

# Vaporization of Marijuana Among Recreational Users: A Qualitative Study

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**ABSTRACT. Objective:** Vaporization of marijuana products, or “vaping,” has become a prevalent mode of administration and is typically perceived to hold unique benefits compared to combustible administration methods. Such positive beliefs regarding marijuana vaporization may contribute to its abuse liability. This qualitative study examined cognitions pertaining to vaping among recreational marijuana users. **Method:** Focus groups were conducted with frequent marijuana users ( $N = 31$ ; five groups; six to seven per group;  $M = 5.0$  days/week marijuana use). Three topic areas were queried during discussions with the goal of revealing factors that may contribute to the abuse liability of vaporization. These comprised differences between smoking and vaporizing marijuana products, perceived advantages of vaporization, and perceived disadvantages of vaporization. Focus groups lasted approximately 60 minutes and followed a semistructured agenda; the sessions were audio

recorded and transcribed for an applied thematic analysis. An executive summary of each group was made and key themes pertaining to vaporization were summarized. **Results:** Several themes emerged, including differences between smoking and vaporizing marijuana, convenience, discretion, and efficiency of vaping, perceived health benefits, the absence of traditional smoking rituals, and the high cost of vaporization devices. **Conclusions:** Several factors appear to promote marijuana vaporization, including device aspects (e.g., discreet, convenient), the subjective high, economical efficiency, and perceived harm-reducing and health-promoting effects. These qualitative data highlight unique cognitions about marijuana vaping that may substantially increase its abuse liability. Quantitative research is needed to examine the extent to which cognitions about marijuana vaporization contribute to actual use patterns and problematic behaviors. (*J. Stud. Alcohol Drugs*, 80, 56–62, 2019)

VAPORIZATION OF MARIJUANA products, or “vaping,” has become a prevalent mode of administration for many users in the wake of legal and political shifts surrounding marijuana use (Budney et al., 2015b). Vaporization includes the heating of hash oil or cannabis plant material to release aerosolized cannabinoids, including tetrahydrocannabinol (THC) and cannabidiol, and is often combined with water vapor and subsequently inhaled. Cannabis vaporization devices range from large tabletop units to small portable pen-shaped devices much like electronic cigarettes (Lee et al., 2016). In addition, cannabis vaporization may include use of a “dab rig” device to consume highly concentrated marijuana extracts (e.g., “dabs,” “ice,” “budder,” “shatter”; Popova et al., 2017). Vaping is common among marijuana users, with lifetime and past-month prevalence of vaping estimated as 61% and 37%, respectively, in recreational users (Lee et al., 2016). However, only a minority (12%) of recreational users who endorsed vaping reported it as

the primary mode of administration (Borodovsky et al., 2016; Cranford et al., 2016). Some evidence suggests that vaporizing marijuana is more prevalent among individuals with higher socioeconomic status and among younger individuals (Jones et al., 2016; Lee et al., 2016) and is also associated with tobacco, alcohol, and illicit drug use (Jones et al., 2016). Indeed, there appears to be a proliferation of vaping among adolescents and young adults (Jones et al., 2016; Morean et al., 2015), which may be in part due to the ninefold increase in nicotine vaporization (via electronic cigarettes) in recent years in this age group (Arrazola et al., 2015) and the increasing availability of “e-liquids” that contain cannabinoids (Peace et al., 2016). Despite increasing popularity of vaporization of marijuana products, there is limited empirical research to date on its effects, safety, or abuse liability (Giroud et al., 2015).

There are several aspects of marijuana vaporization that may contribute to the proliferation of its use. First, vaporization heats cannabinoids at a lower temperature (180–200 °C) relative to combustible smoking (230 °C), which produces significantly lower carbon monoxide exposure compared with smoked marijuana (Abrams et al., 2007; National Academies of Sciences, Engineering, and Medicine, 2017; Newmeyer et al., 2017). As a result, the respiratory health benefits of eliminating the majority of (if not all) toxic smoke via vaporization versus smoking marijuana are

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thought to be comparable to the purported health benefits from using electronic versus combustible cigarettes. Second, marijuana users may prefer vaping to combustible smoking because the discreet nature of vaping deodorized marijuana extracts can decrease likelihood of detection (Giroud et al., 2015).

Third, the availability and marketing of vaping devices may contribute to their ubiquitous use, “normalization,” and the development of more hazardous marijuana formulations for use in these devices (Fischer et al., 2015). Last, marijuana legalization appears to contribute to use of vaporizers and cognitions surrounding marijuana use (Popova et al., 2017). For example, the likelihood of vaping is nearly doubled in states with marijuana legalization laws relative to states without such laws (Borodovsky et al., 2016). The changing landscape in the legality and subsequent availability of marijuana products appears to not only influence patterns of use, but also modality of consumption. Moreover, users often rely on employees at dispensaries and “vape shops” for their knowledge about marijuana (Popova et al., 2017). Thus, as the number of dispensaries increase, particularly in states with laws permitting use of marijuana for recreational purposes, the risk of potential miscommunication and misperceptions about marijuana and its use will likely increase as well. It is posited that as vaporization product availability and popularity grows, the profitability of this market will be prioritized without consideration of public health implications, as seen in the case of electronic cigarettes (Budney et al., 2015b).

It is well documented that beliefs about the effects and outcomes of substance use influence use behavior (Bekman et al., 2011). Initial empirical studies have begun to examine beliefs about vaporizing marijuana (relative to smoking). One study of medical and nonmedical marijuana users used an open-ended question (“What were the best aspects of using that vaporizer?”) and identified four primary advantages (perceived health benefits, better taste, no smoke smell/more discreet, and more effect for same amount of marijuana/saves money per use) and two disadvantages (inconvenience/difficulties in use, delay caused by setup) of vaping (Malouff et al., 2014). Additional studies among college students and online samples of marijuana users assessed cognitions via a single question with fixed responses (e.g., “Why do you choose to use e-cigarettes or similar products to consume marijuana?”) (Jones et al., 2016) or a yes/no response to a list of predetermined beliefs (e.g., “tastes better,” “more convenient”; Lee et al., 2016; Morean et al., 2017). These studies generally indicate that the top reasons for vaping marijuana relative to smoking are because vaping is more convenient, produces less odor, is more discreet/easier to hide (Jones et al., 2016; Lee et al., 2016; Morean et al., 2017), and it eliminates or minimizes health consequences typically associated with smoking (i.e., is safer; Giroud et al., 2015; Malouff et al., 2014). These positive cognitions

about vaping may increase likelihood of early initial marijuana use, produce positive experience with initial use, and promote more frequent use, which can contribute to greater abuse liability (Budney et al., 2015b).

The majority of research on beliefs about marijuana vaping has relied on predetermined cognitions, assessed via forced choice questions, which limits the specificity and restricts potential heterogeneity in responses (Jones et al., 2016; Lee et al., 2016; Morean et al., 2017). Qualitative research methodology is ideally suited for increasing our knowledge base about individuals’ reasons for and beliefs about marijuana vaping behavior. In this regard, one quasi-qualitative study used open-ended written answers to evaluate marijuana vaping cognitions in 96 individuals who reported using vaporizers to consume marijuana (Malouff et al., 2014). In the current study, we sought to extend and bolster this qualitative work through use of focus group discussions, which offer greater breadth and depth compared with written-response answers, as participants’ responses build off one another to create a clear conceptualization of each topic of interest. Specifically, among recreational marijuana users, we examined cognitions about marijuana vaporization, including perceived advantages and disadvantages to this marijuana administration mode, with the goal of identifying and isolating key factors related to abuse liability.

## Method

### *Participants*

Recreational marijuana users were recruited in 2015–2016 from the community in Rhode Island and Massachusetts. In both states, the use of marijuana for recreational purposes was illegal and the use of marijuana for medical purposes was legal at the time this study was conducted. Potential participants were recruited using flyers posted in the community and via posting on Craigslist. Individuals were invited to participate in focus groups about marijuana use and purchasing behavior (five groups; six to seven participants per group;  $N = 31$ ; 28% female; median annual individual income bracket: \$10,000–\$19,999). The focus groups were the first phase of a larger experimental laboratory study examining marijuana demand. Participants met the following inclusion criteria: English speaking, 18–50 years of age (due to maintenance of identical inclusion and exclusion criteria in the linked laboratory parent study), not seeking treatment for marijuana use, marijuana use at least 4 times in the past month on average and at least monthly for the past 6 months, purchase of marijuana at least twice in the past 6 months, and were recreational users (i.e., without a medical marijuana registration card). Participants who reported having obtained a medical marijuana registration card completed separate qualitative interviews, and thus were not included in the focus group data presented here.

### *Procedure and measures*

Study procedures were approved by the institutional review board at Brown University and all participants provided informed consent before study participation. Before focus group commencement, participants provided demographic information and completed the Marijuana History and Smoking Questionnaire to assess age at onset of marijuana use, typical marijuana use quantity, typical mode of self-administration, amount of money spent monthly on marijuana, and other questions related to marijuana use patterns (Metrik et al., 2009). Focus groups were moderated by the study principal investigator (E.A.), who was accompanied by a research assistant trained in note-taking. Group discussions followed a semistructured agenda designed to collect information from participants on marijuana use patterns, including vaporization of marijuana. Other data not presented here pertaining to marijuana use and purchase behavior were collected as well. Focus group discussions were audio recorded, captured in observational notes, and lasted between 67 and 81 minutes ( $M = 76$  minutes). All participants were compensated \$40 in cash for focus group participation.

### *Data analysis plan*

Debriefs and data summaries were completed immediately following each focus group. All focus groups were transcribed verbatim and subsequently reviewed to remove identifiers and verify accuracy with the audio recording, initially by a master's-level research assistant and subsequently by the principal investigator. A qualitative coding structure was developed from the semistructured focus group agenda and was refined throughout the coding process to include emergent topics. Each transcript was individually coded by the research assistant and also by the principal investigator using thematic analysis (Guest et al., 2012). Using an open coding process, each line of the data was examined and evaluated to identify topics (Glaser & Strauss, 1967). Codes were refined as the analysis progressed, and associated codes were grouped to develop themes within the data. Coders met weekly to discuss and resolve coding discrepancies and to identify points of consensus. Codes were entered into NVivo qualitative data analysis software for thematic analysis (QSR International Ltd., Melbourne, Australia).

After the initial open-coding review of transcripts was complete, all codes pertaining to vaping were reviewed. In addition, data mining tools in the software package were used to ensure that all passages relative to vaping were included. Specifically, the following search terms were queried: "vape," "vaping," "vaporizer," "vaporization." The vaping-related content was then subjected to a secondary coding and analysis process; that is, additional, vaporization-specific codes were created and applied to the data. These codes were then reviewed and summarized to identify the key themes re-

ported here. Illustrative quotes were subsequently selected to reflect each theme and the assigned participant study number is presented in parentheses following each quote.

## **Results**

### *Preliminary analyses*

Participants identified race as African American (19.4%), White (58.1%), American Indian/Alaska Native (3.2%), Asian (6.5%), Native Hawaiian/Pacific Islander (3.2%), or other (9.7%). Participants reported variable amounts of marijuana used per week: less than 1/16 ounce (9.7%), 1/16 ounce (9.7%), 1/8 ounce (22.6%), 1/4 ounce (29.0%), more than 1/4 ounce (29.0%). The sample reported that they used marijuana 5.0 days per week on average ( $SD = 2.1$ ), initiated marijuana use at age 19.2 ( $SD = 5.0$ ), and spent an average of \$129.20 ( $SD = \$99.50$ ) on marijuana over the past 30 days.

### *Qualitative themes*

Three vaporization-specific topics were queried during focus group discussions: (a) differences between smoking and vaporizing marijuana, (b) perceived advantages of vaporizing marijuana, and (c) perceived disadvantages of vaporizing marijuana. Unique themes emerged during the discussion of each topic area.

*Differences between smoking and vaporizing marijuana products.* Many participants reported experiencing stronger marijuana effects from vaporizing marijuana products as compared with smoking and explained that the type of high experienced following vaporization of marijuana varies based on temperature, procedure (e.g., how the device is handled), the quality of the vaporizer, the type of vaporizer (e.g., tabletop device, pen), and the material being vaped (e.g., plant material, concentrated hash oil). One participant explained, "If you vape weed, you actually get more effects than if you just put it in a blunt" (#12). Another participant agreed that "different methods give you different types of highs . . . vaporizing gives you a head high . . . bowls give you . . . a body high" (#2). One participant noted that administration via a vaporizer "does feel different, and vaping, for me, is usually way more of a head high . . . and you get hit by . . . the just straight THC a lot easier, especially if you have a lower temp" (#28). Similarly, some participants reported that vaporization resulted in more gradual effects of marijuana but agreed that the resultant high was typically stronger than smoked marijuana. Another participant believed that vaporizing is "different than smoking cuz with a vaporizer, you get . . . more specific . . . cannabinoids out of it" (#28). In contrast, one participant explained that effects of vaporizing marijuana were different from smoking and influenced what was able to be accomplished during the day. The

participant explained, “The high I get is different than like smoking a blunt . . . I feel like when I face a blunt . . . I’m just like whoa. But like when I smoke a vaporizer, I’m like okay . . . I can carry on with my day” (#17). Others noted that vaporizers are more sharable and “social” (#1) devices when compared with traditional administration modes such as bowls, bongs, or joints.

*Perceived advantages of vaporizing marijuana products.*

(A) *CONVENIENCE AND DISCRETION ASSOCIATED WITH MARIJUANA VAPORIZATION*: Participants discussed many perceived advantages of marijuana vaporization. Participants noted that compared with more traditional combustible modes of administration, vaporizers are more convenient and require less preparation. Specifically, vaporizers were considered ideal for use while driving, in a public area, or residing in housing with restrictions on smoking marijuana (e.g., college dormitories, with individuals who disapprove or do not permit marijuana use). They explained that vaporization “makes it so much easier for me. Because when I’m at home I can smoke . . . before I got one I would have to go on . . . rides all the time. And . . . it’s just a pain . . . when you just wanna sit down and just smoke and chill the rest of the night” (#17). Participants also discussed their belief that vaporizers were often advantageous because “you can really smoke anywhere” (#7). This may be partially attributed to the fact that vaporization does not typically result in as many olfactory cues as compared with smoked marijuana. Indeed, participants viewed vaping as more convenient because “normally vaporizers don’t smell like pot, so a lot of people use them in their rooms and stuff” (#10). The desire to conceal the scent of marijuana was reaffirmed by other participants. One participant with children stated, “I use the vaporizer just cuz we have kids at home. We didn’t want the house smelling like weed, so . . . we have the vaporizer for home” (#29). Several other participants expressed a desire for anonymity and discretion with their marijuana use. One participant reported “us[ing] it on campus . . . walking around . . . it’s the most . . . inconspicuous way” (#4). Other participants agreed, explaining that vaporizing marijuana is “easy and secretive” (#13) and “it’s discreet. It looks like an e-cig” (#3).

(B) *EFFICIENCY ASSOCIATED WITH MARIJUANA VAPORIZATION*: Many participants believed that vaporization of marijuana is a more efficient way to get high compared with smoking and offered several explanations for this difference. They believed that the stronger effects experienced from vaporization (relative to smoking) happen because vaping uses less THC. As a result, vaping marijuana was viewed as more cost effective because less marijuana product is needed to get the same effect. One participant conveyed the notion that “vape does get me feeling right a lot quicker and all for less” (#12). Vaporizing was perceived to be a more “conservative” (#2, #4, #27) and “economical” (#21) approach to marijuana use. Another participant stated, “for . . . the amount that you use . . . you can get way higher” (#28). The belief that vaporiz-

ing marijuana is less expensive and more conservative than smoking marijuana was reiterated by several participants in each focus group. This was further associated with the notion that with vaporizers “all you need is .3 [grams] and then you’ll get as high as you can off of .3 than you do off of 3 grams” (#27). This sentiment was echoed by a different focus group participant who stated “you can actually smoke less and . . . feel the strong effect” (#12). Another perceived advantage was the practice of reusing previously vaporized marijuana “for edibles” (#2). Participants explained their belief that after marijuana is vaporized, the plant material still contains active THC, and thus can be used to make edibles (#10, #7, #2). Participants also discussed their belief that vaporizers are advantageous because they don’t “burn the weed” (#4) and therefore participants experience “the purest flavor at the beginning” (#4).

(C) *PERCEIVED HEALTH BENEFITS OF VAPORIZATION*: Many participants noted that compared with smoking, vaporizing marijuana is “healthier” (#14, #12) and “better for your lungs” (#2). One participant believed that vaporizing “is good for clearing up your lungs and your windpipe . . . if you have bronchitis or something, you basically get water in there that’s breaking up . . . that mucus and that congestion” (#6). Another participant echoed similar beliefs, explaining that “if you have . . . a sinus infection . . . it clears you right out just cuz . . . it’s hot steam pretty much all up in your sinuses, so it’s nice for that” (#4). As stated by one participant, “I don’t feel really any negative effects, like physiologically which is something I would feel . . . in my lungs when I would smoke before” (#3). Another participant summarized these sentiments in saying that “vaporizers are definitely the healthiest way to smoke” (#27).

*Perceived disadvantages of vaporizing marijuana products.*

(A) *ABSENCE OF TRADITIONAL MARIJUANA SMOKING RITUAL*: Although many aspects of marijuana vaporization were perceived to be positive, participants also discussed several perceived disadvantages of vaporization. Participants explained that vaping lacks authenticity and can vary greatly from the traditional experience of combustible marijuana smoking. Several discussions focused on the enjoyment of the “ritual of smoking marijuana” (#27) and some participants reported less satisfaction from vaporization because of the absence of visual and olfactory aspects of smoking. For those who expressed that they did not enjoy vaping, many reiterated that not seeing smoke production after puffing confused and bothered them. One participant explained “you see the smoke, it’s like all right, now I know what I’m doing. Vape, you don’t. When you blow out, sometimes, you might not even blow out smoke” (#19). Another individual mentioned that compared with using a vaporizer, “the act of . . . smoking a joint feels so satisfying” (#28). In addition, vaping was seen as a gradual high, which was perceived by some participants to be less desirable. One participant noted

“if you’re taking a bong rip or something, it’s nice to feel the before and after right away, feel the effect” (#9). Participants who did not prefer vaporization appeared to seek a more traditional type of high and smoking experience.

(B) *HIGH COST OF VAPORIZATION DEVICES*: In addition, participants discussed the fact that cost of vaporization devices is high. Participants mentioned that purchasing a vaporizer is “an investment” (#2), “not cheap” (#27, #22), and can cost several hundred dollars. Further, some explained that buying cheaper vaporizers is unwise as “most . . . are those cheap ones. They’re just a coil that heats up and it’s burning [marijuana] anyways” (#12), eliminating the possibility of reuse. Thus, although some components of vaporization may be advantageous, vaping may not be practical for those who cannot endure the cost. In addition, some participants noted that compared with smoking, vaping may lead to more anxiety. Two participants felt they got to the point of being “uncomfortably” (#13) high with a vaporizer and that it was a “whole other level of being high” (#18).

## Discussion

This study obtained narrative information about the practice of vaporizing marijuana products from recreational marijuana users who did not have a medical marijuana registration card. Although the prevalence of marijuana vaporization is more common in areas that have legalized marijuana use and among medical marijuana users (Cranford et al., 2016), findings from the current study indicate that marijuana vaporization is common among recreational users living in areas of the United States where use of marijuana for recreational purposes is illegal. Three vaporization-related topic areas were queried during focus group discussions, including differences between smoking and vaporizing marijuana products, perceived advantages of vaporizing marijuana products, and perceived disadvantages of vaporizing marijuana products, with the goal of understanding factors that may contribute to the abuse liability of vaping marijuana (Budney et al., 2015a; Fischer et al., 2015; Lee et al., 2016).

Many participants agreed that aside from the initial cost of a vaporization device, vaping relative to smoking marijuana is more fiscally conservative, which is a novel theme that has not been previously examined in quantitative studies. Participants asserted that lower quantities of marijuana plant material are required to get high when vaping because the material is heated at a lower temperature that does not result in combustion. Indeed, one pervasive belief and practice discussed was that vaporized marijuana could be reused to make edible marijuana products because active THC remains in the flower even after it has been vaporized. Although there is no empirical evidence to support this belief, simply holding this belief may increase the appeal of vaporization from a cost/benefit perspective, which may perpetuate

and elevate use. In this regard, one recent study found that regular marijuana users reported participating in a similar practice of using leftover marijuana from cultivation unsuitable for combustible smoking, or “shake,” to make edibles, effectively extracting as many hours of intoxication from the plant as possible (Borodovsky & Budney, 2017). Thus, many cannabis users appreciate the utility of both recycling marijuana and making use of the entire plant to obtain optimum economical effectiveness. Moreover, although the initial cost of vaporization devices is high, as devices become more ubiquitous and market competition grows, the cost of these devices will decrease and the prevalence of this administration mode will likely increase (Malouff et al., 2014). Future work is needed to understand the accuracy of these nuanced beliefs and practices around “recycling” vaped marijuana and how this is related to marijuana abuse liability.

Convenience and discretion of marijuana vaporization emerged as a common theme, which is likely most relevant for handheld portable vaporization devices. This theme is consistent with content assessed via studies using quantitative methods (Jones et al., 2016; Lee et al., 2016; Morean et al., 2017). Participants discussed several locations and situations wherein discretion and convenience of marijuana use are desirable, including places that increase public health concern. For example, many small vaporizers are very inconspicuous and thus are likely to be used while driving (Lee et al., 2016). This may be due in part to the significant decrease in recognizable marijuana odor associated with vaping, which may decrease perceived legal ramifications (Giroud et al., 2015; Jones et al., 2016; Morean et al., 2015). Moreover, the concealability and discretion with vaporizers may heighten risk for initiating and sustaining marijuana use by college students, who may believe that vaping while walking around on campus or while residing in dormitories will be undetectable (Budney et al., 2015b). More research is needed concerning the unique aspects of vaporization that increase risk of using these devices while driving and among college students. Last, individuals who vape may be valuing discretion and convenience without consideration of potential harmful impact on others (e.g., secondhand exposure). Indeed, under certain conditions, secondhand marijuana smoke exposure has been shown to yield detectable levels of THC in both blood and urine, minor subjective and physiological effects, and even marginal impairment on certain behavioral tasks (Herrmann et al., 2015). As a consequence, although this is hazardous as a broad public health concern in the wake of shifts in legality of marijuana use, such involuntary exposure is particularly troubling for adolescents, children, and infants.

Another emergent theme, consistent with what is commonly reported in quantitative research, concerns the belief that marijuana vaporization is less harmful (i.e., safer) than smoking marijuana (Jones et al., 2016; Lee et al., 2016; Morean et al., 2017). This theme is likely applicable across

commonly vaporized marijuana formulations and across device types. Empirical evidence to date indicates that relative to smoking, vaporizing marijuana may significantly reduce the level of carcinogenic toxins inhaled from combustible smoke (Polosa, 2015; Van Dam & Earleywine, 2010), although long-term harm-reduction effects associated with vaporization are unknown. However, it is worth noting that the benefits of vaporization versus smoked marijuana are likely limited to reductions in already existing marijuana-induced chronic bronchitic symptoms (Tashkin, 2015). Thus, switching to vaporization may only benefit marijuana users with pre-existing pulmonary disease (e.g., asthma, chronic obstructive pulmonary disease; Tashkin, 2015). Despite this, the health benefits of vaporization were discussed by participants in the present study. Specifically, some marijuana users believed that there are purported health benefits to vaping marijuana (e.g., it helps treat bronchitis). Certainly, there are significant differences between the belief that marijuana vaping is safer and less harmful (relative to smoking; harm reduction) compared with the belief that vaping is “beneficial” (health-promoting). The latter belief is a potentially problematic misperception that could potentially increase risk for hazardous marijuana consumption. Future work is needed to examine the nature of these cognitions among individuals who use marijuana for such medical purposes, as the presence of medical symptoms or conditions may uniquely shape health-specific beliefs.

It is also worth noting that many users reported that marijuana vaporization of plant material, relative to smoking, results in a different (i.e., stronger, better) subjective high that varies based on the unique aspects of the vaping device conditions (e.g., temperature, how device is held). Indeed, the subjective effect profile experienced following vaping versus smoking is worthy of further inquiry in subsequent research as beliefs about impairment from varying modes of administration may greatly enhance abuse liability. Presumably, this theme may also pertain to vaporization of marijuana oil, although research is needed to directly investigate the specificity of this theme. Interestingly, empirical experimental data indicate that relative to smoked marijuana, vaporization of plant material with a tabletop device does not appear to produce significant differences in subjective “high” (Abrams et al., 2007; Newmeyer et al., 2017). There are likely many unexamined intra- and inter-individual factors and heterogeneity in vaping (e.g., device, formulation) that influence the subjective effects of vaping and require investigation. Likewise, whereas the majority of participants agreed that vaping marijuana is generally a positive experience, two participants reported anxiety and extreme discomfort following vaporization. Although not directly queried, it is likely that these participants were exposed to high-potency oils and THC formulations. Certain formulations of marijuana—including concentrated oils, dabs, shatter, and wax—contain extreme levels of THC. These formulations may contribute

to negative psychiatric and physical effects of vaping and, in users not negatively affected, may promote increased tolerance and risk for development of cannabis use disorder (Loflin & Earleywine, 2014). Because these high-potency formulations are becoming more prevalent across the United States and as legalization laws change, it is crucially important to understand the effect these formulations have on marijuana use behavior and related problems.

There are several points of inquiry that were limited in the current study. First, we did not systematically ask participants to distinguish between marijuana products (i.e., flower, oil, dabs) during focus group discussions. Second, and related, we did not systematically ask participants to distinguish between vaporization device types during focus groups. The heterogeneity in vaping behavior, including variety in both product and mode of administration, warrants careful attention, and efforts should be made to disentangle which perceptions and cognitions may be linked with distinct marijuana formulations and devices. Third, because of the larger parent study that included a laboratory marijuana-administration phase, the sample intentionally did not include adults older than 50 years of age. However, epidemiological data indicate that marijuana use has more than tripled in adults ages 50–64 years, and even steeper increases have been observed for adults age 65 and older from 2002 to 2014 (Azofeifa et al., 2016). There may be specific cognitions that more strongly contribute to marijuana vaping behavior among older individuals. For example, older adults now display significant decreases in protective factors specific to the use of marijuana, including strong disapproval of marijuana use, limitations on marijuana access, and beliefs regarding use of marijuana as having great negative risk on one’s health and well-being (Salas-Wright et al., 2017). Reductions in the aforementioned protective factors are related to the changes in use of marijuana among older adults in recent years (Azofeifa et al., 2016).

Overall, there are several factors that likely promote the use of marijuana vaporization, including aspects of the device (e.g., discreet, convenient), the subjective high, economical efficiency, and perceived harm-reducing and health-promoting effects. These factors outnumber and likely outweigh the disadvantages of vaporizing marijuana products. Importantly, certain positive cognitions about marijuana vaping, regardless of their veracity, have the potential to contribute to problematic and hazardous marijuana use behaviors. Additional quantitative research is needed to understand the extent to which cognitions about marijuana vaporization contribute to actual use behavior. Specifically, research that incorporates modern data collection techniques, such as ecological momentary assessment, is needed to provide a detailed characterization of marijuana vaping frequency and behaviors. This information has the potential to ultimately inform the development of prevention and intervention programs that target beliefs about use

via motivational interviewing (e.g., information sharing) or cognitive restructuring. In addition, efforts to curb marijuana vaporization may benefit from regulating device features that facilitate or promote convenient and inconspicuous marijuana use (Morean et al., 2015).

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