

ORIGINAL INVESTIGATION

Pilot Investigation of Changes in Readiness and Confidence to Quit Smoking After E-Cigarette Experimentation and 1 Week of Use

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ABSTRACT

Introduction: This study examined changes in smokers' readiness and confidence to quit smoking, smoking behavior, nicotine withdrawal symptoms, and tobacco product preference following electronic cigarette (EC) experimentation and 1 week of ad libitum use.

Methods: Current cigarette smokers, with no prior use of ECs and uninterested in quitting, completed 3 study phases: baseline assessment ($N = 20$), experimentation ($N = 19$), and ad libitum use ($N = 16$). Baseline assessment consisted of completion of assessment measures and exhaled carbon monoxide measurements. Experimentation phases consisted of four, 75-min sessions in which participants completed assessment measures and sampled 3 EC brands and their own brand of cigarette (OBC). Ad libitum use included participants selecting and being provided their preferred EC brand from the experimentation phase to be used "as you want" for 1 week. Outcome measures included readiness and confidence to quit smoking, nicotine withdrawal symptoms, product preference/satisfaction, and smoking behavior items.

Results: Readiness and confidence to quit increased significantly during the experimentation period and continued to increase during ad libitum use. There were no significant differences in reported effectiveness in reducing smoking urges and cravings between OBC and EC though OBC were rated as more enjoyable and satisfying. During ad libitum use, regular cigarette smoking decreased by approximately 44% from baseline levels with overall tobacco use (EC + OBC) remaining the same.

Conclusions: Among a small convenience sample of unmotivated cigarette smokers, EC experimentation and 1 week of ad libitum use increased readiness and confidence to quit regular cigarettes and reduced regular cigarette smoking.

INTRODUCTION

Tobacco use is the leading cause of preventable death, and approximately six million individuals worldwide die each year due to its use (U.S. Department of Health and Human Services, 2010; World Health Organization, 2012). Recently, a number of concerns have been raised over the development, marketing, and sale of a new nicotine containing product—the electronic cigarette (EC). The EC is a battery-powered nicotine delivery device that looks similar to a real cigarette and mimics many of the cues of smoking; however, it does not require combustion to deliver nicotine or produce smoke. Although some view this product as a potentially safer alternative to regular cigarettes (Etter, 2012; Wagener, Siegel, & Borrelli, 2012), others see it

as hazardous to the user and a potential burden to public health (Cobb & Abrams, 2011). As a result of the Family Smoking Prevention and Tobacco Control Act of 2009, the U.S. Food and Drug Administration (FDA) currently has regulatory authority over tobacco products; however, regulatory standards have not been set since it is not yet clear how to effectively regulate these products to best protect public health. Currently, ECs are allowed to be regulated as "tobacco products" under the Act and are not drugs/devices unless they are marketed for therapeutic purposes (FDA, 2011).

As of 2011, approximately 57.9% of U.S. adults had heard of the EC and 21.2% of current smokers and 1.3% of never smokers had tried an EC (King, Alam, Promoff, Arrazola, & Dube, 2013) with awareness likely increasing over the past

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2 years as a result of increased marketing efforts (Elliott, 2012). In addition to concerns over the safety of ECs, questions over how EC use may affect smokers' smoking behavior, perceptions, and motivation to quit smoking have not been fully answered. Some, including the FDA, argue that ECs may decrease motivation to quit smoking, be used as a way to get nicotine in places where smoking is prohibited (i.e., "bridge product") and/or serve as a "gateway" product for nonsmokers (Cobb & Abrams, 2011; U.S. Food and Drug Administration, 2009). Specifically, it has been suggested that ECs may promote continued smoking by alleviating the environmental pressures to quit, allowing current smokers to more easily manage nonsmoking environments and the rising costs of regular tobacco cigarettes, as ECs are much less expensive (for a pack-a-day smoker, ECs are approximately \$675 annually versus \$1,825 for regular cigarettes; UBS Investment Research, 2012).

Given the recent introduction of ECs into the marketplace, the current state of behavioral and population-based EC research is limited to only several small clinical and laboratory trials and a few survey studies. These preliminarily studies suggest that for current EC users, ECs significantly reduce cigarette craving, withdrawal, and number of cigarettes smoked, leading to either partial or complete substitution for regular cigarettes (Bullen et al., 2010; Etter & Bullen, 2011). These findings were recently supported by a small pilot clinical trial that found 22.5% of smokers achieved sustained smoking abstinence at 6-month follow-up (Polosa et al., 2011), with the use of the EC. It is important to note that while promising, some of these studies are limited by self-selected samples of visitors to EC forums and Web sites (Etter & Bullen, 2011), lack of a control condition (Polosa et al., 2011), or potential conflicts of interests due to funding by EC manufacturers (Bullen et al., 2010). Those limitations alone do not rule out the findings of those studies but suggests that much of the current EC knowledge base should be interpreted with caution.

To date, no EC studies have investigated changes in current smokers' readiness and confidence to quit smoking following initial experimentation of an EC and following a short period of ad libitum use (i.e., as you want). Investigating what, if any, changes occur might help us better understand the impact of EC experimentation and use by never before EC users. This article presents a pilot clinical laboratory trial examining changes in smokers' readiness and confidence to quit smoking and smoking behavior following initial EC experimentation and after a 1-week period of ad libitum use. Measures of product satisfaction and preference, and nicotine withdrawal were also collected and analyzed. We conducted a prospective study of adult daily smokers, who had never previously tried an EC and reported no interest in quitting smoking in the next 30 days.

METHODS

Participant Eligibility and Recruitment

All study research assistants were trained in protocol procedures and completed required Health Insurance Portability and Accountability Act and Collaborative Institutional Training Initiative trainings, and all study participants provided informed consent for all aspects of the study. The study procedures were

approved by the University of Oklahoma Health Sciences Center Internal Review Board.

Local radio, print, and Internet advertisements (e.g., craigslist) were used to recruit current, nontreatment seeking, users of regular cigarettes. Smokers completed a phone screener to determine eligibility. Smokers were included in the study if they (a) had not previously tried ECs, (b) smoked at least 15 regular cigarettes per day for the past year, (c) were not currently engaging in a smoking cessation attempt and reported no intention of quitting smoking in the next 30 days, (d) aged 18–55 years, (e) fluent in English, (f) had no history of cardiovascular distress (e.g., heart attack in the past year, arrhythmia, uncontrolled hypertension), (g) were not pregnant, planning to become pregnant, or breast feeding, (h) currently not using noncigarette tobacco (e.g., cigars, chewing tobacco, pipe), and (i) were reportedly absent of any major psychiatric impairment.

Procedure

The overall study design consisted of three phases: baseline, experimentation, and ad libitum use.

Baseline Phase

Participants first visited the lab and completed demographic information, smoking history, and smoking behavior questionnaires. Carbon monoxide (CO) was also measured in participants' exhaled breath using a Micro Smokerlyzer[®] CO monitor (Bedfont Scientific Ltd, 2011) to confirm smoking (≥ 10 ppm). Participants were then scheduled a second visit (experimentation) within the next week and asked to not use any tobacco products 12 hr prior to the visit. Total completion time for the baseline phase was approximately 45 min.

Experimentation Phase

During the experimentation phase, participants' breath CO was measured to ensure compliance with the overnight abstinence criterion (i.e., CO < 10 ppm). Next, participants completed four separate experimentation sessions, each separated by 60 min. Experimentation sessions lasted approximately 75 min each (i.e., 15 min completing measures and experimentation + 60 min of resting). During the four experimentation sessions, participants completed a pre- and postexperimentation questionnaire of product satisfaction, effectiveness and liking, and readiness and confidence to quit smoking and sampled three different popular EC brands for a period of at least 2 min and no longer than 10 min (SmokeTip[®], ProSmoke[®], and BluCig[®]) and their own brand of cigarette (OBC). Brands were presented in a random order to control for any possible effects of order; participants were not blinded to the brand sampled, as participants were also presented with screen shots from each ECs' Web site containing information on components and assembling of the product, refill cartridges, and prices. Participants viewed Web site screen shots of the EC being sampled so to more closely mimic what smokers would see when they purchased ECs. At the time of the study (May 2012–June 2012), both SmokeTip and ProSmoke were primarily sold online; BluCig, however, was sold both online and in stores (i.e., Walgreens and Sheetz). Researchers provided the three ECs, and participant provided their own preferred brand for experimentation. Individuals were matched to EC flavor (menthol or tobacco flavor) and nicotine level (light or full flavor) according to their regular cigarettes. Additionally, level

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of nicotine was reduced from full to light if the participant indicated that the initial cartridge was too strong after the first few puffs. ProSmoke's medium and high cartridges contain 14 and 18 mg of nicotine, respectively; BluCig's full-flavored and light cartridges contain 13–16 mg and 9–12 mg of nicotine, respectively; and SmokeTip's light and full-flavored cartridges contain 12 and 16 mg of nicotine, respectively. White ECs were used to simulate the appearance of a regular cigarette. All three products were similar in appearance.

Ad Libitum Phase

At the end of the experimentation phase, participants were asked if they would like to take home a 1-week supply of the EC brand of their choice to “use as you want.” All participants agreed and were sent home with a starter kit and a 1-week supply of cartridges. Participants were typically provided 5–7 cartridges, since 1 cartridge is equivalent to approximately 1 pack of cigarettes. Researchers instructed participants on how to assemble the product, change cartridges, and recharge the battery. They were informed that a study representative would contact them in seven days to complete a follow-up survey by phone that would last approximately 10 min. This 1-week period is referred to as the ad libitum use phase.

Participants received compensation for their participation (\$30 for baseline phase, \$100 for experimentation phase, no payment for ad libitum phase). No funding or product support was provided by any EC or tobacco company for this study.

Measures

At baseline, participants completed a questionnaire that included the following: (a) demographic information, (b) smoking history and behavior, (c) the Fagerström Test for Nicotine Dependence (FTND; [Heatherton, Kozlowski, Frecker, & Fagerström, 1991](#)), (d) the 15-item Minnesota Nicotine Withdrawal Scale (MNWS; [Hughes & Hatsukami, 1986](#)) to assess for smoking craving and nicotine withdrawal symptoms, and (e) the Contemplation Ladder and the Confidence Ruler, validated measures that assess readiness and confidence to quit smoking and predict intentions to quit smoking and smoking cessation attempts ([Biener & Abrams, 1991](#); [Boudreaux et al., 2012](#); [Carpenter, Hughes, Solomon, & Callas, 2004](#); [Gwaltney, Metrik, Kahler, & Shiffman, 2009](#)). During the experimentation phase and at the 1-week follow-up, participants completed the following measures: (a) MNWS, (b) the Contemplation Ladder, (c) the Confidence Ruler, and (d) an adapted version of the Drug Effects and Liking Scale was used to measure product satisfaction, desire, and liking of study product; positive and negative effects of product; and product effectiveness in reducing urges/craving ([Mendoza-Baumgart et al., 2007](#)). During the experimentation phase, total experimentation time of each

product was measured. At the 1-week follow-up, participants also reported smoking behavior over the last week and number of EC cartridges used.

Analyses

Descriptive statistics were conducted on demographic and smoking history data. Differences in preference between products were analyzed using one-way analysis of variance. Changes in readiness and confidence to quit smoking (pre-experimentation, postexperimentation, and end of ad libitum use) and in smoking behavior and nicotine withdrawal symptoms (baseline to follow-up) were analyzed using generalized estimating equations (GEE; [Zeger & Liang, 1986](#)), with time as the within-subjects factor. All GEE analyses controlled for baseline values and FTND score. Though ECs do not contain tobacco, the intent of the U.S. FDA is to regulate them as tobacco products unless they are marketed for therapeutic purposes. Therefore, “Total tobacco units” per day (EC + OBC) was determined by the following equation, which assumes 20 cigarettes = 1 EC cartridge based on manufacturers usage guidelines [reported average cigarettes per day + ((No. EC cartridges × 20)/7)].

RESULTS

Participant Characteristics

Following 2 weeks of advertisements, 26 smokers contacted our study, of whom 20 met our inclusion criteria, provided consent, and completed baseline measures. Over the three phases of the study (see [Table 1](#) for participant characteristics over the three study phases), one participant never showed to the experimentation phase visit ($n = 19$ completed experimentation), and three were unable to be contacted following the ad libitum phase ($n = 16$ completed ad libitum phase measures). Among the three smokers who did not complete measures following ad libitum use, two had selected BluCigs and one had selected Prosmoke. A Wilcoxon Rank Sum test indicated that there were no significant differences between these three smokers and those who completed follow-up measures in terms of baseline nicotine dependence or in readiness or confidence to quit smoking postexperimentation ($p > .05$).

Among those who entered the baseline period, 65% were women, White/Caucasian (80%), and with mean age of 40.1 years ($SD = 11.6$). Most were employed at least part time (65%) and had at least a high school education (85%). Participants smoked an average of 18.6 cigarettes/day ($SD = 6.0$), were moderately addicted to nicotine

Table 1. Participant Characteristics at Each Study Phase

	Baseline ($n = 20$); M (SD) or % (n)	Experimentation ($n = 19$); M (SD) or % (n)	Ad libitum ($n = 16$); M (SD) or % (n)
Age (years)	40.1 (11.6)	39.6 (11.8)	39.1 (11.9)
% Women	65% (13)	68% (13)	69% (11)
% White/Caucasian	80% (16)	79% (15)	75% (12)
Number of Cigarettes/day (baseline)	18.6 (6.0)	17.9 (5.5)	16.9 (5.3)
Nicotine dependence (baseline)	5.1 (2.0)	5.0 (2.1)	4.8 (1.9)

(FTND = 5.05, *SD* = 2.01), and averaged 2.7 lifetime 24-hr quit attempts (*SD* = 2.3). Participants averaged 22.7 years of smoking (*SD* = 10.6). Forty-five percent lived in a home with at least one additional smoker.

Response to Product During Experimentation and Product Preference

During the experimentation phase, compared with OBCs, participants rated ProSmoke and SmokeTip as significantly less enjoyable ($p < .0001$). No significant differences for liking/enjoyment were seen between OBC and BluCig, but differences were approaching significance ($p = .06$) with BluCig rated as less enjoyable. OBCs were also rated as significantly more satisfying than ProSmoke and SmokeTip; this difference approached significance compared with BluCig ($p = .07$). There were no significant differences between OBCs and ECs in reported effectiveness in reducing smoking urges and cravings ($p = .34$; Table 2).

There were no significant differences found between participant’s ratings of EC products on liking/enjoyment, effectiveness, or satisfaction. However, the difference between BluCig to ProSmoke on product liking/enjoyment approached significance ($p = .08$) with BluCig rated as more enjoyable. Assuming a uniform distribution of 33.3% for each of the three choices under a null hypothesis, at the end of the experimentation phase, a significant majority of participants chose BluCig (63.2%) over the other two EC products, with SmokeTip the least selected product (10.5%; $p < .01$). No significant differences were seen between products and time of use during experimentation (Table 2).

Readiness and Confidence to Quit

Over the experimentation period, participants reported a significant increase in confidence to quit smoking [$\beta = -0.50$ (0.25), $p = .04$; Figure 1a] and in overall readiness to quit smoking [$\beta = -0.23$ (0.10), $p = .03$; Figure 1b]. Though readiness and confidence continued to increase during the ad libitum use phase, these increases did not reach significance for confidence to quit [$\beta = -0.43$ (0.50), $p = .39$] but did for readiness to quit smoking [$\beta = -0.68$ (0.31), $p = .03$]. Over the combined experimentation and ad libitum use phases, participants reported a significant increase in readiness to quit smoking [$\beta = -0.90$ (0.33), $p = .006$; Figure 1b] and reported an increase in confidence to quit smoking that approached significance [$\beta = -0.93$ (0.48), $p = .052$; Figure 1a].

Smoking Behavior and Nicotine Withdrawal

Participants reported a significant reduction (44%) in regular cigarettes smoked per day from baseline to the end of the ad libitum use phase ($p < .0001$; Figure 2). Participants used an average of 3.0 EC cartridges (*SD* = 1.8, range 1–7) over the 7-day ad libitum use phase. Total tobacco units per day (cigarettes + EC) remained relatively unchanged from baseline to the end of the ad libitum period ($p = .67$; Figure 2). No significant changes in nicotine withdrawal symptoms were

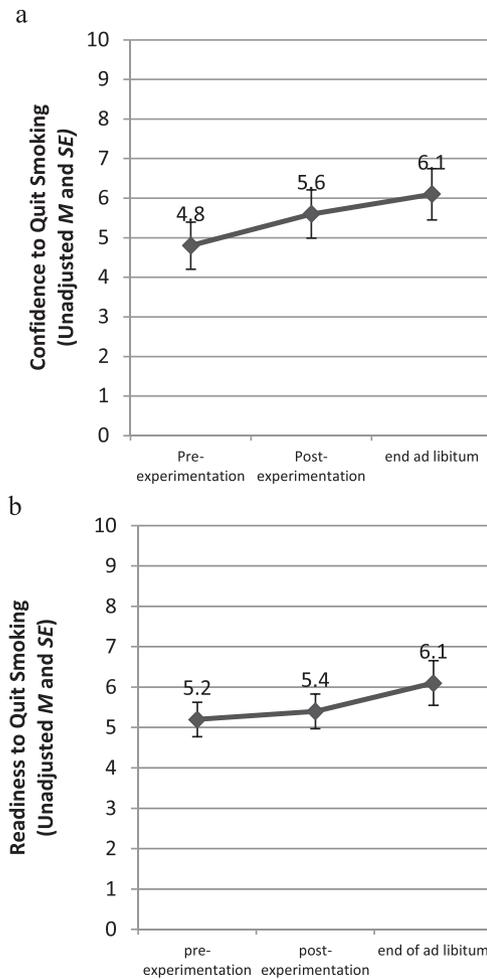


Figure 1. Changes (a) in confidence to quit smoking cigarettes and (b) in readiness to quit smoking cigarettes.

Table 2. Attitudes Toward E-cigarettes, Own Brand of Cigarettes, Brand Preference, and Product Sampling Time

<i>N</i> = 19	Own brand cigarette (OBC); <i>M</i> (<i>SD</i>)	BluCig; <i>M</i> (<i>SD</i>) or % (<i>n</i>)	ProSmoke; <i>M</i> (<i>SD</i>) or % (<i>n</i>)	SmokeTip; <i>M</i> (<i>SD</i>) or %	<i>p</i> Value (analysis of variance)
Ratings of products					
Liked/enjoyed product	8.6 (1.8)	6.6 (2.4)	4.7 (2.5) ^a	5.2 (2.7) ^a	<.0001
Effectively reduced urges/craving	7.3 (3.3)	7.2 (2.1)	6.2 (2.4)	6.1 (2.3)	0.335
How satisfying is this product	8.7 (1.7)	6.6 (2.6)	5.2 (3.0) ^a	5.0 (2.8) ^a	<.0001
Smoking/vaping time (min)	3.9 (1.4)	3.9 (2.0)	4.4 (2.4)	3.9 (2.0)	0.812
Brand preferred/taken (ad libitum use)	NA	63.2% (12)	26.3% (5)	10.5% (2)	<.01

Note. NA = not applicable.

^aIndicates significant product preference differences from OBC ($p < .05$) using Tukey’s post hoc analyses.

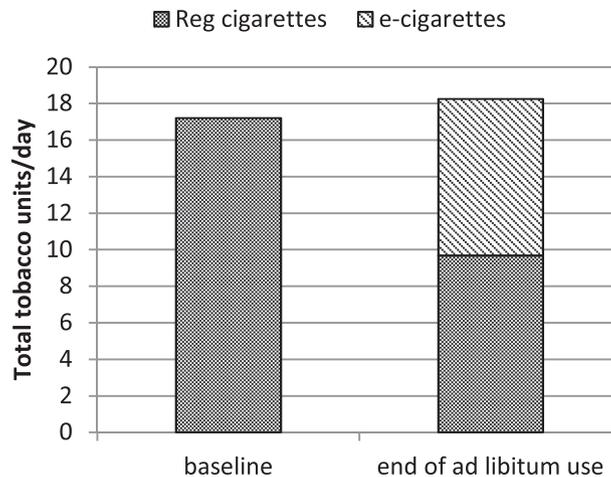


Figure 2. Changes in total tobacco units.

seen comparing reported symptoms at baseline ($M = 11.5$, $SD = 8.6$) to symptoms following ad libitum use ($M = 9.5$, $SD = 8.5$, $p = .22$).

DISCUSSION

This study investigated changes in readiness and confidence to quit smoking and smoking behavior following EC experimentation and 1-week ad libitum use among smokers not interested in quitting. Following initial experimentation and EC Web site viewing, unmotivated smokers reported an increase in both readiness and confidence to quit smoking. Though not reaching significance, reported readiness and confidence continued to increase with ad libitum use, suggesting that these products do not appear to undermine motivation after 1 week of use. On the contrary, experimentation of ECs alone increased smokers' readiness and confidence to quit smoking. Higher levels of readiness and confidence to quit smoking predict smoking cessation (Carpenter et al., 2004; Gwaltney et al., 2009); therefore, these findings suggest that EC experimentation and use by current smokers may potentially induce a smoking cessation attempt and lead to higher rates of regular tobacco cigarette quitting.

Similar to other EC studies, with minimal instruction on how to use the EC during the ad libitum use phase, most smokers made a partial substitution of their regular combustible cigarettes. Regular cigarette smoking decreased by approximately 44% from baseline levels, but overall tobacco units per day remained relatively unchanged. This finding, in addition to no significant increase in smokers reported withdrawal symptoms during substitution, suggests that ECs are effective in managing craving and withdrawal symptoms, which is consistent with previous studies (Vansickel & Eissenberg, 2012; Vansickel, Weaver, & Eissenberg, 2012). More importantly, even though smokers in this study had no intention of quitting smoking in the next 30 days and were not provided any cessation or reduction message, many chose to reduce their regular cigarette smoking. Furthermore, though not directly tested in this study, this finding may also suggest that the message delivered when providing the EC may be important to the overall effect on the total number of tobacco units (EC + regular cigarettes) per

day. Telling smokers to use ECs "as they wish" may lead to no appreciable decline in overall tobacco use, but providing ECs in conjunction with clinical interventions aimed at increasing motivation to quit smoking may provide an even stronger effect on smoking reduction and possibly even cessation.

This study is also one of the first studies to examine product preference between three popular EC brands. Though differences in preference between these three products did not reach significance (likely due to the limited statistical power) in terms of self-reported satisfaction, liking/enjoying, and effectiveness, it was clear that a majority of smokers preferred BluCig as the brand they wished to try for ad libitum use, with SmokeTip as the least selected brand. Unlike SmokeTip, BluCig and ProSmoke use vegetable glycerin instead of propylene glycol as their main excipient. Propylene glycol has been known to cause mouth and throat irritation (Varughese et al., 2005; Wieslander, Norbäck, & Lindgren, 2001). This may potentially be reason for some of the differences seen. Participants' brand preferences were also potentially influenced by previous advertisement exposure; however, EC advertisements proliferated several months following the present study's data collection (Elliott, 2012).

The ongoing cost-benefit equation of the EC continues, with researchers, tobacco control experts, and public health officials attempting to understand the potential benefits and burdens of the EC to the individual smoker and to the overall population. Though the overall population impact of ECs cannot be determined from this study (e.g., potential renormalization of smoking behavior, potential bridge/starter product), the results do suggest more benefit than cost to the individual smoker, with decreased smoking and increased readiness and confidence to quit smoking. Furthermore, while not ideal, smoking reduction appears to have some cardiovascular and pulmonary benefit (Bolliger et al., 2002; Godfredsen, Prescott, & Osler, 2005; Hatsukami et al., 2005). Whether smoking reduction via an EC is also beneficial remains to be seen; however, at least one survey study of current EC users suggest improved lung function and other benefits with smoking cessation/reduction via EC (Ettter & Bullen, 2011).

As a pilot clinical laboratory investigation, this study has several important limitations. First, this was an uncontrolled study that utilized a small convenience sample, and

generalizability to all first time users of ECs is limited. Second, we did not biochemically verify smoking reduction following the ad libitum use period. Though there is no “gold standard” approach to biochemically verify reduction/substitution of smoking with ECs, some previous investigations have used decreases in CO of ≥ 1 ppm as evidence of reduced smoking. Third, the study period was short, and so it is not exactly clear if changes in readiness, confidence, and smoking would have been sustained; however, the study was specifically designed to evaluate initial changes in these outcomes following first time and ad libitum use. Fourth, we only assessed for participants’ interest in quitting cigarette smoking and not all tobacco/nicotine products. Though many of those who support tobacco harm reduction are far less concerned with long-term use of nicotine delivered in “cleaner” fashions (e.g., nicotine replacement therapy, EC, low nitrosamine products), these findings may be considered less promising for some in the tobacco control community if participants only meant to stop smoking but continue use of the EC. Lastly, even though the sample reported not being interested in quitting smoking in the next 30 days, their readiness to quit was slightly higher than expected. Therefore, the current sample may be considered a more motivated group of uninterested smokers, which may not generalize to those who never even think about quitting. In spite of these limitations, this is the first study to directly assess changes in readiness and confidence to quit smoking following initial experimentation and use and to directly test for preference differences between several popular EC brands.

This study suggests that among smokers uninterested in quitting, EC experimentation and 1 week of use can increase readiness and confidence to quit and lead to a reduction in number of regular cigarettes smoked. EC experimentation could potentially serve as a successful cessation induction method for smokers who are uninterested or unable to quit smoking. Large, longer term, and controlled studies will need to be conducted to rule out any consequences of this method of smoking cessation.

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DECLARATION OF INTERESTS

None declared.

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