



Full length article

# Explaining the effects of electronic cigarettes on craving for tobacco in recent quitters



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## ABSTRACT

**Objective:** To explore how e-cigarettes attenuate craving for tobacco, in e-cigarette users who recently quit smoking.

**Design:** Cross-sectional survey of recent quitters, Internet (French and English), 2012–2014. Participants were 374 daily users of e-cigarettes who had quit smoking in the previous two months, enrolled on websites dedicated to e-cigarettes and to smoking cessation. We measured perception that e-cigarettes attenuate craving for tobacco cigarettes, characteristics of e-cigarettes, modifications of the devices, patterns of e-cigarette use, reasons for use, satisfaction with e-cigarettes, dependence on e-cigarettes, and personal characteristics.

**Results:** The strongest attenuation of craving for tobacco was obtained by using higher nicotine concentrations in refill liquids, modular systems (rather than unmodified devices), and high voltage batteries. The strength of the effect of e-cigarettes on craving was also associated with more intensive use (more puffs per day, more refill liquid). Stronger effects on craving were associated with satisfaction with e-cigarettes, and with reporting that e-cigarettes helped to quit smoking. Participants who reported the strongest effects on craving for tobacco were the most dependent on the e-cigarette and had the strongest urges to vape.

**Conclusions:** From a public health perspective, there is a trade-off between e-cigarettes that provide high levels of nicotine, high satisfaction and more effects on craving for tobacco, but may also be addictive, and e-cigarettes that contain less nicotine and are less addictive, but are also less satisfactory and less efficient at relieving craving and at helping dependent smokers quit smoking. This trade-off must be kept in mind when regulating e-cigarettes.

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## 1. Introduction

Electronic cigarettes (e-cigarettes) are increasingly popular (Hajek et al., 2014). There is increasing evidence from randomized trials that e-cigarettes are effective smoking cessation aids (Adriaens et al., 2014; Hajek et al., 2014), and observational studies also suggest that e-cigarettes help smokers quit smoking and former smokers avoid relapse (Biener and Hargraves, 2014; Brown et al., 2014; Hajek et al., 2014). One possible cause of this effect is that e-cigarettes attenuate craving for tobacco and other tobacco withdrawal symptoms. Although withdrawal symptoms have often been hypothesized to cause relapse in former smokers, only craving and depression consistently have predicted future relapse to smoking and even so, this effect is often not found (Patten and Martin,

1996). Thus, it is relevant to study the effects of e-cigarettes on craving specifically.

From surveys of e-cigarette users, we know that most former smokers report that e-cigarette relieve craving for tobacco (Dawkins et al., 2013b; Etter and Bullen, 2011b; Harrell et al., 2014), that dealing with craving is an important reasons why former smokers use e-cigarettes (Etter and Bullen, 2011b), and that e-cigarette users think that restricting the range of available flavors would increase their craving for tobacco (Farsalinos et al., 2013b). From tests conducted in the laboratory, we know that craving for tobacco cigarettes decreases immediately after e-cigarette use (Adriaens et al., 2014; Bullen et al., 2010; Dawkins and Corcoran, 2014; Dawkins et al., 2013a, 2012; Evans and Hoffman, 2014; Nides et al., 2014; Vansickel et al., 2010), that nicotine-containing e-cigarettes have a stronger effect on desire to smoke than nicotine-free e-cigarettes (Dawkins et al., 2012), and that being told that the an e-cigarette contains nicotine (even though it actually contains no nicotine) attenuates craving for tobacco (Copp et al., 2014). One study found that new e-cigarette models (refillable tanks) are

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more effective at relieving craving for tobacco than older models (“cig-alike”; Farsalinos et al., 2014b), but another study found no difference (Dawkins et al., 2014). Otherwise, there is very little published research on the factors associated with the effects of e-cigarettes on craving for tobacco, such as the characteristics of the device and refill liquid (“e-liquid”), specific ways to use the devices, the characteristics of users, satisfaction with the devices, or the sensations felt while when inhaling.

Thus, the aim of this study was to provide a detailed analysis of the effects of e-cigarettes on craving for tobacco, and of the factors associated with this effect. Such a description is useful for vapers, to help them choose the products that are best at helping them quit smoking, for clinicians who advise vapers and smokers, for researchers who design clinical studies, for manufacturers and retailers, and for policy makers who regulate e-cigarettes. From a regulatory perspective, it is important to identify the characteristics of e-cigarettes that are associated with craving relief. In particular, it would be unwise to ban or restrict ingredients or product characteristics that contribute to relieving craving for tobacco.

## 2. Methods

The study builds on our previous surveys of vapers (Dauptcheva et al., 2013; Etter and Bullen, 2011a; Etter, 2010a; Etter and Bullen, 2011b, 2014). We posted a questionnaire on the smoking cessation website Stop-Tabac.ch (Etter, 2008; Etter and Hughes, 2006), in English and French, between October, 2012 and September, 2014. We chose this site for convenience (it is managed by the author). We contacted discussion forums and websites informing about e-cigarettes or selling them, and asked them to publish links to the survey (<http://www.stop-tabac.ch/en/ECIG2012/>). Participants were >18 years, and only daily users of e-cigarettes who had quit smoking in the previous 62 days were eligible. The time frame of 2 months was selected because craving and other withdrawal symptoms are most intense during the first days and weeks after quitting smoking, and curves of withdrawal ratings tend to flatten after 2 months (Etter and Hughes, 2006). A subsample ( $n = 204$ ) answered a follow-up questionnaire after 1 month. The study was approved by the ethics committee of the Geneva University Hospitals.

The questionnaire assessed:

- Prior or current use of e-cigarettes.
- Duration of use, nicotine content, puffs/day, brand and model (open text fields), cost, flavors, propylene glycol (PG) or vegetable glycerin (VG), where e-cigs are purchased, throat hit.
- Use of pre-filled cartridges, unmodified tank systems, or modular systems modified by the users.
- “Does the e-cigarette relieve desire or craving to smoke?”, with 5 response options: Yes, definitely; Yes, a lot; Yes, somewhat; Maybe; No; Not applicable (“Not applicable” was considered as a missing value). For presentation in the tables, the variable was recoded to 3 categories: Yes, definitely; Yes, a lot; Somewhat+maybe+no, but for statistical analyses, we used all 5 response categories.
- Relief of tobacco withdrawal symptoms, using the Minnesota Withdrawal Scale plus an item on mood swings (Etter and Hughes, 2006; Etter et al., 2012) (same response options as above).
- Modifications of the e-cigarette.
- Perceived effect of vaping on smoking cessation and relapse, satisfaction.
- Self-report of dependence on the e-cigarette (0–100 scale), time to first puff on e-cigarette in the morning (an indicator of dependence; Courvoisier and Etter, 2010; Etter et al., 2003).

- Comparison of dependence on e-cigarettes with their former dependence on tobacco cigarettes (weaker, same, stronger).
- Smoking status, cigarettes per day and time to first cigarette before they quit smoking.
- Age and sex, height and weight, country, depression assessed with a 2-item screening test (Whooley et al., 1997), problem drinking assessed with the Alcohol Use Disorders Identification test (AUDIT-C; Bush et al., 1998), cannabis use, and website where respondents learned about the survey (open text field). Websites were categorized as related to e-cigarettes (i.e. commercial or discussion forums) or neutral (Google, Smokefree.gov and Stop-tabac.ch).
- IP addresses (i.e. computer numbers) to delete duplicate records.

### 2.1. Assessment of dependence on e-cigarettes and urges to vape

There is no validated measure of dependence on the e-cigarette. For tobacco cigarettes, commonly used instruments include the 6-item Fagerström test for nicotine dependence (FTND; Heatherton et al., 1991), and the 19-item nicotine dependence syndrome scale (NDSS; Shiffman et al., 2004). A third instrument, the cigarette dependence scale (CDS), is a brief (12 items), self-administered, single-dimension measure that covers DSM-IV and ICD-10 criteria of nicotine or tobacco dependence (Courvoisier and Etter, 2010; Etter, 2008). We modified FTND, NDSS and CDS to assess dependence on e-cigarettes. We labeled the modified scores e-FTND, e-NDSS and e-CDS. For e-FTND and e-CDS, we used 10 puffs on e-cigarettes as equivalent to one tobacco cigarette, because smokers take about 10 puffs from each cigarette (Etter and Perneger, 2001). We assessed urges to vape with 2 items adapted from the mood and physical symptoms scale (MPSS; West and Hajek, 2004): time spent feeling the urge to vape today, and strength of these urges today. We assessed craving for e-cigarettes with an adapted version of the 4-item Craving subscale of the Wisconsin smoking withdrawal scale (WSWS; Etter and Hughes, 2006; Welsch et al., 1999).

### 2.2. Statistical analyses

We used *t* tests and ANOVA models to compare means, Mann–Whitney *U* tests to compare medians, chi-square tests to compare proportions. For most variables, we reported medians rather than means, because medians are less sensitive to extreme values. We used linear regression models to test associations between continuous variables.

## 3. Results

### 3.1. Participants

We obtained usable answers from 374 daily e-cigarette users who had quit smoking within the past 62 days. The median age of these 374 participants was 41 years, and most were men (58%). Distribution of respondents by country was: France (39%), Switzerland (21%), USA (13%), Belgium (5%), UK (4%), Canada (4%), and other countries (14%). Participants learned about the survey on: stop-tabac.ch (15%), forum-ecigarette.com (14%), e-cigarette-forum.com (5%), Facebook (3%), Reddit (3%), Google (3%), Smokefree.gov (2%), other websites (2%), no answer (53%). Most participants (68%) had obtained a diploma that gave access to university, and household income tended to be above average (Table 1).

Participants had quit smoking 28 days before they took the survey, and had also been using the e-cigarette for 28 days (medians). Before they quit smoking, participants smoked 20 cigarettes per day and smoked their first cigarette 10 min after waking up (medians).

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