

Electronic Cigarettes and Cannabis: An Exploratory Study

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Key Words

Cannabis · Marijuana · Electronic cigarette ·
Electronic vaporizer · Smoking · Internet survey

Abstract

Aims: To describe cannabis ‘vaping’ with electronic cigarettes (e-cigarettes) or electronic vaporizers (e-vaporizers).

Methods: Internet survey in 2013–2014. Participants were 11 people who ‘vaped’ cannabis with e-cigarettes and 44 people who vaped cannabis with e-vaporizers, enrolled online.

Results: Most participants were men (78%). They had used e-cigarettes for 6 days and e-vaporizers for 50 days on average to vape cannabis. Current users of e-cigarettes vaped cannabis on 2 days/week versus 6 days/week for users of e-vaporizers. In these devices, they mostly inserted cannabis buds and oil rather than hashish or wax/butane honey oil. Dual users, who both smoked and vaped cannabis, currently smoked 5 joints/week compared to 14 joints/week before they started to vape cannabis ($p = 0.004$). Half the participants (45%) reported that vaping cannabis helped them stop or reduce their total cannabis use, 37% that it had no impact on their cannabis use, and 6% that it increased it. Vaping cannabis was perceived as healthier and more discrete than smoking it (less odor). Disadvantages included dry mouth and fewer positive cannabis effects. **Conclusions:** Cannabis vaping via e-cigarettes or e-vaporizers is an infre-

quent behavior that was previously almost undocumented. E-cigarettes do not appear to be a very appealing way to use cannabis.

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Introduction

Electronic cigarettes (e-cigarettes) are increasingly popular among tobacco smokers [1]. E-cigarette comprises a battery, an atomizer (metallic coil electrically heated), and a tank or cartridge that contains a liquid that is heated and vaporized. E-cigarettes are mainly used with nicotine, but they can also be used with cannabis. Cannabis-containing refill liquids for e-cigarettes are not available commercially, but can easily be made at home by users (see below). These home-made liquids are used with commercially available e-cigarettes that are designed to vape nicotine, not cannabis.

In contrast, electronic vaporizers (e-vaporizers) use a flow of hot air to vaporize dry material or oils [2–4]. E-vaporizers comprise a battery, a heating element (metallic coil), and a chamber in which the cannabis material is inserted: buds, hashish, oil, or butane hash oil/butane honey oil (BHO), a particularly concentrated cannabis extract that can be either smoked, eaten or vaped [5]. The metallic coil is electrically heated and when the user puffs,

a flow of hot air passes through or over the cannabis, and the heat vaporizes the cannabinoids on the surface of the cannabis products. The user inhales a vapor that contains tetrahydrocannabinol (THC) [4]. Thus, the main difference between e-cigarettes and e-vaporizers is that in e-cigarettes, the cannabis material is in liquid form, mixed with propylene glycol, glycerol, and sometimes nicotine, water, flavors and ethanol, whereas in e-vaporizers, the cannabis material is used in raw form (buds, hashish, oil, BHO). On the Internet, e-vaporizers are either advertised for use with 'dry herbs' or with cannabis [6].

The use of e-vaporizers to inhale cannabis has already been studied, albeit mainly in the laboratory (rather than in the population), and mainly with nonportable devices, in particular the Volcano vaporizer [4, 7–10]. The Volcano is a large vaporizer that heats cannabis at a temperature where cannabinoids are vaporized (200°C), but below the combustion temperature (i.e. 240–1,200°C) [7]. This temperature range ensures that no carbon monoxide, hydrocarbons or other toxic combustion substances are produced [4]. The amounts of THC in the Volcano vapor are comparable to the amounts in cannabis smoke [11, 12]. In volunteers, the plasma THC levels were similar when using the Volcano device and when smoking cannabis, but the device delivered no carbon monoxide (because there is no combustion) [4]. Respiratory symptoms are decreased and respiratory function is improved in cannabis users who vaporize cannabis instead of burning it [9, 10]. The Volcano is often used to administer cannabis for medical reasons, and an international survey found that it is the most frequently used cannabis vaporizer [13].

The amounts of THC in the vapor produced by e-cigarettes or by portable e-vaporizers (as opposed to the Volcano), or THC plasma levels in users, have not yet been reported in the peer-reviewed literature. These amounts are probably highly variable, depending on the vaporizing technology, the power and temperature of the vaporizer, the type of cannabis product, the puffing behavior and the level of dependence of the users. It is quite likely that users self-titrate, meaning that they inhale vapors until they are satisfied and obtain the desired effects and the desired amount of THC.

The characteristics of users of e-vaporizers have seldom been described, and almost exclusively with the Volcano [4, 7–10]. However, many portable vaporizers have appeared recently [2, 3]. The use and effects of e-cigarettes or portable e-vaporizers to 'vape' cannabis, and the profile, motivations and behavior of cannabis 'vapers' have not yet been reported in the scientific literature. Thus, the aim of this study was to describe and compare, for the first

time, the profile of people who vaped cannabis either with e-cigarettes or with e-vaporizers, the patterns of use and the perceived effects of vaping on cannabis use.

Methods

For convenience (the author manages these websites), we posted a questionnaire in English and French on the smoking cessation website Stop-Tabac.ch and on the cannabis cessation website Stop-Cannabis.ch between December 2013 and May 2014 [14–16]. We also asked websites informing about cannabis or e-cigarettes and specialized discussion forums to publish links to this online questionnaire. The questionnaire covered current and past use of e-cigarettes or e-vaporizers to inhale cannabis, perceived effects on cannabis use, what cannabis product they used in e-cigarettes/e-vaporizers: buds, hashish, oil, or wax/BHO, cannabis and tobacco smoking (daily, nondaily, former smoker, never smoker of cannabis or tobacco), age, sex and country of residence (table 1). To assess duration of use, we asked: 'For how many days *in total* did you use the electronic cigarette or the portable electronic vaporizer to inhale cannabis?' Participation was anonymous and limited to people who ever used e-cigarettes or e-vaporizers to inhale cannabis.

In response to open-ended questions (free text fields), participants indicated which brand and model of e-cigarette or e-vaporizer they used most, the reasons why they used these devices to inhale cannabis rather than smoke or ingest it, the most positive and negative points about vaping cannabis and side effects, and how they prepared cannabis-containing refill liquids for e-cigarettes. To classify participants in either category, we used responses to open-text fields on e-cigarette and e-vaporizer brands and models. For each model, we searched the Internet and YouTube to distinguish e-cigarettes (i.e. with liquids) from e-vaporizers (i.e. with dry materials or oil).

As this was an exploratory study, no sample size calculation was performed. Medians rather than means were used for continuous variables because medians are less sensitive to outliers, which can excessively influence means in small samples. We used Mann-Whitney U tests to compare medians, t tests to compare means, and χ^2 tests to compare proportions.

Results

Participants

We obtained 61 usable responses from respondents who declared that they had ever used e-cigarettes or e-vaporizers to inhale cannabis, including 11 people who used e-cigarettes to vape cannabis, 36 people who used portable e-vaporizers, 8 people who used nonportable e-vaporizers, 1 participant who used a nonelectronic vaporizer (a Vapo2 glass bulb heated manually with a lighter), and 5 participants who could not be attributed with certainty to any of the former groups. These 61 respondents

Table 1. Characteristics of people who used e-cigarettes or portable e-vaporizers to inhale cannabis, and usage patterns, Internet, 2013–2014

Characteristic	E-cigarette	E-vaporizer	Statistic	p value
Number of respondents	11	44		
Age, years ¹	45 (27, 57)	36 (21, 58)	U = 120	0.48
Men, %	78	79	$\chi^2 = 0$	0.94
Current users of ecig/e-vaporizer to inhale cannabis, % (the rest = past users)	55	91	$\chi^2 = 10.4$	0.006
Cannabis product used in ecig/e-vaporizers, %				
Buds	45	77	$\chi^2 = 3.7$	0.054
Oil	54	21	$\chi^2 = 2.8$	0.09
Hashish	18	21	$\chi^2 = 0$	0.90
Wax/BHO	9	18	$\chi^2 = 0.5$	0.46
Duration of use of ecig/e-vaporizer to inhale cannabis, days ¹	6 (82, 135)	50 (15, 365)	U = 100	0.017
In current users (n = 46), median days per week using the ecig/ e-vaporizer to inhale cannabis	2	6	U = 68	0.10
In current users, puffs per day of cannabis on ecig/e-vaporizer ¹	23 (3, 63)	12 (5, 20)	U = 92	0.40
In current users, money spent peer week to vape cannabis (substance + equipment), USD ¹	20 (0, 30)	20 (5, 40)	U = 38	0.66
In current users, effects of cannabis vaping on their total consumption of cannabis, %			$\chi^2 = 1.0$	0.62
It helps me stop or reduce my total cannabis use	50	45		
It has no influence on my total cannabis use	33	38		
It makes me use even more cannabis	17	5		
Cannabis smoking, %			$\chi^2 = 2.4$	0.49
Smoke cannabis daily	36	41		
Occasionally (nondaily)	18	27		
Former cannabis smokers	27	44		
Never been a cannabis smoker	0	5		
In dual users who currently smoked and vaped cannabis (ecig: n = 3, e-vaporizer: n = 22)				
Joints smoked per week now ¹	6 (4, 10)	5 (0.4, 18)	U = 26	0.55
Joints smoked per week before they started to use ecig (n = 3)/e-vaporizers (n = 25) to inhale cannabis ¹	14 (12, 20)	14 (4, 21)	U = 31	0.62
Tobacco smoking, %			$\chi^2 = 7.1$	0.07
Daily	18	14		
Occasionally (nondaily)	0	7		
Former tobacco smoker	64	32		
Never smoker	0	34		

¹ Median (25th and 75th centiles).

included 24 daily users (39%), 25 occasional (nondaily) users (41%), and 12 former users (20%) of these devices to inhale cannabis. Most participants were men (78%) and the median age was 37 years. Respondents lived in the US (38%), France (16%), Canada (13%), Switzerland

(5%), other countries (10%) or did not indicate a country of residence (18%). All participants were current or past cannabis smokers. A quarter of participants (26%) currently smoked tobacco. No participant indicated that they vaped illicit substances other than cannabis.

Brands

The e-cigarette brands used to vape cannabis included the Ego (n = 4, various manufacturers), Evic by Joyetech, Cigartex, Vapeo Eroll, Provari by Provape, Kanger, and Open (n = 1 each). The most frequently used portable e-vaporizers were the Magic Flight Launch Box (n = 9), Pax by Ploom (n = 7), Da Vinci and Atmos (n = 2 each), Lux by Vaporwild, Vapour Blunt, Vapir One, Sonic, micro Gpen, Iolite Original, Onyx Firebird, Da Buddha, Persei and Vision Spinner (n = 1 each). Nonportable e-vaporizers included the Volcano by Storz and Bickel (n = 2), the Plenty by Storz and Bickel, the VP100 by USA Vaporizer, the Black Box by EasyVape, the Herborizer XL and the Tower (n = 1 each).

Cannabis Smoking

Most participants (62%) were current cannabis smokers, and cannabis vapers (i.e. dual users) currently smoked on average 5 joints per week, compared with 14 joints per week before they first started to vape cannabis ($t = 3.2$, $p = 0.004$, from paired samples t test). Of current users of both smoked cannabis and e-cigarettes or e-vaporizers, 45% thought that vaping cannabis helped them decrease their total cannabis use, 37% thought that vaping had no influence on their total cannabis use, and 6% thought it made them use more cannabis.

Comparing Users of E-Cigarettes and E-Vaporizers

There were fewer current users (and more past users) of these devices among the 11 users of e-cigarettes than among the 44 users of e-vaporizers (portable + nonportable; table 1). The total duration of use of these devices was shorter among users of e-cigarettes (median = 6 days) than among users of e-vaporizers (median = 50 days, $p = 0.017$). The number of days per week using the device was also lower among e-cigarette users than among users of e-vaporizers. Users of e-cigarettes were less likely to use cannabis buds and more likely to use cannabis oil than users of e-vaporizers. Finally, e-cigarette users were more likely to be former tobacco smokers than users of e-vaporizers (table 1).

E-Cigarette Users

The most frequently used cannabis products in e-cigarettes were cannabis buds and oil. Participants indicated that there are several ways to extract THC for use in refill liquids for e-cigarettes. In the simplest form, cannabis buds are ground and soaked in commercial refill liquids for e-cigarettes (comment by a participant: *'Cannabis or grass are macerated. Those are ground as finely as possi-*

ble'). The buds can be used several times, but this technique may clog the atomizer. THC can also be extracted with carbon dioxide: *'I use an ecig 'tank' designed for nicotine fluids and then I put CO₂ extracted THC oil into the tank, I believe they use vegetal glycerin in the CO₂ oil to help vaporize the oil'*. Ethanol and polyethylene glycol (PEG) are also used as dilutants: *'My e-liquid is a dilution of cannabis oil with a few % of ethanol and propylene glycol. It is used with a standard e-cig: Ego battery and Kanger T2 wick'*. *'I prepare e-liquid by dissolving a relatively pure [cannabis] extract in PEG-300 or ethanol and heating it'*. *'I soak frozen cannabis flowers in 90° alcohol, then I evaporate the alcohol, I was unable to mix this extract with propylene glycol or glycerol'*. Participants may also modify their e-cigarette for cannabis use: *'My Ego is not made for cannabis, I made it compatible'*. THC can also be extracted with butane gas or isopropyl alcohol, as indicated by a participant: *'The first method was the butane gas absorbent. It gives very good results [...]. The second less effective way that I've tried is isopropyl alcohol absorbent'*.

Among e-cigarettes users, 27% used refill liquids with artificial cannabis flavor (not real cannabis), and when they did so, they used the artificial cannabis flavor during one day on average (comment from a user: *'the artificial cannabis flavor is disgusting'*).

Reasons for Use

In free text fields, participants indicated why they used e-cigarettes or e-vaporizers to inhale cannabis instead of smoking or eating it (113 comments from 50 participants), and the perceived beneficial effects of cannabis vaping (127 comments from 44 participants). The answers to these two questions were merged because they were largely similar. Answers to these two questions included the perception that vaping is healthier than smoking (47 comments, e.g. *'for health benefits'*, *'it's better for the lungs than smoke'*, *'for treatment of COPD'*, *'to stop coughing'*, *'my COPD is totally under control'*, *'my respiratory health has improved, I can climb stairs without becoming wheezy'*); the better quality of the 'high' (32 comments: *'more pleasant high'*, *'clearer high'*, *'better effect'*), less impairing than with cannabis smoking (*'I feel more active and more social using the vaporizer'*, *'better quality high'*); that vaping is discrete, stealthy, leaves no lingering smell, can be used when smoking is not possible (28 comments: *'it smells less than smoking does'*, *'to avoid detection in non-smoking areas'*, *'stealthy'*, *'the smell is much more discrete than smoking'*); that vaping cannabis is cheaper than smoking it and uses less cannabis (22 comments: *'cheaper in the long run'*, *'less amount of stash*

needed', 'it leaves material that can be made into edible cannabis products'); curiosity (18 comments: 'to see what it was like', 'a friend had it', 'I was curious', 'just wanted to try it once', 'others recommend it'); that there is no tobacco, no nicotine, no combustion (17 comments: 'to avoid smoke-related toxins', 'want to wean myself from nicotine addiction'); that vapor is easier to inhale than smoke (11 comments: 'less as harsh', 'the vapor is smoother'); that it tastes better (6 comments: 'smoking cannabis tastes terrible compared to vaping cannabis'), and to medicate (2 comments: 'medical patient so I needed a conservative way to medicate').

Disadvantages and Side Effects

The perceived disadvantages and side effects of cannabis vaping (77 comments from 40 participants) included the fact that the atomizers get clogged, that it takes time to charge and to prepare the device, that the batteries get discharged (11 comments: 'you have to check the batteries otherwise you may be disappointed with the results', 'there is a learning curve when you first start to vape'); that the high is not as good as with smoking (8 comments: 'doesn't hit the same spot', 'the effects are rather minimal compared to smoking or eating', 'it has less of an impact as a medicine for me personally'); dry mouth, throat irritation, nose clog (7 comments), and that it is difficult to control the dose (4 comments: 'can get too wasted').

Discussion

E-cigarettes and portable e-vaporizers are a new way to inhale cannabis. In contrast with the large numbers of nicotine vapers enrolled with the same recruitment strategy in our previous studies [14, 15, 17], we were able to enroll only a limited number of cannabis vapers. This suggests that vaping is not very frequent among cannabis users, or that cannabis vapers were reluctant to answer the survey. Interestingly, we found fewer users of e-cigarettes than users of portable e-vaporizers to vape cannabis. E-cigarettes were also used for a shorter duration than e-vaporizers, and half of those who had ever used e-cigarettes to vape cannabis had stopped doing so by the time of the survey (compared with only 10% of users of e-vaporizers). In e-cigarette users, the duration of cannabis vaping was also much shorter (6 days) than the duration of e-cigarette use in current and former tobacco smokers enrolled with a similar recruitment strategy (3–4 months) [14, 15]. This suggests that e-cigarettes are not a very appealing way to use cannabis. It is possible that the techni-

cal difficulty of preparing homemade cannabis-containing e-liquid is a barrier for many people, or that the THC is not satisfactorily transferred from the cannabis to the liquid, or from the liquid to the vapor, or from the vapor to the blood of users.

For both tobacco and cannabis, inhalation allows for immediate effects and for self-titration of the substance by the user. In users of cannabis-containing e-vaporizers or e-cigarettes, the number of puffs per day (12–23 puffs/day on average) was much lower than the number of puffs in regular users of nicotine-containing e-cigarettes observed in other studies (150–200 puffs/day for nicotine users) [14, 15]. This pattern of use may reflect the behavior of most cannabis users: they use just enough cannabis to get high, and the impairment may last several hours. In contrast, given the short half-life of nicotine, tobacco smokers or nicotine vapers need to smoke or vape relatively constantly throughout the day to maintain a steady blood nicotine level and avoid withdrawal symptoms [18].

Buds and oil were the cannabis products most frequently used by cannabis vapers (one limitation of our study is that we did not define 'oil', a term that can designate various cannabis products). Inhaling oil can cause a potentially fatal disease called lipoid pneumonia, which was reported in a user of nicotine-containing e-cigarettes [19]. It is unclear whether the oil in oil-containing e-cigarettes and e-vaporizers is transferred to the vapor, and this deserves investigation. Wax or BHO is a new, high-THC cannabis product obtained by compressing butane gas in a metallic tube filled with cannabis [20]. Wax/BHO was used by 15% of cannabis vapers, but we are aware of no published data that would enable us to compare this figure with the frequency of wax/BHO use in cannabis smokers. Artificial cannabis flavors were seldom used in e-cigarettes, apparently because they are not satisfactory.

In cannabis vapers who also smoked cannabis (dual users), the number of joints smoked per week was substantially lower than the number of joints smoked before they first started to vape cannabis (although retrospective assessments may lack validity). Furthermore, most users said that vaping cannabis either helped them decrease their total cannabis consumption or had no effect on their total cannabis use. Thus, our results suggest that cannabis vaping may help users stop smoking this product, but this hypothesis needs to be verified in experimental studies. If this hypothesis was confirmed, vaping, as a harm reduction tool, could bring considerable health benefits.

In open-ended questions, the most frequently cited advantages of cannabis vaping was that it was perceived

as healthier than smoking, as there is no combustion and no concomitant use of nicotine. These results are compatible with previous reports [8–10]. Thus, vaping cannabis eliminates both the exposure to toxic combustion products and to nicotine, as cannabis is often mixed with tobacco when smoked. Initiation to tobacco smoking and to nicotine dependence in nonsmokers, and relapse to tobacco smoking in former tobacco smokers are serious consequences of cannabis smoking [21]. Vaping, as a replacement for smoking, could eliminate these undesirable consequences of cannabis use.

The perceived disadvantages of cannabis vaping included technical problems, the possibly inferior effects compared to the effects obtained by smoking cannabis, the difficulty to correctly dose the cannabis, and dry mouth. These disadvantages may explain why cannabis vaping does not appear to be very popular. However, THC delivery may improve as new models of e-cigarettes and e-vaporizers appear on the market. Thus, our results may not apply to future products.

Even though answers to open-text questions indicated that participants vaped cannabis for reasons other than reducing their cannabis use, many participants nevertheless reported that vaping helped them reduce their cannabis use. This suggests that vaping replaces smoking, and because vaping is possibly less satisfactory than smoking, vapers end up decreasing the total amount of cannabis they use.

Most cannabis vapers were men, possibly because in the general population, the prevalence of cannabis use is higher in men than in women [22].

Participants used many different models and brands. The presence of many suppliers on this market suggests that there is a demand for these products.

There were more positive than negative comments on cannabis vaping, either because our recruitment method resulted in the self-selection of satisfied users, or because vaping is actually appreciated by most users.

Limitations

This study was conducted in a small, self-selected sample of cannabis vapers, enrolled on cannabis, e-cigarette and smoking cessation websites and discussion forums. This recruitment strategy may have led to the selection of people highly motivated to quit or currently trying to quit and thus, to an overestimation of the effects of vaping on cannabis smoking. Furthermore, most participants did not smoke tobacco, which is unusual in cannabis users. Participants were on average 37 years old, which is relatively old for cannabis users. Thus, these results do not

necessarily apply to all cannabis users, and they need to be confirmed by studies conducted in more representative samples of vapers. These studies may also analyze the content of online discussion forums, use more comprehensive questionnaires and interviews and focus on groups with cannabis vapers. The products will need to be described precisely. For example, our questionnaire asked about oil without providing a definition of it, even though the expression ‘cannabis oil’ can designate several different products. In spite of these limitations, this study enabled us to produce new, interesting information that was not previously available, and to generate new hypotheses (in particular that vaping cannabis helps to stop smoking it).

Conclusions

Cannabis vaping via e-cigarettes or portable e-vaporizers is an emerging practice that does not seem to be very frequent among cannabis users, and was previously almost undocumented. E-cigarettes (with liquids) appear to be less appealing than portable e-vaporizers (with dry materials or oil) to vape cannabis. Cannabis vapers in this study used e-cigarettes or e-vaporizers less intensively than tobacco smokers used nicotine-containing e-cigarettes in previous studies. Users chose this technology to decrease health risks, to avoid combustion, to avoid tobacco and nicotine, to avoid the lingering smell, because vaping cannabis is cheaper than smoking it, or just out of curiosity. There is a need to inform the public, health professionals and policy makers about this new behavior, and to produce the scientific background for a dispassionate discussion of the legal and social implications of these new technologies.

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Disclosure Statement

J.-F.E.’s salary is paid by the University of Geneva. He was reimbursed by a manufacturer of e-cigarettes and e-liquids for traveling to London and to China, to visit e-cigarette factories, but received no honoraria for these meetings. J.-F.E. authored a book on e-cigarettes.

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