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Predictors of adult e-cigarette users vaporizing cannabis using e-cigarettes and vape-pens

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Abstract

Background—Limited research exists on the use of portable, battery-powered cannabis vaporizers by adult e-cigarette users.

Objective—We assessed cannabis vaporization among adult e-cigarette users.

Methods—522 adult vapers completed an online survey. Demographics; lifetime and past-month cannabis vaporization via e-cigarettes/vape-pens; preferences for hash oil, THC wax, or dried buds; and cannabis vaporization beliefs and motives were examined. Demographics, age of e-cigarette onset, e-cigarette use frequency, state-level legal status of cannabis, cannabis vaping beliefs/motives, and impulsivity were examined as predictors of lifetime cannabis vaporization, past-month cannabis vaporization, and cannabis vaping frequency.

Results—E-cigarette users reported lifetime (LT 17.8%) and past-month (PM 11.5%) cannabis vaporization. Vapers preferred hash oil (LT/PM 45.5/47.5%), THC wax (15.2/32.2%), and dried buds (39.4/35.6%). Cannabis vapers were motivated to vape cannabis because it tastes better (39.3/37.9%%), is healthier (42.9/39.7%%), is easier to conceal/hide (35.7/46.6%), does not smell as strong (42.9/39.7%), is more convenient (42.9/29.5%), and produces a stronger/better high (58.1/40.7%) than smoking cannabis. Lifetime and past-month cannabis vaporization, respectively, were associated with initiating e-cigarette use at an earlier age (OR = .090/0.88), being impulsive (OR = 2.25/3.23), having poor self-control (OR = 2.23/1.85), and vaporizing cannabis because it is easier to conceal/hide (OR = 2.45/2.48) or is more convenient than smoking cannabis (OR = 5.02/2.83). Frequency of vaping cannabis was associated with heavier e-cigarette use ($\eta_p^2 = 0.10$) and impulsivity ($\eta_p^2 = 0.09$).

Conclusions—Adult e-cigarette users are vaporizing cannabis using e-cigarettes and vape-pens. Use of these products should be monitored as they continue to gain popularity.

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Declaration of Interests

The authors report no conflicts of interest.

Keywords

electronic cigarettes; vaping; vape-pens; cannabis; marijuana

BACKGROUND

Portable, battery powered cannabis vaporizers, including vape-pens and e-cigarettes, are electronic devices that are designed to vaporize cannabis using a heating element that is activated when a person inhales. These portable vaporizers provide an efficient way to ingest a variety of forms of cannabis including hash oil, a waxy substance infused with D-9-tetrahydrocannabinol (i.e., THC, the primary psychoactive ingredient in cannabis), and dried cannabis buds (e.g., Giroud et al., 2015; Morean et al., 2015). Although cannabis remains illegal at the federal level in the United States, vape-pens are readily available for purchase on the Internet, at head shops, and at cannabis dispensaries in states in which medical or recreation cannabis is legal. Of concern, vaporizable hash oil and THC waxes have the potential to deliver concentrations of THC that exceed the potency of combustible cannabis by 4–30 times (e.g., Mehmedic et al., 2010), which may lead to stronger effects from vaping cannabis than smoking cannabis (e.g., Lee et al., 2015; Malouff et al., 2014). Also of note, portable, battery powered cannabis vaporizers often look very similar to traditional nicotine vaporizers (i.e., e-cigarettes) and produce a less conspicuous odor than smoking combustible forms of cannabis (e.g., joints, blunts, bowls), which makes vaping cannabis easier to conceal and may promote use (e.g., Bryan, 2014; CNN, 2015; Kost and Kovaleski, 2014; Givens and Cheng, 2013; Malouff et al., 2014). The current study focuses on these devices specifically, given their similarity in appearance and likely appeal to nicotine e-cigarette users.

The wide availability of vape-pens, the frequent coverage of vaping cannabis by the popular media (e.g., Bryan, 2014; CNN, 2015; Kost and Kovaleski, 2014; Givens and Cheng, 2013), and a growing body of scientific data on the phenomenon (e.g., Etter, 2015; Giroud et al., 2015; Lee, Crosier, Borodovsky, Sargent, & Budney, 2015; Malouff, Rooke, & Copeland, 2014; Morean et al., 2015) indicate that vaporizing cannabis is a growing trend in both adults and adolescents. Of note, research indicates that users of traditional cannabis products (e.g., joints, pipes, bongs) and nicotine e-cigarette users, respectively, are at increased risk for vaporizing cannabis (e.g., Lee et al., 2016; Malouff et al., 2014; Morean et al., 2015). For example, a recent national survey of adult cannabis users indicated that 61% reported lifetime cannabis vaping and 37% reported past-month cannabis vaping, with 45% reporting use of a vape-pen and 11% reporting using an e-cigarette to vaporize cannabis (Lee et al., 2016). Regarding risk for cannabis vaporization associated with nicotine e-cigarette use, results of a recent study indicated that 90% of a sample of adult cannabis vapers also used nicotine e-cigarettes (Etter et al., 2015). Similar findings have been documented in adolescents (Morean et al., 2015); rates of using e-cigarettes to vaporize cannabis were elevated among teens who had ever used e-cigarettes (18.0%), had used cannabis in other forms (e.g., joints, pipes, bongs; 18.4%), or who previously had used both e-cigarettes and cannabis (26.5%).

Researchers have begun to identify additional risk factors associated with vaporizing cannabis including male sex (e.g., Etter et al., 2014; Lee et al., 2016; Morean et al., 2015), younger age (Lee et al., 2016; Morean et al. 2015), and an earlier age of onset of cannabis or e-cigarette use (Lee et al., 2016). Researchers also have identified several motivations for vaping versus smoking cannabis including perceived health benefits, better taste, the lack of a smoke smell, a better/stronger high, and greater satisfaction (e.g., Lee et al., 2016; Malouff et al., 2014). However, additional risk factors have yet to be identified, and no published research has focused exclusively on risk for cannabis vaporization in adult e-cigarette users.

OBJECTIVES

The current study evaluated lifetime and past-month rates of using portable, battery powered cannabis vaporizers (i.e., e-cigarettes or vape-pens) in an online, community sample of adult e-cigarette users. Similar to the study conducted by Morean and colleagues (2015), we evaluated rates of vaporizing hash oil, THC-infused wax, and dried cannabis buds. The present work was designed to test aspects of the theory of planned behavior (TPB; Ajzen, 1991). The TPB provides a framework for understanding cannabis use in young people, and describes the relationship between cognitive characteristics and the development and maintenance of behavioral patterns (Ajzen, 1991). The TPB posits that attitudes, subjective norms, and perceived behavioral control shape people's intentions and behaviors (Ajzen, 1991). The TPB further suggests that attitudes toward behaviors are a function of an individual's accessible beliefs about the behavior (Ajzen & Fishbein, 1975). For example, a person's beliefs that vaping cannabis is healthier than smoking joints may contribute to a higher likelihood of intentions to vape cannabis and greater risk for engaging in use. Research has shown that cannabis-specific cognitions including evaluative attitudes are related to cannabis use in young people (Malmberg et al., 2012). Thus, the present work examines a range of beliefs about and motivations for vaping cannabis, and associations with cannabis vaporization in young adults. Perceptions of interest include that vaping tastes better, is healthier, is easier to conceal/hide, does not smell as strong as cannabis smoke, is more convenient (e.g., you do not need a lighter or other paraphernalia), and produces a better/stronger high.

It is important to note that while the TPB has been successfully applied to the prediction of a variety of social and health-related behavior (e.g., Ajzen & Klobas, 2013; French & Cooke, 2012; Godin & Kok, 1996; Plotnikoff, Lubans, Costigan, & McCargar, 2013), some work has shown the power of non-deliberative processes in contributing to young adult cannabis behaviors (Gonzalez et al., 2012; Gonzalez, Schuster, Mermelstein, & Diviak, 2015). The literature on dual process approaches (Epstein, Pacini, Denes-Raj, & Heier, 1996) suggests a distinction between reflective and impulsive influences on behavior (Strack & Deutsch, 2004). Thus, it is plausible that there may be some variance in the behavior (specifically, cannabis vaping) left unexplained by the TPB, and this variance may be a function of some people engaging in cannabis vaping on impulse as opposed to deliberative processing. Indeed, prior research has highlighted a link between cannabis use and impulsivity (e.g., Ansell et al., 2015; Day et al., 2013; Wrege et al., 2014). Thus, we also examined whether self-reported trait impulsivity was related to cannabis vaporization. Based on prior research, we hypothesized that using e-cigarettes or vape-pens to vaporize cannabis would be

associated with being male, younger, initiating nicotine e-cigarette use at an earlier age, higher levels of impulsivity, and lower levels of self-control. No specific hypotheses were made regarding the other central study variables given their relative novelty.

METHODS

Participants

600 participants provided consent for an anonymous survey. Given the current study aims, 522 participants who had non-missing data on vaporizing cannabis were included in the analytic sample. The analytic sample was 50.4% male with an average age of 34.07 years (SD = 9.65). Participants were majority White (71.5%, 10.0% Asian, 5.7% Black, 5.0% Hispanic/Latino, 3.3% American Indian/Alaskan Native, 3.4% Biracial), and earned a mean income in the range of $35–$49,000.

Procedures

During September of 2015, participants were recruited to complete a brief, anonymous, online “Health Behaviors Survey” via Amazon Mechanical Turk (i.e., Mturk), a crowdsourcing data collection service that previously has been demonstrated to be a valid method for collecting scientific survey data (Mason & Suri, 2012) including data on illicit substance use (e.g., Chavarria, Allan, Moltisanti, & Taylor, 2015; Stickland & Stoops, 2015).

The online survey was approved by the Institutional Review Board of Oberlin College. To help ensure high data quality, only MTurk workers who had completed at least 5,000 previous MTurk jobs (demonstrating familiarity with the platform) and who had at least a 98% approval rating of their prior work (demonstrating high quality work) were eligible for the study. Participation was voluntary, and those who completed the study were compensated $2.00. Eligibility criteria included being at least 18 years old (mandated of Mturk workers), currently residing in the United States, and past-month nicotine e-cigarette use. A total of 2,344 participants provided consent, of whom 627 were eligible. Twenty-nine participants had missing data on all non-screener questions (i.e., did not begin the survey), and 76 exited the survey prior to reporting on vaporizing cannabis, resulting in a final analytic sample of 522 participants.

Measures

Demographics—Participants reported on biological sex, age, race, and annual income as an index of socioeconomic status (response options: <$5,000, $5000–$11,999, $12,000–$15,999, $16,000–$24,999, $25,000–$34,999, $35,000–$49,999, $50,000–$74,999, $75,000–$99,999, and ≥ $100,000).

Age of onset of nicotine e-cigarette use—Participants reported the age at which they initiated nicotine e-cigarette use.

Frequency of nicotine e-cigarette use—Participants reported how frequently they used a nicotine e-cigarette. Response options included: less than once a month, once a

month, 2–3 times/month, once a week, 2 days a week, 3 days a week, 4 days a week, 5 days a week, 6 days a week, and everyday.

Legal status of cannabis—Participants reported whether cannabis currently is illegal in the state in which they reside (no/yes).

Lifetime use of cannabis—Participants reported if they had ever tried traditional forms of marijuana (e.g., joint, pipe, bong, edible) at any point in their life (no/yes).

Lifetime and past-month vaporization of cannabis—Participants reported if they had ever used an e-cigarette or vape pen to vaporize cannabis (no/yes) and, if so, whether they had used an e-cigarette or vape pen to vaporize cannabis in the past month (no/yes).

Type of cannabis vaporized—Participants reported on the type(s) of cannabis that they preferred vaporizing. Response options included: hash oil, THC wax, and dried marijuana flower buds. Response options for each item were no/yes.

Beliefs about and motives for vaporizing cannabis versus smoking cannabis —All participants reported whether they believed that, relative to smoking cannabis, vaping cannabis 1) tastes better, 2) is healthier, 3) is easier to conceal/hide, 4) does not smell as strong as cannabis smoke, 5) is more convenient (e.g., you do not need a lighter or other paraphernalia), and/or 6) results in a better/stronger high. Participants who reported that they had ever vaporized cannabis using an e-cigarette or vape-pen then reported their personal motivations for vaping cannabis using the same six prompts. Response options for each item were no/yes.

Preference for Vaping or Smoking Cannabis—Participants who endorsed lifetime use of traditional cannabis products and vaporization of cannabis were asked to report whether they prefer vaping or smoking cannabis.

Impulsivity—We assessed self-reported engagement in impulsive behavior (e.g., I do things without thinking) and self-control (e.g., I plan tasks carefully) using an abbreviated, 8-item version of the Barratt Impulsiveness Scale (BIS; Morean et al., 2014). Prior research indicates that this brief version of the BIS evidences stronger psychometric properties than lengthier versions of the measure when used to assess substance use outcomes (e.g., drinking and smoking; Morean et al., 2014).

Data Analytic Plan

We examined frequencies for all study variables within the total sample with the exception of motivations for vaping cannabis and preferences for vaporizing hash oil, THC wax, or dried buds, which subsequently were examined within the subsamples of adult e-cigarette users who reported lifetime or past-month cannabis vaporization. To gain a better understanding of additional factors that may contribute to vaporizing cannabis among adult nicotine e-cigarette users, we evaluated the extent to which lifetime use and past-month use, respectively, were associated with sex, age, race, annual income (a proxy for socioeconomic status), age of onset of e-cigarette use, frequency of e-cigarette use, the legal status of

cannabis in the state in which a participant resides, and beliefs about/motives for vaporizing cannabis (e.g., vaporizing cannabis is healthier than smoking cannabis). We also evaluated whether these factors, in combination with preferences for vaping hash oil, THC wax, or dried buds, were associated with cannabis vaping frequency within the subsample of past-month cannabis vapers. Further, we examined whether engaging in impulsive behavior (e.g., I do things without thinking) or having poor self-control (e.g., I plan tasks carefully [reverse coded]) was associated with cannabis vaporization (i.e., lifetime use, past-month use, and frequency of cannabis vaporization).

Next, using data from the total sample, we conducted a binary logistic regression to examine factors associated with lifetime use of an e-cigarette or vape pen to vaporize cannabis. The following variables were included as predictors in the model: age, sex, race, income, legal status of cannabis, age of onset of e-cigarette use, frequency of e-cigarette use, beliefs about vaporizing cannabis, and impulsivity (i.e., impulsive behavior and self-control).

We then conducted a second binary logistic regression to examine factors associated with past-month use of an e-cigarette or vape pen to vaporize cannabis. The same variables used to predict lifetime cannabis vaporization were included as predictors in this model except that beliefs about vaporizing cannabis were replaced by motives for vaporizing cannabis.

Finally, within the sample of past-month cannabis vapers, we conducted a univariate general linear model to evaluate factors associated with frequency of cannabis vaporization. The same variables used to predict past-month cannabis vaporization were included as predictors in this model with the addition of preferences for hash oil, THC wax, or dried buds.

RESULTS

In total, 52.3% of the sample reported that they had every tried any form of cannabis, and 17.8% reported lifetime use of an e-cigarette or vape-pen to vaporize cannabis. Among lifetime cannabis vapers, 45.2% reporting that they preferred vaping cannabis versus smoking it. 11.5% of the sample reported vaping cannabis in the past-month (i.e., 64.5% of the lifetime users) on an average of 3–4 days per week. Among past-month cannabis vapers, 40.0% reported that they preferred vaping cannabis versus smoking it. Cannabis vapers reported preferences for hash oil (lifetime use only; past-month use: 45.5%; 47.5%), THC wax (15.2%; 32.2%), and dried buds (39.4%; 35.6%). Cannabis vapers reported that, relative to smoking cannabis, vaping tastes better (39.3%; 37.9%%), is healthier (42.9%; 39.7%%), is easier to conceal/hide (35.7%; 46.6%), does not smell as strong (42.9%; 39.7%), is more convenient (42.9%; 27.6%%), and produces a stronger/better high (58.1%; 40.7%). See Table 1 for complete information on central study variables.

The first binary logistic regression model accounted for 37.8% of the variance in lifetime use of an e-cigarette or vape-pen to vaporize cannabis ($p < .001$, classification accuracy = 79.5%). Males (OR = 2.05); those who initiated e-cigarette use at an earlier age (OR = .090); those who believed that vaporizing cannabis is easier to conceal/hide (OR = 2.45), smells less strongly than smoking cannabis (OR = 2.14) or is more convenient (OR = 5.02); those who were impulsive (OR = 2.25); and those who had poor self-control (OR = 2.23) were

more likely to vape cannabis at some point during their lives than were their respective counterparts (*p*-values < .05; See Table 2, column titled "Lifetime," for odds ratios and 95% confidence intervals).

The second binary logistic regression model accounted for 34.4% of the variance in past-month use of an e-cigarette or vape-pen to vaporize cannabis ($p < .001$, classification accuracy = 83.3%). Older individuals (OR = 1.12); those who initiated e-cigarette use at an earlier age (OR = 0.88); those who believed that vaporizing cannabis is easier to conceal/hide (OR = 2.48) or is more convenient (OR = 2.83); those who were impulsive (OR = 3.23); and those who had poor self-control (OR = 1.85) were more likely to vape cannabis in the past month than were their respective counterparts (*p*-values < .05; See Table 2, column titled "Past-Month," for odds ratios and 95% confidence intervals).

Finally, the univariate general linear model accounted for 28.4% of the variance in frequency of vaping cannabis using e-cigarettes or vape-pens. However, more frequent cannabis vaping was significantly associated only with higher levels of impulsivity ($\eta_p^2 = 0.09$) and more frequent e-cigarette use ($\eta_p^2 = 0.10$; p-values < .05; See Table 3 for complete model results).

DISCUSSION AND CONCLUSIONS

Adult e-cigarette users reported lifetime (17.8%) and past-month (11.5%) use of an e-cigarette or vape-pen to vaporize cannabis. Of note, the rate of lifetime cannabis use (in traditional forms) in the current study (52.3%) was consistent with national estimates (49%; National Institute on Drug Abuse, 2012) and the rate of lifetime cannabis vaping observed in the current study was nearly identical to the rate observed in a sample of adolescent e-cigarette users in Connecticut (18.0%; Morean et al., 2015). Also similar to adolescents (Morean et al., 2015), adult cannabis vapers reported preferences for hash oil (Lifetime; Past-month: 45.5%; 47.5%), THC wax (15.2%; 32.2%), and dried buds (39.4%; 35.6%). Consistent with previous research (e.g., Lee et al., 2016; Malouff et al., 2014), adult e-cigarette users who reported vaping cannabis identified several motivations for vaping cannabis rather than smoking it including: vaping tastes better (39.3%; 37.9%%), is healthier (42.9%; 39.7%%), is easier to conceal/hide (35.7%; 46.6%), does not smell as strong (42.9%; 39.7%), is more convenient (42.9%; 27.6%%), and produces a stronger/better high (58.1%; 40.7%).

Both lifetime and past-month vaporization of cannabis were associated with initiating e-cigarette use at an earlier age, higher impulsivity, deficits in self-control, and beliefs/motivations that vaporizing cannabis is easier to conceal/hide and is more convenient. The current findings uniquely add to the extant body of research that has established a link between cannabis use and impulsivity (e.g., Ansell et al., 2015; Day et al., 2013; Wrege et al., 2014), extending the risk associated with impulsivity to include vaporizing cannabis. These findings further support the dual process perspective regarding engagement in behaviors (Epstein et al., 1996; Strack & Deutsch, 2004), indicating a distinction between reflective and impulsive influences on cannabis vaping among young adults. As with previous work examining impulsivity within a TPB framework (Churchill, Jessop, & Sparks, 2008), these findings suggest that inclusion of impulsivity measures alongside TPB variables

may enhance predictive utility of the resulting model, particularly when behaviors of interest are not adequately characterized by analytic decision-making skills strategies.

Further, results regarding risk associated with an earlier age of onset of nicotine e-cigarette use also are consistent with prior findings published by Lee and colleagues (2016). Furthermore, the results regarding beliefs about and motivations for using cannabis (i.e., vaping cannabis is easier to conceal/hide and is more convenient) are consistent with popular news stories that have raised concerns about individuals vaporizing cannabis because it is easier to conceal than smoking cannabis (e.g., Bryan, 2014; CNN, 2015; Kost and Kovaleski, 2014; Givens and Cheng, 2013) and with prior research identifying motivations for vaping cannabis (e.g., Lee et al., 2016, Malouff et al. 2014). Finally, consistent with previous research on lifetime cannabis vaporization (e.g., Lee et al., 2016; Morean et al., 2015), males were more likely than females to have vaped cannabis using an e-cigarette or vape-pen at some point during their lives.

It is worth pointing out that several findings in the current study were unique and could be considered as inconsistent with previous research. While prior research has suggested that younger individuals and males are more likely to be lifetime cannabis vapers (Lee et al., 2016; Morean et al., 2015), in the current study, neither past-month cannabis vaporization nor cannabis vaping frequency were associated with being male. Similarly, neither lifetime, past-month, nor cannabis vaping frequency were associated with being younger. In fact, older individuals were more likely to report vaping cannabis in the past month in the current study. It is unclear exactly why older individuals were more likely to vaporize cannabis in the past month and why there was a lack of a sex difference in risk for past-month use. However, several possible explanations are plausible. For example, prior research that has documented a sex-based difference in cannabis vaping has focused on lifetime cannabis vaporization (e.g, Lee et al., 2016; Morean et al. 2015). Therefore, it is possible that males are more likely to experiment with vaping cannabis (as was observed in the current study and in previous research), but that there is no sex difference among more regular cannabis vapers (i.e., past-month, frequency of use). Similarly, younger individuals may be more likely to experiment with vaping cannabis, but older adults may be more likely to vape cannabis more regularly. It is clear that further research is needed on this topic.

Finally, above and beyond all other independent variables, only more frequent nicotine e-cigarette use and higher levels of impulsivity were associated significantly with more frequent vaping of cannabis using an e-cigarette or a vape-pen. These findings indicate that nicotine e-cigarette use is, indeed, a risk factor for vaping cannabis and highlight the importance of considering impulsivity as a risk factor for vaping cannabis. That said, it is not clear why other factors that were associated with past-month vaping, in general, (e.g., age of onset of nicotine e-cigarette use and vaping motives) were not associated with past-month vaping frequency. It is possible that lack of statistical power contributed to the absence of other findings, as the model was run with only 60 participants. Future research conducted with larger samples of past-month cannabis vapers is needed.

The current study findings should be considered in light of several limitations. The data were self-report and relied on participants' ability and willingness to report accurately about their

behavior. However, the fact that the rates of cannabis use and cannabis vaporization observed in the current study were consistent with prior research helps to mitigate this concern. Also, participants were Mturk workers who reported past-month nicotine e-cigarette use. Thus, it is unclear the extent to which the current findings are generalizable to other samples including individuals who vape cannabis but do not use nicotine e-cigarettes or those who vape cannabis using products other than e-cigarettes and vape-pens (e.g., electric table-top vaporizers or gas powered vaporizers). However, it is promising that a number of results were consistent with research conducted in adolescent (Morean et al., 2015) and adult samples (e.g., Lee et al. 2016). Discrepancies between the current study findings and prior research also may be due, at least in part, to the fact that the analytic sample exclusively comprised current e-cigarette users, a population that previously has been shown to be at risk for cannabis vaporization (e.g., Morean et al., 2015). It is possible that focusing on an at-risk sample may have obscured findings observed in more general populations (e.g., age and sex differences). It also merits noting that the question assessing the legal status of marijuana was vague in that it did not distinguish between the legal status of medical and recreational cannabis. As such, it was not possible to discern whether any participants were using marijuana for medical reasons. Further, we could not speak to whether participants were using vape-pens or e-cigarettes to vape cannabis, as these two devices were included together in the question stem. Finally, past-month use of a range of traditional cannabis products (e.g., smoking joints, pipes) was not assessed in the current study due to an error in the survey skip logic. As such, it was not possible to examine the extent to which the use of traditional cannabis products conferred risk for vaporizing cannabis, a finding reported in prior research (Morean et al., 2015). A related limitation, it was not possible to evaluate how frequently cannabis users vaporize cannabis relative to smoking it.

In spite of its limitations, the current study adds to the emerging literature on the use of portable, battery powered vaporizers like e-cigarettes and vape-pens to vaporize cannabis, with a specific focus on their use within a sample of adult, nicotine e-cigarette users. Future research examining additional characteristics associated with vaporizing cannabis is needed as portable, battery powered electronic vaporizers (and other cannabis vaporizers) continue to gain popularity.

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Table 1

Demographic Characteristics

		Cannabis Vaporization Status			
	Total Sample	**Never Users**	**Lifetime Users (all)***	**Lifetime Users (no past-month)**	**Past-Month Users**
	N = 522	**n = 429**	**n = 93**	**n = 33**	**n = 60**
Sex (Female)	49.6	50.3	46.2	51.5	43.3
Age	34.07 (9.65)	34.66 (9.98)	31.33 (7.34)	31.91 (9.02)	31.00 (6.28)
Race (White)	71.5				
Income**	$49,812.86 (27,550.81)	$50,244.16 (27,491.55)	$47,827.96 (27,885.29)	$48,409.09 (27,511.49)	$47,508.33 (28,314.44)
Age at e-cigarette onset	30.18 (10.44)	31.08 (10.54)	25.75 (8.76)	26.79 (9.52)	25.11 (8.29)
E-cigarette frequency (days/week)**	4.08 (2.89)	4.20 (2.89)	3.35 (2.81)	3.55 (3.03)	3.25 (2.70)
Cannabis Status (Illegal)	60.5	59.0	67.7	66.7	68.3
Beliefs about Vaping Cannabis					
Taste	17.8	14.0	35.5	33.3	36.7
Health	19.5	15.6	37.6	36.4	38.3
Conceal	16.3	11.2	39.8	30.3	45.0
Smell	16.7	12.1	37.6	36.4	38.3
Convenient	10.9	6.8	30.1	36.4	26.7
Better high	27.4	23.5	45.2	54.5	40.0
Motives for Vaping Cannabis					
Taste	–	–	35.5	39.3	37.9
Health	–	–	37.6	42.9	39.7
Conceal	–	–	39.8	35.7	46.6
Smell	–	–	37.6	42.9	39.7
Convenient	–	–	30.1	42.9	27.6
Better high	–	–	45.2	58.1	40.7
Impulsivity	1.90 (0.70)	1.81 (0.64)	2.33 (0.78)	1.97 (0.61)	2.53 (0.80)
Poor Self-Control	2.05 (0.63)	2.05 (0.63)	2.06 (0.63)	2.07 (0.72)	2.06 (0.58)

Note. Categorical variables are presented as percentages. Continuous variables are presented as mean (standard deviation)

*indicates that “all lifetime users” comprises past-month users and lifetime only users

** income and e-cigarette frequency have been transformed from their original formats, which included ranges, for ease of presentation.

Table 2

Predictors of Lifetime and Past-Month Cannabis Vaporization

	Cannabis Vaporization					
	Lifetime			Past-Month		
	Adjusted OR	95% CI		Adjusted OR	95% CI	
Sex						
Females	reference			reference		
Males	2.05*	1.01	4.18	1.60	0.71	3.61
Age	1.09	0.99	1.21	1.12*	1.01	1.25
Race/Ethnicity						
Not White	reference			reference		
White	1.05	0.48	2.29	0.88	0.36	2.15
Income	0.85	0.71	1.01	0.90	0.74	1.10
Age at e-cigarette onset	0.90*	0.82	0.98	0.88*	0.80	0.97
E-cigarette frequency	0.95	0.85	1.07	1.02	0.90	1.16
Cannabis Status						
Illegal	reference			reference		
Legal	1.08	0.51	2.27	0.90	0.38	2.10
Vaporizing Marijuana…	**Beliefs**			**Motives**		
Tastes Better	1.92	0.91	4.03	1.34	0.59	3.04
Healthier	1.58	0.77	3.25	1.47	0.63	3.45
Easier to Conceal	2.45*	1.16	5.15	2.48*	1.10	5.59
Smells Less Strongly	2.14*	1.02	4.49	2.13	0.93	4.87
More Convenient	5.02***	2.20	11.46	2.83*	1.14	7.02
Better/Stronger High	2.80	0.31	25.20	1.29	0.54	3.09
Impulsivity	2.25**	1.31	3.87	3.23***	1.73	6.06
Poor Self-Control	2.23*	1.05	3.33	1.85*	1.16	4.35

Note.

* $p < .05$

** $p < .01$

*** $p < .001$

Table 3

Predictors of the frequency of vaping cannabis among past-month cannabis vapers

	B	Std. Error	η_p^2
Sex (Male)	0.05	0.66	0.00
Age	0.10	0.09	0.02
Race (White)	0.90	0.82	0.02
Income	0.09	0.16	0.01
Age at e-cigarette onset	−0.04	0.08	0.01
E-cigarette frequency	0.29	0.12	0.10 *
Cannabis Status (Legal)	0.51	0.78	0.01
Vaporizing Cannabis (Motives)			
Tastes Better	0.09	0.68	0.00
Healthier	0.48	0.70	0.01
Easier to Conceal	0.07	0.69	0.00
Smells Less Strongly	0.29	0.71	0.00
More Convenient	−0.34	0.76	0.00
Better/Stronger High	−0.11	0.73	0.00
Preference for Hash Oil	0.40	0.81	0.01
Preference for THC Wax	0.36	0.85	0.00
Preference for Dried Bud	0.36	0.95	0.00
Impulsivity	1.09	0.49	0.09 *
Poor Self-Control	−0.67	0.57	0.03

Note.

* $p < .05$

** $p < .01$

*** $p < .001$