



Electronic cigarette liquid and device parameters and aerosol characteristics: A survey of regular users

Arit M. Harvanko^{a,*}, Andrea K. McCubbin^b, Kristin B. Ashford^c, Thomas H. Kelly^d

^a Department of Behavioral Science, Department of Psychology, Kastle Hall, 173 Funkhouser Dr, Lexington, KY 40506-0044, United States

^b University of Kentucky College of Nursing, 509C College of Nursing Building, Lexington 40536-0232, United States

^c University of Kentucky College of Nursing, 417 College of Nursing Building, Lexington 40536-0232, United States

^d Department of Behavioral Science, Department of Psychology, University of Kentucky College of Nursing, Department of Psychiatry, Medical Behavioral Science Building, Lexington, KY 40536-0086, United States

HIGHLIGHTS

- Power settings and nicotine concentrations were variable among regular electronic cigarette users.
- 'Taste' and avoiding 'headache' or 'sore throat' were highly rated criteria when purchasing liquids.
- Propylene glycol and vegetable glycerin were associated with desirable and undesirable subjective effects, respectively.

ARTICLE INFO

Keywords:

Nicotine
Abuse liability
Propylene glycol
Vegetable glycerin
Wattage
Taste

ABSTRACT

Introduction: Electronic cigarettes are widely variable devices, typically with user definable liquid and device parameters. Yet, little is known about how regular users manipulate these parameters. There is also limited understanding of what factors drive electronic cigarette use and liquid purchasing, and whether two common ingredients, propylene glycol and vegetable glycerin, alter the subjective effects of these devices.

Methods: During the spring of 2016 522 adults, who reported daily use of electronic cigarettes containing nicotine, completed a survey on electronic cigarettes. Survey questions included an electronic cigarette dependence questionnaire, questions on tobacco and electronic cigarette use, and device and liquid preferences.

Results: Fifty-nine percent of respondents reported using another tobacco product, which was positively associated with level of nicotine dependence. On average, devices were set to 28.3 ($SD = 24.2$) watts. Ability to change device voltage, and level of resistance typically used, was significantly associated with level of nicotine dependence. Amount of liquid consumed, nicotine concentration, and milligrams of nicotine used per week, were positively associated with nicotine dependence. Participants rated 'good taste' as the most important consideration when using and purchasing liquids, and propylene glycol is associated with undesirable effects and vegetable glycerin with desirable effects.

Conclusions: These data indicate that electronic cigarette users utilize a wide range device parameter settings and liquid variables, and that individuals with greater nicotine dependence favor voltage control devices, and lower resistance heating elements. Taste is a key factor for electronic cigarette selection, and concentrations of propylene glycol and vegetable glycerin may have a significant impact on the reinforcing effects of liquids.

1. Introduction

Electronic nicotine delivery systems, and specifically 'electronic cigarettes' (ECs), represent a varied group of devices with user adjustable parameters, including heating element variables (such as heater coil configurations and power settings), and concentrations of nicotine, a variety of flavorants, and other ingredients in liquids. Early ECs (i.e.

'first-generation' ECs) were relatively simple devices that restricted the user from altering power levels and heater coil configurations, and typically limited liquids to only those sold for a specific device. ECs evolved from these simpler first-generation devices to more sophisticated 2nd and 3rd generation devices. Key changes include heating element control by specifying wattage, voltage, or temperature, adjustable heater coil configurations (e.g. number, diameter, length, and

* Corresponding author at: University of Kentucky, Kastle Hall, 173 Funkhouser Dr, Lexington, KY 40506-0044, United States.
E-mail address: Arit.H@uky.edu (A.M. Harvanko).

materials of coils), and refillable tanks that allow the user to control liquid composition. Because ECs have many variables, it is necessary to understand how regular EC users utilize their devices and their parameters to construct relevant regulatory policy or maximize efficacy of ECs for smoking cessation.

One key function of ECs is to deliver nicotine, which is influenced by user-adjustable parameters. Previous laboratory research has demonstrated that concentration of nicotine in EC liquids can have a significant impact on the EC-using experience and the composition of the aerosols they produce. Expectedly, increases in liquid nicotine concentration have been shown to increase concentration of nicotine in EC aerosols (Talih, Balhas, Eissenberg, et al., 2015) and plasma nicotine levels following EC use, with plasma nicotine levels following high nicotine concentrations (i.e. 3.6% nicotine) exceeding levels typically achieved from conventional tobacco cigarettes (CC) (Ramôa, Hiler, Spindle, et al., 2016). The nicotine concentration in EC liquids has also been demonstrated to have a negative relationship with puff topography, such that EC users will take shorter duration puffs from ECs containing higher nicotine concentrations compared to lower concentrations (Lopez, Hiler, Soule, et al., 2016). Lastly, previous research showing that liquids with greater proportions of propylene glycol (PG), relative to vegetable glycerin (VG), increases nicotine concentration in EC aerosols, which may suggest that PG/VG concentrations could alter plasma nicotine concentrations following EC use (Talih, Balhas, Salman, et al., 2016).

It has also been suggested that EC device parameters affect the level of nicotine emitted by ECs. Shihadeh and Eissenberg (2015) provide a framework for understanding the level of nicotine emitted by ECs, emphasizing that many different EC variables impact nicotine emission. Variables in this framework include: liquid container design (e.g. cartomizer, tank, drip tip, disposable), heating element parameters (electrical resistance, voltage, and surface area of the heating coil), liquid variables (nicotine concentration, solvent composition, flavoring, and other additives), and usage behaviors (puff duration, inter-puff interval, and number of puffs). Since these variables likely affect nicotine delivery, they also likely affect the abuse liability of ECs. Additionally, these variables can influence the potential harm of ECs. For example, voltage level (directly associated with wattage when coil resistance is held constant), is associated with emissions of carcinogens from ECs (Kosmider, Sobczak, Fik, et al., 2014). Other research has demonstrated that constituents in EC liquids – namely PG and VG – can degrade into carcinogens when used in an EC. Yet, whether regular EC users typically use ECs in a manner that would lead to high levels of carcinogen emission is not well studied.

It is important to know what factors motivate the initiation and continued use of ECs in order to more completely understand their abuse liability and efficacy as potential smoking cessation tools. Farsalinos, Romagna, Tsiapras, et al. (2013) reported that the majority of EC users in their sample use multiple different flavors within a day, and that the EC would be ‘less enjoyable’ if flavor availability were limited. Therefore, taste might drive both the initiation and continuation of EC use. It is unclear from these data, however, what the relative contribution of taste is compared to other possible motivations for initiation and continuation of EC use. Users of ECs have also identified “throat hit” as an important stimulus characteristic, with reports suggesting that liquid and device parameters (e.g. use of higher liquid nicotine concentrations) may be associated with this effect (Etter, 2016a), though whether device power (i.e. wattage) is associated with throat hit is not yet known.

In August 2016, a Food and Drug Administration (FDA) rule came into effect that placed ECs under FDA regulation. Now that there is a regulatory mechanism for ECs it is important to study usage patterns of regular EC users. Usage patterns of regular EC users may, for example, highlight common behaviors that put individuals at undue health risk, which would provide an important regulatory target. Knowing common EC settings and usage behaviors will also inform future research, such

that studies can utilize the most common EC user settings to determine if these settings confer significant health risks to the user. The extant literature is lacking estimates from a broad sample of regular EC users on key variables that likely influence the reinforcing effects of ECs, their potential harms, and motivations for initiation and continued use of ECs. This poses several problems: 1) it is difficult to conduct generalizable research on ECs without knowing what adjustable parameter settings are commonly used, 2) it is difficult to assess health risks associated with ECs without knowing whether settings that could cause harmful effects are commonly used, and 3) it is difficult to employ meaningful regulation without first understanding how ECs are being used. To address this gap in the extant literature, a survey of regular nicotine-dispensing EC users in the United States was conducted. The primary goal of the survey was to determine how adjustable parameters are typically used, the factors that motivate EC liquid selection, and the factors that influence initiation and continued EC use. Also examined was the association between nicotine dependence and (1) frequency of EC use (2), adjustable settings, and (3) liquid preferences. Results of this survey will support the translation of laboratory research findings to the natural ecology, and to inform EC-related public health policy efforts.

2. Methods

2.1. Participants

A non-EC internet marketplace (Amazon’s Mechanical Turk [mTurk]) was used to recruit study participants. A listing on the site invited EC users to complete the survey during the spring of 2016. Participants were first asked 10 screening questions to verify EC use and establish eligibility. To complete the full survey, participants were required to: report daily use of a nicotine containing EC throughout the past month, use ECs as their primary means of administering nicotine, have a 95% or higher approval rating on previously completed mTurk tasks, and be over 18 years of age.

2.2. Overall procedure

Participants were required to complete all questions applicable to them, and were not shown questions that did not apply to them (e.g. if a participant indicated not currently using tobacco, they were not presented questions regarding tobacco use). To minimize duplicate entries, the survey could be completed on a specific computer only once. This study was approved by the University of Kentucky Institutional Review Board.

2.3. Measures

The survey was comprised of several sub-sections: a nicotine dependence questionnaire (the Penn State [Electronic] Cigarette Dependence Index), tobacco and electronic cigarette usage history, device preferences, and liquid preferences.

2.3.1. Penn State [electronic] cigarette dependence index (PSCDI)

This scale contains 10 questions regarding use of electronic and tobacco cigarettes and behaviors associated with nicotine dependence (Foulds, Veldheer, Yingst, et al., 2015). Scores range from 0 to 19, with higher scores indicating greater dependence on electronic and tobacco cigarettes.

2.3.2. Tobacco and electronic cigarette usage history

This experimenter-designed section consisted of seven items assessing quantity and frequency of EC usage, and reasons for initial and continued use. Questions included: ‘do you own an electronic cigarette [yes/no],’ ‘were you a regular tobacco user prior to using an electronic cigarette,’ ‘are you currently trying to quit using tobacco products,’ ‘are you currently trying to quit using tobacco products by using electronic

Download English Version:

<https://daneshyari.com/en/article/7259099>

Download Persian Version:

<https://daneshyari.com/article/7259099>

[Daneshyari.com](https://daneshyari.com)