital. |

| Example tweets | | | | |
|--------------------------------|------------------|---|--|---|
| Themes | Number of tweets | Percent among 333 tweets coded for extreme effects ^a | Percent among the 3,540 tweets coded as related to dabbing marijuana | Example tweets |
| - Memory loss/forgetfulness | 5 | 2% | 0.1% | <ul style="list-style-type: none"> • Dabs really mess up your memory for that entire day that you do them • Dabs before dinner is always exciting because half way there you forget where you're going then remember you're on your way to eat. |
| General (non-specific) effects | 154 | 46% | 4.4% | <ul style="list-style-type: none"> • Dabs get me so high that I don't even realize I'm that high • Took my first dab Tuesday. Almost died. • gonna take 1 dab and die for 9 hours |

^aHumorous images/videos were excluded from this sub-analysis.