



User-identified electronic cigarette behavioral strategies and device characteristics for cigarette smoking reduction



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HIGHLIGHTS

- ECIG users identify many behaviors and device characteristics for smoking reduction.
- Many ECIG users are unaware of their ECIG device/liquid characteristics.
- Many smokers who use ECIGs for smoking reduction continue to smoke cigarettes.
- Switching abruptly from cigarettes to ECIGs may be more associated with smoking reduction.

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ABSTRACT

Background: There is limited evidence on how cigarette smokers use electronic cigarettes (ECIGs) for smoking cessation and reduction. This study used concept mapping, a participatory mixed-methods research approach, to identify ECIG use behaviors and device characteristics perceived to be associated with cigarette smoking cessation or reduction.

Methods: Current ECIG users aged 18–64 were recruited from seven cities selected randomly from U.S. census tract regions. Participants were invited to complete concept mapping tasks: brainstorming, sorting and rating ($n = 72$). During brainstorming, participants generated statements in response to a focus prompt (“A SPECIFIC WAY I HAVE USED electronic cigarettes to reduce my cigarette smoking or a SPECIFIC WAY electronic cigarettes help me reduce my cigarette smoking is...”) and then sorted and rated the statements. Multidimensional scaling and hierarchical cluster analyses were used to generate a cluster map that was interpreted by the research team. **Results:** Eight thematic clusters were identified: Convenience, Perceived Health Effects, Ease of Use, Versatility and Variety, Advantages of ECIGs over Cigarettes, Cigarette Substitutability, Reducing Harms to Self and Others, and Social Benefits. Participants generated several statements that related to specific behavioral strategies used when using ECIGs for smoking reduction/complete switching behaviors such as making rapid transitions from smoking to ECIG use or using certain ECIG liquids or devices. Former smokers rated the Perceived Health Effects cluster and several behavioral strategy statements higher than current smokers.

Conclusions: These results help to identify ECIG use behaviors and characteristics perceived by ECIG users to aid in cigarette smoking cessation or reduction.

1. Introduction

Electronic cigarettes (ECIGs) are a class of products that heat and

aerosolize a liquid containing propylene glycol (PG), vegetable glycerin (VG), nicotine, and chemical flavorants (Breland et al., 2017). ECIGs have become increasingly popular in the U.S. with dramatic increases

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observed since 2011 among youth (US Department of Health and Human Services, 2016) and adults (McMillen, Gottlieb, Shaefer, Winickoff, & Klein, 2015). Reported reasons for ECIG use include curiosity (Berg, Haardoefer, Escoffery, Zheng, & Kegler, 2015; Li, Newcombe, and Walton, 2015) and perceived lower financial cost compared to cigarettes (Kadimpati, Nolan, & Warner, 2015; Soule, Rosas, & Nasim, 2016), but the reason reported most commonly among adults is smoking cessation or reduction (Adkison et al., 2013; Berg et al., 2015; Brown et al., 2014; Goniewicz, Lingas, & Hajek, 2013; Hummel et al., 2015; Kadimpati et al., 2015; Kralikova, Novak, West, Kmetova, & Hajek, 2013; Li et al., 2015; Mark, Farquhar, Chisolm, Coleman-Cowger, & Terplan, 2015; Pepper, Ribisl, Emery, & Brewer, 2014; Peters et al., 2015; Richardson, Pearson, Xiao, Stalgaitis, & Vallone, 2014; Soule et al., 2016; Stein et al., 2015). However, there is a limited evidence base on their effectiveness in aiding cigarette smoking cessation or reduction (Kalkhoran & Glantz, 2016; McRobbie, Bullen, Hartmann-Boyce, & Hajek, 2014).

A comprehensive review (Glasser et al., 2017) identified randomized controlled trials (Adriaens, Van Gucht, Declerck, & Baeyens, 2014; Bullen et al., 2013; Caponnetto et al., 2013; Tseng et al., 2016) that have shown ECIG use was associated with smoking cessation or reduction for some smokers, but also longitudinal cohort studies (Adkison et al., 2013; Al-Delaimy, Myers, Leas, Strong, & Hofstetter, 2015; Grana, Popova, & Ling, 2014; Pearson et al., 2015; Vickerman et al., 2017; Vickerman, Carpenter, Altman, Nash, & Zbikowski, 2013) that have shown no effect or negative effect of ECIG use on smoking cessation. Much of this recent research on ECIG use has focused on the extent to which cigarette smokers use ECIGs and how ECIG use status is associated with smoking status. For example, a recent meta-analysis reported that ECIG use is associated with continued smoking (Kalkhoran & Glantz, 2016) while other studies examining national survey data report that ECIG use is associated with smoking cessation (Zhu, Zhuang, Wong, Cummins, & Tedeschi, 2017). However, these and other studies often focus on if smokers use ECIGs, but do not assess how smokers use ECIGs. Because ECIGs are a diverse class of products that allow for diverse user behaviors, research should examine *how* cigarette smokers use ECIGs for smoking cessation and reduction in addition to *if* cigarette smokers use ECIGs for smoking cessation and reduction. An understanding of the different types of behaviors and ECIG device characteristics that ECIG users report, especially those perceived to be associated with cigarette smoking cessation, may help explain why some cigarette smokers who use ECIGs continue to smoke while others reduce or quit smoking completely. Furthermore, a more thorough analysis of ECIG use behaviors and device characteristics may help identify strategies for aiding cigarette smokers in switching completely to ECIGs as a possible harm reduction approach.

Research that identifies ECIG use behaviors and device characteristics that are associated with cigarette smoking cessation or reduction can inform regulation by identifying characteristics of ECIG products and behaviors that have the greatest potential for positive and negative public health impact. However, national surveillance systems are often not sufficient to capture the diverse ECIG use characteristics and behaviors that may be associated with cigarette smoking cessation or reduction. Methods that allow for in-depth examination of ECIG use behaviors where users can describe their own experiences are needed to understand the association between ECIG use and cigarette smoking cessation or reduction. Concept mapping (CM; Kane & Trochim, 2007; Trochim, 1989), a mixed-method participatory approach, is such a method that has been used previously to examine ECIG use behaviors (Soule et al., 2016; Soule, Lopez, Guy, & Cobb, 2016; Soule, Maloney, Guy, Eissenberg, & Fagan, 2017; Soule, Nasim, & Rosas, 2016). Importantly, this method allows individuals with firsthand knowledge on a topic (i.e., experienced ECIG users who self-report having decreased cigarette smoking by using ECIGs) to generate, organize, and rate importance of content related the research topic. CM also yields similar results compared to other methods such as exploratory factor analysis,

but has unique advantages including being able to be completed in a relatively short time frame without the need of a large sample and generating a useful visual representation of the final framework. Therefore, the purpose of this study was to use CM to identify ECIG use behaviors and device characteristics that ECIG users perceive to be associated with cigarette smoking cessation or reduction. We hypothesized that some strategies and device characteristics identified by ECIG users would be more associated with complete switching from cigarette smoking to ECIGs than others.

2. Methods

2.1. Participants

This study was approved by the Virginia Commonwealth University Institutional Review Board. Past-30 day ECIG users between the ages of 18 and 64 who self-reported cigarette smoking reduction by using ECIGs were recruited by posting advertisements on Craigslist classified pages in a total of seven cities selected randomly from each U.S. census tract region (Northeast, Midwest, South, West; as in Soule et al., 2017). This method yields a more generalizable sample which ensures participation from individuals across the U.S. and results in a more diverse sample compared to other CM studies that recruited ECIG users from ECIG Internet forums (e.g., Soule et al., 2016). Advertisements also were sent directly to ECIG users who were part of an IRB-approved research registry created using similar recruitment procedures (i.e. Craigslist advertisements). Individuals who were interested in the study contacted study staff and were screened for inclusion. Individuals who were not 18–64 years old, non-U.S. citizens, non-ECIG users, ECIG users who had not smoked 100 cigarettes in their lives, and individuals who did not report reducing cigarette smoking by using ECIGs were excluded. One hundred two individuals were contacted for screening and 18 were ineligible (14 reported smoking < 100 lifetime cigarettes, 2 did not self-report reducing cigarette smoking using ECIGs, and were not U.S. citizens). Participants provided informed consent and were sent a link to an online CM program (The Concept System® Global MAX™) to complete the study. Of the 83 individuals invited to participate in the first task (brainstorming), 72 completed it (response rate = 86.7%).

2.2. Sociodemographic and tobacco measures

Participants answered a demographic questionnaire in the CM program that asked about their ECIG use history, device characteristics, other tobacco use, and demographics. ECIG use history items included an assessment of how long participants had used ECIGs regularly (some days or most days; as per items from the National Adult Tobacco Survey; Centers for Disease Control and Prevention, 2016), number of days of ECIG use in the past 30 days, and frequency of ECIG use throughout the day (at least once per day, every once in a while throughout the day, fairly frequently throughout the day, almost always throughout the day). ECIG liquid nicotine concentration, relative concentrations of propylene glycol and vegetable glycerin (PG/VG ratio), flavors used, liquid storage/delivery system (disposable, cartomizer, clearomizer/tank, drip tip), ECIG device type (cig-alike, vape pen style, box mod, rebuildable/mechanical mod), and electrical characteristics (battery voltage, power in watts, coil resistance in ohms) were assessed. Participants reported cigarettes smoked per day and smoking frequency (every day, some days, or not at all) in the past 30 days and one year ago. Participants then completed demographic questions on age, race/ethnicity, and gender.

2.3. Concept mapping procedures

2.3.1. Brainstorming

Participants were directed to provide five to eight statements in response to a prompt related to ways participants used ECIGs to reduce

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